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"To the solid ground
Of nature trusts the Mind that builds for aye" —WORDSWORTH

G.Sal.
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160

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4080	„	10	–74
4081	„	17	–108
4082	„	24	–148
4083	„	31	–182
4084	February	7	216
4085	„	14	256
4086	„	21	290
4087	„	28	30
4088	March	6	70
4089	„	13	2
4090	„	20	2
4091	„	27	4
4092	April	3	[illegible]
4093	„	10	57
4094	„	17	[illegible]
4095	„	24	56
4096	May	1	[illegible]
4097	„	8	699–7
4098	„	15	741–7
4099	„	22	783–82
4100	„	29	825–86
4101	June	5	865–904
4102	„	12	905–946
4103	„	19	947–988
4104	„	26	989–1028

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160

INDEX

NAME INDEX

ABOLINS, Prof. Leo : Alkaline Phosphatase in various Cell Types of the Anterior Pituitary of the Guinea Pig, 556
Academy, 1948 : The Royal (Dr. A. Tindell Hopwood), 876
Acheson, G. G., and West, Dr. T. F. : Reaction of β-Naphthol with l-α- and l-β-Phellandrene, 976
Ackers, C. P. : Practical British Forestry, second edition, *review* by Prof. E. P. Stebbing, 295
Acta Crystallographica, No. 1, 1005
Adam, Prof. N. K. : Interaction of Water and Porous Materials, 629
Adams, Agatha Boyd (edited by Knight, Prof. Edgar W., and) : University of North Carolina Graduate School Research and Publications, *review*, 705
Addison, Prof. Herbert : Hydraulic Measurements, second edition, *review* by B. C., 79
Addison, Lord : Honorary degree of doctor of laws of the University of Sheffield conferred on, 555
Adolph, E. F., and associates : Physiology of Man in the Desert, *review* by Dr. B. McArdle, 744
Adrian, Prof. E. D. : The Physical Background of Perception, *review* by Dr. O. A. Trowell, 498
Aeronautical Society, Royal :
  Gold Medal awarded to Sir Bennett Melvill Jones, 593
  Silver Medal awarded to I. I. Sikorsky, 593
  Bronze Medal awarded to Miss F. B. Bradfield, 593
  Simms Gold Medal awarded to Sir William T. Griffith, 593
  George Taylor (of Australia) Gold Medal awarded to Dr. J. W. Drinkwater and W. G. Glendinning, 593
  Edward Busk Memorial Prize awarded to Air Marshal the Hon. Sir Ralph Cochrane, 593
  R.38 Memorial Prize awarded to W. M. Widgery, 593
  Branch Prize awarded to A. N. Clifton and J. A. Kirk, 593
  Election of officers for 1948–49, 843
Aeronautical Society, Royal, and others : Symposium on Internal Stresses in Metals and Alloys, 70
African Council, Central : Appointment of Dr. J. E. Keyston as research secretary, 230
African (East) Industrial Research Board : Report for 1946, 122
African (South) Council for Scientific and Industrial Research : Second Annual Report, 903
African (South) Institute for Medical Research : Annual Report for 1946, 162
African (South) Museums Association : Annual General Meeting (J. R. Harding), 984
African (West) Cacao Research Institute (O. J. Voelcker), 117
Agharkar, Prof. S. P. : Scientific Research in India, 513
Agnew, L. R. C. : Weight of the Rat Thymus, 205
Agricultural, Animal Health and Forestry Research, Committee for Colonial: Second Annual Report, 143
Agricultural Parasitology, Institute of : Place taken by a new Nematology Department of the Rothamsted Experimental Station, 1006
Agricultural Research Council : Awards of Postgraduate Scholarships, 16
Agricultural and Horticultural Research Station, Long Ashton : Annual Report for 1946, 862
Agriculture for Scotland, Department of (Ministry of Agriculture and Fisheries and the) : Postgraduate Scholarships in Husbandry, Agricultural Economics, Statistics and Agricultural and Dairy Engineering, 637
Agriculture and Fisheries, Ministry of : Bulletin 22, Practical Soil Sterilization, 196
  Bulletin 65, Crop Production in Frames and Cloches, 196
  Bulletin 138, Irrigation, 196
  Agricultural and Veterinary Scholarships, 430
Agriculture and Fisheries, Ministry of, and the Department of Agriculture for Scotland : Postgraduate Scholarships in Husbandry, Agricultural Economics, Statistics and Agricultural and Dairy Engineering, 637
Ahmad, Dr. Nazir : Scientific Research in India, 513
Ainsworth, Dr. G. C. : Mycological Education, 507
Aircraft Establishment, Royal : New Chemical and Physical Laboratory at the, 212
Air Force, Royal : Opening of a new School of Education, 469
Aitkenhead, P. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
Aiyangar, Rao Bahadur K. V. Rangaswami : Elected a Fellow of the Royal Asiatic Society of Bengal, 553
Akers, Sir William : Tribute to Sir Robert Robinson at the special meeting of the Industrial Research Committee of the Federation of British Industries at the Royal Institution, 509
Al-Hussaini, A. H. : Alkaline Phosphatase in Fish Gut, 274
Albareda-Herrera, Prof. J. M. : Appointed a member of the Pontifical Academy of Science, 922
Albert, Dr. Adrien, and Goldacre, Reginald : Mode of Action of Acridine Antibacterials, 95
Albert, Dr. Adrien, and Marshall, P. B. : Absence of Correlation between Respiratory Inhibition of Plasmodia by Acridines and Antimalarial Action, 1008
Alberts, Hugo W. : Forage Resources of Latin America, 657
Alexander, Dr. F. E. S. : Observations of Unorthodox Radar Vision in the Vicinity of New Zealand and Norfolk Island, 146
Alexander, Prof. N. S. : *Obituary* of Prof. M. C. Potter, 673
Alexander, R., and others : Isolation in Chick Embryos of a Filtrable Agent possibly related etiologically to Lumpy Skin Disease of Cattle, 526
Allen, Dr. Clifford : An Analysis of Volitional Life (C. Lambek), translated from the Danish by Agnete Kortsen, *review*, 789
  Our Inner Conflicts (Dr. Karen Horney), *review*, 830
Allen, Prof. J. : Scale Models in Hydraulic Engineering, *review* by Prof. J. Th. Thijsse, 219
Allen, Dr. L. A. : Biological Aspects of Water Pollution, 875
Allen, Philip : Awarded a Commonwealth Fund Fellowship, 1006
Allen, R., and others : Comparison of Cross-Sections for the Capture of 220 and 900 keV. Neutrons, 727
Allibone, Dr. T. E. : Elected a Fellow of the Royal Society, 466
  Electromics, *review*, 702
  Development of the Spark Discharge, 970
Allied Circle, Amsterdam, and the British Society for International Understanding : Study Conference on the Overseas Territories of Western Europe, 843
Alliot, H. (Noriot, Ch., et) : La lutte contre les termites, *review* by A. D. I., 544
Allsopp, Dr. A. : Chromatographical Study of Meristematic Plant Tissues, 833
Allsopp, C. B., and Catcheside, Dr. D. G. : Chemical Breakage of Chromosomes, 1011
Almada, José de, and others : Colonial Administration by European Powers, 372
Alston, A. H. G. : Information on the Berlin Herbarium, 272
Alty, Prof. Thomas : Appointed deputy principal of the University of Glasgow, 16
Aluminium Development Association : Research Scholarship, 882
Ambache, Dr. N. : Peripheral Action of Botulinum Toxin, 482
American Association for the Advancement of Science : George Westinghouse Science Writing Awards for 1947 presented to George A. Keaney and Steven M. Spencer, 125
  Centenary Meeting, 717
American Chemical Society (Chicago Section) : Willard Gibbs Medal for 1948 awarded to Prof. Carl F. Cori, 388
American Institute of Biological Sciences : Establishment of an, 512
American Public Health Association : Lasker Group Award for 1947 presented to the British Ministries of Food and Health, 16
American Society of Mechanical Engineers, and others : Conference on Mechanical Wear, 758
American Telephone and Telegraph Co. : Frank B. Jewett Fellowship awards for 1948–49, 429
Amoroso, Prof. E. C., and others : Ovarian Activity in the Pregnant Mare, 355
Amos, Dr. A. J. (Kent-Jones, Dr. D. W., and) : Modern Cereal Chemistry, fourth edition, *review* by A. L. Bacharach, 293
Anantaraman, M. : Oribatid Mites and their Economic Importance, 409
Anderson, G. W. : Appointed agricultural officer, Zanzibar, 966
Anderson, Sir John, and others : Atomic Challenge, a Symposium, *review*, 995
Anderson, Dr. J. G. C. : Awarded a Wollaston Fund of the Geological Society, 122
Andrade, Prof. E. N. da C. : *Addendum* to *obituary* of Prof. P. Lenard, 48
  Max Planck, 284
  The Atom and its Energy, *review* by Prof. P. B. Moon, 582
  Max Planck Memorial Ceremony at Göttingen, 751
Andrew, E. R. : Awarded a Commonwealth Fund Fellowship, 1006
Andrew, G., and others : Reversion, a New Procedure in Absorptiometry, 805
Andrewartha, Dr. H. G., and Birch, L. C. : Measurement of 'Environmental Resistance' in the Australian Plague Grasshopper, 447
Andrewes, Dr. C. H. : The Common Cold, 328
Andrews, F. W. : Degree of D.Sc. of the University of London conferred on, 51
Angyal, Dr. S. J., and Rassack, R. C. : The Sommelet Reaction, 723
Animal Health Trust : Fison Lectures (Prof. L. Seekles), 637, 1005
  Award of a research grant to J. Steele, 924
Anscombe, Dr. F. J., and Singh, Dr. B. N. : Limitation of Bacteria by Micro-Predators in Soil, 140
Anthony, Lieut.-Colonel H. D. : A Descendant of Benjamin Franklin, *review*, 909
Anthropological Institute, Royal : Huxley Memorial Lecture for 1947 (Dr. W. L. H. Duckworth), 628
Appleton, Sir Edward : Science and the Progress of Industry, 368
  Special meeting of the Industrial Research Committee of the Federation of British Industries at the Royal Institution in honour of, 508
  The Scientist in Industry, 508, 537
  Scientific Radio, 794
  Appointed a member of the Pontifical Academy of Science, 922
Appleton, Sir Edward, and others : Anomalous Effect in Ionospheric Absorption, 967
Applied Biologists, Association of : Symposium on Biological Aspects of Water Pollution, 874
Applied Mathematics, Communications on (New Journal issued by the Institute for Mathematics and Mechanics of New York University), 636
Arber, Dr. Agnes : Awarded the Gold Medal for 1948 by the Linnean Society of London, 272, 882
Archæological Survey of the Union of South Africa ; Report for 1946–47, 881

NAME INDEX

Archæology in Ankara, British Institute of : Inauguration of the, 270
Aristotelian Society: Supplementary Vol. 21, Explanation in History and Philosophy, *review* by F. I. G. Rawlins, 665
Arley, Dr. Niels : Blackett's Hypothesis of the Magnetic Field of Rotating Bodies, 598
Armattoe, Dr. R. E. G. : Given a Viking Fund award to undertake a field trip to West Africa, 125
Armellini, Prof. G. : I fondamenti scientifici della astronomia, *review* by H. S. J., 419
Armitage, Dr. F. D. : Mycological Education, 507
Army Council : Appointment of Prof. F. J. M. Stratton as deputy scientific adviser, 388
Armytage, W. H. G. : Lyon Playfair and Technical Education in Britain, 752
Arnold, Prof. Chester A. : An Introduction to Palæobotany, *review* by Prof. John Walton, 623
Arnon, Dr. D. I. : Trace Elements in Plant Physiology, 364, 365
Arrol, Dr. W. J. : Determination of Radioactive and Stable Tracer Isotopes, 694
Arrol, Dr. W. J., and Glascock, Raymond : Microsynthesis of C^{14}-Labelled Ethyl Iodide, 932
Ash, G. M. : The Study of Critical British Groups, 735
Asiatic Society of Bengal, Royal : Medal Awards, 553
    Election of members of Council for 1948, 553
    Election of Fellows, 553
ASLIB : Study Group on Special Librarianship, 430
    Meeting to discuss the formation of a proposed Institute of Recorded Sound, 493
ASLIB (Northern Branch) : Conference, 430
Astbury, N. F. : Structure and Properties of Metals, 264
Astbury, Prof. W. T. : The Structure of Biological Tissues as revealed by X-Ray Diffraction Analysis and Electron Microscopy, 514
Astbury, Prof. W. T., and others : Ultracentrifugation and Electron Microscope Studies of Tissues of Inbred Strains of Mice, 759
Astronomical Society, Royal : Geophysical Discussion on the Main Geomagnetic Field, 462
    Publication of papers for the Geophysical Supplement of the *Monthly Notices*, 924
Astrup, Dr. Tage, and Permin, Per M. : Fibrinokinase and Fibrinolytic Enzymes. 689
Aten, jun., A. H. W. : Reported Radioactivity of Osmium, 1019
Athenæum, The : Elections upon Rule II, 125
Atkin, J. B. : Incidents and Reflections, 866
Atkins, K. R. : Transfer Rates in Liquid Helium Films, 925
Atomic Energy Commission : To provide funds for Fellowships, 593
Atomic Scientists' Association (London Branch) : Lectures on Atomic Energy, 164
Audus, Dr. L. J. : Appointed to the Hildred Carlile chair of botany at Bedford College, London, 347, 427 ; work of, 427
Auerbach, Dr. Charlotte : Awarded the Keith Prize for 1945–47 of the Royal Society of Edinburgh, 716
Auger, Prof. Emile : Appointed head of the Natural Sciences Section of U.N.E.S.C.O., 304
Aughtie, —. : Calculating Machines, 713
Austin, Prof. G. Wesley : Cementiferous Paints and their Uses, 569
Australasian Antarctic Expedition, 1911–14 : Scientific Reports, Series B, Vol. 7, Meteorology (Dr. Edward Kidson), 709
Australia, Commonwealth of : Twentieth Annual Report of the Council for Scientific and Industrial Research, 999
Australia (Commonwealth of), National Geographic Society and the Smithsonian Institution : Scientific Expedition to Arnhem Land, 195
Australia and New Zealand Association for the Advancement of Science : Report of the Twenty-fifth Meeting, 881
Australian Scientific Research Liaison Office : Appointment of J. E. Cummins as chief scientific liaison officer in London, 1007
Austrian Chemists, Association of (Steirmark Branch) : To arrange an International Conference on Powder Metallurgy, 307
Avimo, Ltd. : Simultaneous Recording of Related Oscillograph Traces, 89
Awolowo, Obafemi : Path to Nigerian Freedom, 332
Ayliffe, R. S. : Appointed assistant conservator of forests, Trinidad, 51
d'Azyr, Félix Vicq (1748–94), 634

BABCOCK, Ernest Brown : The Genus Crepis, *review* by Prof. I. Manton, 455
Bacharach, A. L. : Controlling the Staff of Life, *review*, 293
    Appointed a member of the Chemical Research Board, 924
Bache (Alexander Dallas), Scientist and Educator, 1806–1867 (Merle M. Odgers), *review* by Lieut.-Colonel H. D. Anthony, 909
Bacon, Dr. J. S. D. : Appointed lecturer in biochemistry in the University of Sheffield, 307
Badcock, W. J. : Appointed chief soil conservation officer, Nyasaland, 966
Baddiley, Dr. J. : Awarded the Meldola Medal for 1947 of the Society of Maccabæans, 715 ; work of, 715
Baddiley, Dr. J., and others : Synthesis of Adenosine Triphosphate, 761
Baden-Powell, D. F. W. : Long-Distance Correlation of Boulder Clays, 287
Badger, Dr. G. M., and Reed, Dr. R. I. : Relative Reactivity of Aromatic Double Bonds, 238
Bailey, Dr. A. S., and Robinson, Sir Robert : Relation of Vomicine to Strychnine and Brucine, 433
Bailey, Sir Edward : Awarded the Wollaston Medal of the Geological Society, 122
    Geology of the Salt Range of the Punjab, 265
    Obituary of Dr. A. L. Du Toit, 426
Bailey, Dr. G. H., and Bausor, H. W. : Chemistry for Matriculation, fourth edition, *review* by Dr. S. H. Harper, 992
Bailey, Dr. L. H. : Ninetieth Birthday of, 964 ; work of, 965
Bailey, Prof. V. A. : Spontaneous Waves in Discharge Tubes and in the Solar Atmosphere, 599
Baker, H. Albert, and others (edited by) : Annual Review of Microbiology, *review* by Sir Paul Fildes, 995
Baker, Dr. H. G. : Relationships in the Plumbaginaceæ, 400
    Significance of Pollen Dimorphism in Late-Glacial *Armeria*, 770
    Bottom Deposits of Lake Windermere in relation to the Quaternary History of the British Isles, 987
Baker, Dr. John R. : The Status of the Protozoa, 548, 587
Baker, Dr. John R. (Thomson, Sir George, and) : Proposed Central Publication of Scientific Papers, 771
Baker, Dr. John W. : Olefine Reactions Catalysed by Lewis Acids, 171
    Appointed to the readership in the mechanism of organic reactions in the University of Leeds, 471
Bald, J. G., and others : Plant Virus Diseases, 945
Balfour of Inchrye, Lord : Importation of Books into Britain, 304
Bálint, Dr. Peter, and Kabdebó, Dr. Helene : Premortal Increase in the Output of Sodium and Chlorine in Fasting Rats, 57
Ball, Eric G. : What is a Dialysate? 404
Ball, S., and others : Chemistry of Visual Processes, 424
Ballard, B. G. : Appointed director of the Radio and Electrical Engineering Division of the National Research Council of Canada, 513
Baly, Prof. E. C. C. : *Death* of, 48 ; *obituary* by Prof. R. A. Morton, 120
Bamber, T. F. : Appointed assistant lecturer in the Department of Mining in the University of Sheffield, 16
Bannon, J., and Curnow, C. E. : Structure of Calcium Fluoride Films Evaporated on Polished Glass Surfaces, 136
Barakat, Mohamed Zaki (Schönberg, Prof. Alexander, and) : Stereochemistry of Trimeric Thioaldehydes, 722
Baral, S. S., and others : Abnormalities in the *F*-Region of the Ionosphere at Calcutta, 24
Barber, D. R. : Chronometric Observations of the Song of *Fringilla coelebs* Linn., 277
Barber, Mary : Appointed to the University of London readership in bacteriology at St. Thomas's Hospital Medical School, 637
Barber, N., and Longuet-Higgins, M. S. : Water Movements and Earth Currents—Electrical and Magnetic Effects, 192
Barber, N. F. : Bridge Networks discriminating between Positive and Negative Sequences in Polyphase Supply, 685
Barclay, Dr. Alfred E., and others : Studies of the Renal Circulation, *review*, 663
Barcroft, Sir Joseph : Biography of, 164
Bardsley, W. (Tolansky, Prof. S., and) : Application of Multiple-Beam Interferometry to the Study of Oscillating Quartz Crystals, 925
Barer, Dr. Robert (Jones, W. M., and) : Electron Microscopy of the Sarcolemma, 1012
Barker, F. C. : Scattering of 100-MeV. Neutrons by Protons, 726
Barker, K., and others : New Formulation of D.D.T. with Selective Properties, 484
Barker, S. A., and others : Enzymic Conversion of Amylose into Amylopectin, 127
Barlow, Dr. R. B., and Ing, Dr. H. R. : Curare-like Action of Polymethylene *bis*-Quaternary Ammonium Salts, 718
Barnes, Dr. B. : *Obituary* of Prof. P. A. C. Dangeard, 878
Barnes, Prof. R. H. : Physiology and Biochemistry of Fats and Lipoids, 534, 535
Barnóthy, Prof. J. : Mesons of Different Masses, 681
Barrell, H. : Promoted to the grade of Senior Principal Scientific Officer, 195
Bartlett, John W., and others : The Artificial Insemination of Farm Animals, edited by Enos J. Perry, *review* by Dr. Arthur Walton, 831
Bartlett, Prof. M. S. : Smoothing Periodograms from Time-Series with Continuous Spectra, 686
Barton, Dr. D. H. R. : Awarded the Harrison Memorial Prize for 1947, 270
Barua, Dr. B. M. : Awarded the Dr. Bimala Churn Law Gold Medal of the Royal Asiatic Society of Bengal, 553
    Elected a Fellow of the Royal Asiatic Society of Bengal, 553
Bate-Smith, E. C. : Paper Chromatography of Anthocyanins and related Substances in Petal Extracts, 835
Bateman, N. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
Bates, Prof. L. F. : Elementary Theory of Electricity and Magnetism, *review*, 829
    Modern Magnetism, second edition, *review* by E. C. S., 871
    Introduction to Modern Physics (F. K. Richtmyer and E. H. Kennard), fourth edition, *review*, 912
Bates, Dr. W. J., and Occhialini, Dr. G. P. S.: Applications of the Reflecting Microscope to the Nuclear Plates Technique, 473
Baud, Dr. C. A. : A Cytochemical Study of the Perinuclear Lipidic Layer in the Liver Cell, 559
Bauer, Dr. D. J. : Association of Xanthine Oxidase with Virus Multiplication, 852
Bausor, H. W. (Bailey, Dr. G. H., and) : Chemistry for Matriculation, fourth edition, *review* by Dr. S. H. Harper, 992
Bavink, Prof. B. : *Obituary*, 122
Bawden, Dr. F. C. : Physiology of Resistance to Disease in Plants, 422
    Report on the Department of Plant Pathology, Rothamsted Experimental Station, for the Years 1939–45, 676
Bawden, Dr. F. C., and Kassanis, B. : Plant Virus Diseases, 945
Bawden, Dr. F. C., and Roberts, F. M. : Plant Virus Diseases, 945
Bawn, Dr. C. E. H. : Appointed to the Grant-Brunner chair of physical and inorganic chemistry at the University of Liverpool, 715 ; work of, 715
Baxter, E. G., and Gold, Dr. V. : A Simple Moving-Boundary Apparatus, 403
Bay, Z., and Papp, G. : Coincidence Device of 10^{-8}—10^{-9} Sec. Resolving Power, 59
Bayliff, R. W., and others : Meteor Whistles, 478
B.C.U.R.A. Quarterly Gazette, No. 1, 841
Beacham, T. E. : Awarded a moiety of the Clayton Prize for 1947 of the Institution of Mechanical Engineers, 470
Beadnell, C. M. : Nature's Own Zoo, *review* by Seton Gordon, 744
Beals, Ralph L. : Cherán, a Sierra Tarascan Village, 697
Bean, H. S. (Berry, Prof. H., and) : Bactericidal Activity of Phenols in Aqueous Solutions of Soap, 396
Beard, Dr. J. S. : The Natural Vegetation of Trinidad, 31
Beatty, Dr. R. T. : Radio Data Charts, revised by J. McG. Sowerby, fourth edition, *review* by B. G. P., 871
Beaufort, Dr. Lieven Ferdinand de : Awarded the Joy Gobind Law Memorial Medal of the Royal Asiatic Society of Bengal, 553
Beaumont, A. : Potato Blight and the Weather in Britain, 429
Beaven, Dr. E. S. : Barley ; Fifty Years Observation and Experiment, *review* by Sir John Russell, 828
Becker, Prof. Ludwig : *Obituary* by Prof. W. M. Smart, 161

NAME INDEX

Becquerel, Prof. Jean : Discovery of Radioactivity, 609
Bedford, Dr. T. : Human Factors in Industry, 791
Bedford College, London : Appointment of Dr. L. J. Audus to the Hildred Carlile chair of botany, 347, 427
  Appointment of Gordon Manley to the University of London chair of geography, 430, 511
  Title of professor of social studies in the University of London conferred on Mrs. Barbara Wootton, 924
Beeby, Dr. Clarence E. : Appointed assistant director-general of U.N.E.S.C.O., 304
Beer, Prof. G. R. de : Re-elected president of the Ray Society, 555
  Elected president of the Linnean Society for 1948–49, 882
  Orientation of Birds on Migratory and Homing Flights, 996
Beer, Dr. R. J. S., and others : The Melanin Problem—a Synthesis of 5 : 6-Dihydroxyindole, 525
Beesley, A. E., and Foster, Dr. G. E. : Effect of Colchicine Treatment on the Alkaloidal Content of *Datura metel*, 561
Beevers, Dr. C. A. : Demonstration of the Heart Beat, 65, 321
Begg, Dr. Michael, and Robertson, Dr. Forbes W. : Nutritional Requirements of *Drosophila melanogaster*, 769
Beharrell, Sir George : Presented by the Netherlands Ambassador with the Insignia of Commander in the Order of Orange-Nassau (Civilian Division), 307
Behnke, Jane (Thimann, Kenneth V., and) : The Use of Auxins in the Rooting of Woody Cuttings, *review* by Prof. M. Thomas, 993
Beilby Memorial Fund : Awards for 1947 to Dr. G. V. Raynor and Dr. G. R. Rigby, 231
Bell, Dr. A. E. : Theory of Skating, 391
Bell, Dr. G. D. H. : Appointed director of the Plant Breeding Institute, Cambridge, 714 ; work of, 714
Bell, R. P. : *Obituary* of Prof. J. N. Brønsted, 269
Bellamy, Dr. L. J., and Watt, C. H. : Factors Involved in the Deactivation of Penicillin Solutions by Rubber Tubing, 940
Bendz, W. I., with the assistance of Scarlott, C. A. : Electronics for Industry, *review* by Prof. J. Hollingworth, 582
Bené, Frank : The Food of Humming-Birds, 881
Benedict, Ruth : The Chrysanthemum and the Sword, *review* by Peter Lawrence, 77
Benham, W. E. : Electronic Waves and Thibaud's 'Particles', 93
Bennet-Clark, Prof. T. A. : Interaction of Water and Porous Materials, 630
Bennett, Dr. G. M. : Stereochemistry of Trimeric Thioaldehydes, 723
Bennett, Dr. Wendell C. : The Ethnogeographic Board, 304
Benson, Robert B. : *Obituary* of Prof. Theodore D. A. Cockerell, 229
Bentley, H. R., and others : Action of Nitrogen Trichloride on Proteins—Production of Toxic Derivative, 126
Bentor, V., and others : Active Penetration of Fat into Adipose Tissue, 482
Bergel, Franz : Degree of D.Sc. of the University of London conferred on, 637
Bergmann, Dr. E. : A Synthesis of Fluoranthene Derivatives, 889
Bergström, Prof. Sune, and Holman, Ralph T. : Total Conjugation of Linoleic Acid in Oxidation with Lipoxidase, 55
Berlin Herbarium : Information on the (A. H. G. Alston), 272
Berliner, Victor, and others : The Artificial Insemination of Farm Animals, edited by Enos J. Perry, *review* by Dr. Arthur Walton, 831
Bernal, Prof. J. D. : Science in Social Affairs, 68
  Proposed Central Publication of Scientific Papers, 799
  World Co-operation in Science, 840
Bernhard, Prof. K. : Physiology and Biochemistry of Fats and Lipoids, 534, 535
Bernische Naturforschende Gesellschaft : Commemorative Meeting to mark the Jubilee of the Discovery of the Electron, 16
Berridge, Dr. Emily : *Obituary* by Dr. E. M. Blackwell, 87
Berriman, R. W. : Electron Tracks in Photographic Emulsions, 432
Berry, Prof. H., and Bean, H. S. : Bactericidal Activity of Phenols in Aqueous Solutions of Soap, 396
Bessis, Dr. Marcel C. : Awarded a grant from the Lady Tata Memorial Fund, 966
Best, A. C. : A Standard Radio Atmosphere for Microwave Propagation, 146
Besterman, Theodore (edited by) : British Sources of Reference and Information, *review* by R. Brightman, 789
Bethe, Prof. Hans Albrecht : Awarded the Henry Draper Medal for 1947 of the U.S. National Academy of Sciences, 861
Beynon, Dr. W. J. G. : Scientific Radio, 794
Beynon, Dr. W. J. G., and others : Anomalous Effect of Ionospheric Absorption, 967
Bezer, Henry James, and Schnurmann, Dr. Robert : Rate of Wear in the Region of the Validity of Amontons' Law, 728
Bhabha, Dr. H. J., and Daniel, R. R. : Meson Scattering with Nuclear Excitation, 883
Bhagavantam, Prof. S., and Rao, B. Ramachandra : Diffraction of Light by Very High Frequency Ultrasonic Waves, 927
Bhagavantam, Prof. S., and Rao, D. A. A. S. Narayana : Dielectric Constant of Diamond, 729
Bhandarkar, Prof. D. R. : Elected a honorary Fellow of the Royal Asiatic Society of Bengal, 553
Bhatnagar, Dr. S. S., and others : A New Sulpha Compound ('6257') and its Use in Human Cholera Infection, 395
Bibliography of Natural History, Society for the : Election of Officers, 1006
Bichel, Dr. Jörgen : Effect of *p*-Aminobenzoic Acid on the Leucocyte Count in Leukæmia, 353
  Awarded a grant from the Lady Tata Memorial Fund, 966
Bickley, Prof. W. G. : 'Semaphore' Numerals, 807
  A Technique for Mechanical Vibration Problems, *review*, 954
Biguenet, Charles : Les cathodes chaudes, *review* by D. A. Wright, 500
Bilham, E. G. : "Here is the Weather Forecast", *review* by M. K. Miles, 540
Binks, W. : Promoted to the grade of Senior Principal Scientific Officer, 195
Biochemical Society : Symposium on Biochemical Reactions of Chemical Warfare Agents, 225
Biological Sciences, International Union of : Symposium on Trace Elements in Plant Physiology, 364
Biometric Society : Formation of a British Region, 271
Birch, L. C. (Andrewartha, Dr. H. G., and) : Measurement of 'Environmental Resistance' in the Australian Plague Grasshopper, 447
Birkbeck College, London : Appointment of Prof. A. C. Offord to the University of London chair of mathematics, 637, 757
  Retirement of Prof. P. Dienes from the University of London chair of mathematics, 756
Birks, John B. : Appointed a lecturer in natural philosophy in the University of Glasgow, 16
Bishop, D. J. : Operational Research in the Research Associations, 585
Bishop, G. R., and others : Comparison of Cross-sections for the Capture of 220 and 900 keV. Neutrons, 727
Bishop, P. O. (Harris, Dr. E. J., and) : Low-Frequency Noise from Thermionic Valves working Under Amplifying Conditions, 971
Bishopp, D. W. : The Main Geomagnetic Field, 464
Bittner, John J., and others : Nutrition in relation to Cancer, 106
Black, Dr. E. B. : Nitrogenous Constituents of the Potato, 211
Black, Dr. W. A. P. : Seasonal Variation in Chemical Constitution of some Common British Laminariales, 174
Blackburn, Dr. Julian : National Intelligence, *review*, 37
  The Framework of Human Behaviour, *review*, 502
  Local Government Reform, 825
Blackburn, Dr. K. B. : Chromosomes and Classification in the Genus *Rosa*, 734
Blackett, Prof. P. M. S. : The Main Geomagnetic Field, 464
Blackett, Prof. P. M. S., and others : Atomic Challenge, a Symposium, *review*, 995
Blackith, R. E. : Primary and Secondary Responses in Biological Assay, 20
Blacklock, Prof. J. W. S. : Appointed to the University of London chair of pathology at St. Bartholomew's Hospital Medical College, 924
Blackwell, Dr. D. E., and others : Lead Telluride Cells for Infra-Red Spectroscopy, 281
Blackwell, Dr. E. M. : *Obituary* of Dr. Emily Berridge, 87
Blair, Dr. G. W. Scott : The Flow of Glaciers, 821
Blanshard, Paul : Democracy and Empire in the Caribbean, 948
Bleaney, Dr. B. : Radio Physics, 795
Bleaney, Dr. B., and Loubser, J. H. N. : Collision Broadening of the Ammonia Inversion Spectrum at High Pressures, 522
Blewett, M., and Coles, M. (Fraenkel, Dr. G., with the assistance of) : B_T, a New Vitamin of the B-Group and its relation to the Folic Acid Group, and other Anti-Anæmia Factors, 981
Bliss, Henry Evelyn : A Bibliographic Classification, Vol. 2, Classes H—K, the Human Sciences, *review* by R. B., 705
Bloomfield, Dr. G. F. : Cross-Linking in Polymeric Systems, 298
Blundell's School : Second Number (1937) of the *Magazine* of the School Science Society, 271
Boas, Dr. W. (Honeycombe, R. W. K., and) : The Disordering of β-Brass by Cold Work, 612
Bobtelsky, Dr. M. (Jordan, J., and) : *p*H of Trisodium Citrate Solutions stored under Customary Laboratory Conditions, 240
Bøggild, Dr. J. K. : Cloud Chamber Investigation of Straggling of Short-Range Particles produced by Slow Neutron Reactions, 810
Boivin, André : Elected a *correspondant* for the Section of Rural Economy of the Paris Academy of Sciences, 272
Bolton, Dr. Charles : *Obituary* by Prof. H. P. Himsworth, 86
Bolton, J. G., and Stanley, G. J. : Variable Source of Radio Frequency Radiation in the Constellation of Cygnus, 312
Bond, C. R. : The Assaying of Penicillin, 286
Booker, Dr. H. G. : Scientific Radio, 794
Boon, Dr. W. R. : The Assaying of Penicillin, 286
Boot, Shoe and Allied Trades Research Association, British : First Annual Report, 880
Booth, Andrew D. : A New Fourier Refinement Technique, 765
Booth, F. : Theory of Electrokinetic Effects, 83
Booth, J. D. : Calculating Machines, 713
Booth, Dr. R. G., and others : Action of Nitrogen Trichloride on Proteins—Production of Toxic Derivative, 126
Boothby, O. L., and Bozorth, R. M. : 'Supermalloy', a New Magnetic Alloy, 554
Boothroyd, A. R., and others: An Electrolytic Tank for Exploring Potential Field Distributions, 845
Bor, Dr. N. L. : Appointed assistant director of the Royal Botanic Gardens, Kew, 840 ; work of, 840
Borger, R. (Cowling, Prof. T. G., and) : Electrical Conductivity of the Ionospheric *D*-Layer, 515
Born, Prof. Max, and Cheng, Kai Chia : Theory of Superconductivity, 968, 1017
Born, Dr. Wolfgang : Embryology of Monsters, 88
Boschma, Prof. H. : *Elminius modestus* in the Netherlands, 403
Bose, Prof. S. R. : Awarded the Paul Johannes Bruhl Memorial Medal of the Royal Asiatic Society of Bengal, 553
Bosley, W., and others : X-Radiation from a 20-MeV. Betatron, 1022
Bosworth, Dr. R. C. L. : Thermal Mutual Inductance, 166
Botanic Garden, Calcutta (Royal) : Early History of the (Dr. D. Chatterjee), 362
Botanic Gardens, Kew (Royal) : Collection of Bog-mosses (*Sphagnum*) presented by W. R. Sherrin, 716
  Retirement of Dr. John Hutchinson, 799
  Appointment of Dr. N. L. Bor as assistant director, 840
Botanical Society of the British Isles : Conference on the Study of Critical British Groups, 514, 733
Bourne, Dr. E. J., and others : Enzymic Conversion of Amylose into Amylopectin, 127
  Starches of the Wrinkled and the Smooth Pea, 206
  Photochemical Degradation of Starch, 762
Bourne, Dr. Geoffrey H. : Alkaline Phosphatase in Taste Buds and Nasal Mucosa, 445
Bourne, L. E. A. : The Electronic Organ, 196
Boursnell, Dr. J. C. : Reaction of Mustard Gas with Proteins, 225
Bouwers, A. : Achievements in Optics, *review* by S. Weintroub, 704
Bowden, Dr. F. P. : Elected a Fellow of the Royal Society, 466
Bowden, Dr. F. P., and Gurton, O. A. : Birth and Growth of the Explosion in Solids initiated by Impact, 348
Bower, Prof. F. O. : Botany of the Living Plant, fourth edition, *review* by Prof. F. T. Brooks, 153
  Death of, 592 ; *obituaries* by Prof. J. Walton, Sir Edward Salisbury, and L. J. F. Brimble, 753

NAME INDEX

Boyd, R. L. F. : Reproduction of Photographically Recorded Oscillograph Signals, 227
Boyland, Dr. E. : Nutrition and Cancer, 106
  Biochemical Reactions of Chemical Warfare Agents, 225
  Nitrogen Mustards, 226
  Appointed to the University of London chair of biochemistry at the Royal Cancer Hospital (Free), 347
  Induction of Tumours by Chemical Compounds, *review*, 621
Bozorth, R. M. (Boothby, O. L., and) : 'Supermalloy', a New Magnetic Alloy, 554
Brabazon of Tara, Lord : Elected president of the Royal Institution, 347, 717
Bracewell, R. N. : Scientific Radio, 794
Bradfield, Miss F. M. : Awarded the Bronze Medal of the Royal Aeronautical Society, 593
Bradfield, J. R. G. : Awarded a Commonwealth Fund Fellowship, 1006
Bradford Technical College : Appointment of Dr. E. W. Fell as senior assistant in metallurgy, 272
Bradley, Dr. A. J. : Structure and Physical Properties of Metals, 263
Bradley, H. : Operational Research in the Research Associations, 585
Bradley, Dr. W. : Appointed professor of colour chemistry and dyeing in the University of Leeds, 16
Bradwell, D. : Appointed analyst, Medical Department, Cyprus, 637
Bragg, Sir Lawrence : Internal Stresses in Metals and Alloys, 70
  Organisation and Work of the Cavendish Laboratory, 627
Bragg, S. L. : Awarded a Commonwealth Fund Fellowship, 1006
Brahmachari, H. D. (Nath, Prof. M. C., and) : Relation of Intermediary Metabolites to the Lowering of the Potency of Pancreatic Insulin in the Animal System, 18
Brambell, Prof. F. W. Rogers : The Field Study and Conservation of the British Fauna, 408
Brandt, C. W., and Ross, D. J. : Podocarpic Acid as a Source of an Œstrogenic Hormone, 892
Braude, Dr. Ernest A., and Stern, E. S. : Solvation of Hydrogen Ion in Oxygen-containing Solvents, 169
Braude, Dr. R. : Stimulation of Growth in Pigs by Iodinated Casein and Stilbœstrol, 856
Brech, E. F. L. : Research on Management, *review*, 869
Brehm, Dr. Warren J. : Awarded a Frank B. Jewett Fellowship for 1948–49 by the American Telephone and Telegraph Co., 429
Bremner, J. W. (Poole, Dr. J. H. J., and) : Investigation of the Radioactivity of Rocks by the Photographic Method, 884
Breuil, Abbé Henri : Awarded the Prestwich Medal of the Geological Society, 122
Brewer, Griffith : *Death* of, 387 ; *obituary* by M. J. B. Davy, 510
Brewin, E. G., and others : Pressor Effect of Renin on Pulmonary Artery Pressure, 893
Brian, M. V., and Brian, A. D. : Regulation of Oviposition in Social Hymenoptera, 854
Brier, G. W. : Northern Hemisphere Surface Pressure and Climatic Fluctuations and Vegetation Growth in Northern Finland, 730
Brightman, R. : X-Ray the City ! (Dr. Ernest Fooks), *review*, 297
  Men of Science in Industry and Society, *review*, 374
  Industrial Research, 1947 (edited by Dr. Percy Dunsheath), *review*, 705
  Science Advances (J. B. S. Haldane), *review*, 747
  British Sources of Reference and Information (edited by Theodore Besterman), *review*, 789
Brimble, L. J. F. : *Obituary* of Prof. F. O. Bower, 754
Brindley, Dr. G. W., and Méring, J. : Theory of the Structure of Clay Minerals—Banded X-Ray Reflexions from Clay Minerals, 774
Brink, N. G., and others : Anti-Pernicious Anæmia Factor, 676
Bristowe, Dr. W. S. : A Book of Spiders, *review* by T. H. S., 706
British Architects, Royal Institute of (Acoustics Group of the Physical Society and the) : International Symposium on Noise, 197
British Association for the Advancement of Science : Installation of Sir Henry Tizard as president, 88
  Officers for 1948, 88
  Programme of the Brighton Meeting, 675
British Association for the Advancement of Science (Division for Social and International Relations of Science) : Conference on Human Factors in Industry, 514, 791
British Association of Chemists : Education in Chemistry, the Teaching of Chemistry in Schools and the Training of Chemists and Chemical Technicians for Industry, 31
British Association for Commercial and Industrial Education : The Short Road to Industrial Co-operation, 571
British Boot, Shoe and Allied Trades Research Association : First Annual Report, 880
British Bryological Society : Annual General Meeting, 802
British Coal Utilization Research Association : Publication of a *Quarterly Gazette*, 841
British Commonwealth of Nations : Opening of Scientific Liaison Offices, 923
British Council : Conference Grants to foreign men of science, 164
  Scholarships for 1948–49 at Foreign Universities, 347
  Appointment of E. Bolton King as director of the Science Department, 674
  Annual Report for the Year ended March 1947, 944
British Drug Houses, Ltd. : Appointment of Dr. V. Petrow as chief research chemist, 555
British Electrical and Allied Industries Research Association : Establishment of a new Section on Power Generation, 162
  Twenty-seventh Annual Report, 492
British Empire Cancer Campaign (Genetical Society of Great Britain and the) : Symposium on the Genetics of Cancer, 843
British Glaciological Society, and others : Discussion on the Flow of Glaciers, 819
British Hat and Allied Feltmakers' Research Association : Grant of £1,000 for research in the Textile Industries Department of the University of Leeds, 1006
British Hydromechanics Research Association : Formation of the, 230
British Industries, Federation of : Special meeting of the Industrial Research Committee at the Royal Institution in honour of Sir Robert Robinson and Sir Edward Appleton, 508
British Industries, Federation of (Industrial Research Committee) and the Industrial Association of Wales and Monmouthshire : Joint regional conference on Industry and Research in Wales, 233
British Institute of Archæology in Ankara : Inauguration of the, 270
British Institute of Management : Presidential Address (Sir Charles Renold), 675
British Institute of Radiology: Silvanus Thompson Memorial Lecture (Prof. W. T. Astbury), 514
British Iron and Steel Research Association : To erect accommodation in Sheffield, 307
  Retirement of R. H. Myers as head of the Steelmaking Division, 595
  Appointment of Dr. A. H. Leckie as head of the Steelmaking Division, 595
British Journal of Surgery : War Surgery Supplement No. 1, Wounds of the Head, 635
British Medical Association : First Annual Scientific meeting since the War, 842
British Museum (Natural History) : Appointment of David Dilwyn John and Dr. Francis Charles Fraser as deputy keepers in the Department of Zoology, 270
  Exhibits illustrating the Succession of Life through Geological Time, 429
  Reopening of the Coral Gallery, 758
  Exhibition of Viruses and Virus Diseases, 966
British Mycological Society : Discussion on Mycological Education, 507
British National Committee for Crystallography, 390
British National Committee for Scientific Radio (Radio Section of the Institution of Electrical Engineers and the) : Convention on Scientific Radio, 233
British Oxygen Co., Ltd. : Offer to the British Welding Research Association to provide a prize fund, 17
British Rheologists' Club : Papers on War-time Rheological Investigations for the British Armed Services, 252
British Rheologists' Club, and others : Conference on Rheological Properties of Textile Materials, 307, 737
  Discussion on the Flow of Glaciers, 819
British Rubber Development Board : Publication of No. 1 of *Rubber Developments*, 89
British Science Writers, Association of : Open to accept Associate Members, 272
  Forum Discussion on Science and the Press, 882
British Social Hygiene Council : Ethics and Science Conference on Society and the Individual, 197
  Summer School on the Schools and the Land, 470
  Summer School on the International and Cultural Relations of Social Biology, 842
  Ethics and Science Conference on Where does Freedom End, 843
British Social Hygiene Council and the Town and Country Planning Association : Conference on the Family, 125
British Society for the History of Science, and others : Discussion on the Place of the History of Science in Education, 347, 572
British Society for International Understanding (Allied Circle, Amsterdam, and the) : Study Conference on the Overseas Territories of Western Europe, 843
British Society for Research on Ageing : Conference, 966
British Tar Confederation : Formation of a Coal Tar Research Association, 757
British Trust for Ornithology: Fourteenth Annual Report, 841
British Welding Research Association : Offer from British Oxygen Co., Ltd., to provide a prize fund, 17
  Appointment of Dr. H. G. Taylor as director, 49
British Zoologists, Association of : Discussion on the Field Study and Conservation of the British Fauna, 408
Brittan, N. H. : The Study of Critical British Groups, 735
Britton, Clare : Sociology of Mental Disease, 408
Broadley, Sir Herbert : Appointed deputy director-general of the United Nations Food and Agriculture Organisation, 637
Broch, Dr. Hjalmar : Stylasteridæ (Hydrocorals) of the John Murray Expedition to the Indian Ocean, 822
Broda, E. : Isotope Exchange and Molecular Structure, 901
Brodetsky, Prof. S. : To retire from the professorship of applied mathematics and headship of the Department of Mathematics in the University of Leeds, 307, 467 ; work of, 467
Brogan, Prof. D. W. : Science and Politics, 6
  Approaches to Sociology, *review*, 950
Bromberg, Y. M., and others : Variations in Spermatogenesis in Oligospermic Men, 176
Bronk, Prof. D. W. : Elected a foreign member of the Royal Society, 921 ; work of, 921
Bronowski, Dr. J., and others : Atomic Challenge, a Symposium, *review*, 995
Brönsted, Prof. J. N. : *Death* of, 15 ; *obituary* by R. P. Bell, 269
Brookbank, W. G. : Appointed agricultural officer, Tanganyika, 51
Brooks, A. C. : Appointed chief chemist, Federation of Malaya, 966
Brooks, Prof. F. T. : The Living Plant, *review*, 153
  Physiology of Resistance to Disease in Plants, 422
Brooks, Prof. S. C. : *Death* of, 674
Broom, Dr. Robert : Awarded the Neill Prize for 1945–47 of the Royal Society of Edinburgh, 716
Broom, Dr. Robert, and Robinson, J. T. : Size of the Brain in the Ape-Man, *Plesianthropus*, 438
Brotherton Collection Committee : Eleventh and Twelfth Reports of the, 882
Brouha, Lucien, and others : What People Are, a Study of Normal Young Men, *review*, 502
Brouwer, Prof. L. E. J. : Elected a foreign member of the Royal Society, 921 ; work of, 921
Brown, Dr. Archibald : Awarded a Commonwealth Fund Fellowship, 1006
Brown, F., and others : Separation and Identification of Methylated Sugars on the Paper Chromatogram, 720
Brown, F. G. W. : Elements of Mechanism (Peter Schwamb, Allyne L. Merrill and Walter H. James), sixth edition revised by Prof. Venton Levy Doughtie, *review*, 79
  Calculus based on the Fundamental Concept of Number, *review*, 261

Brown, Dr. G. L., and Dias, M. Vianna : Sensitivity of a South American Frog to Curare, 234
Brown, P. E., and Lynn-Allen, E. : Breeding of Avocets in Britain, 271
Brown, Walter : Appointed a lecturer in mathematics in the University of Glasgow, 16
Brown, Prof. W. : Physiology of Resistance to Disease in Plants, 422
Brownlee, K. A. : Industrial Experimentation, third edition, *review* by M. R. Sampford, 747
Bruce, Dr. Chas. E. R. : Transition from Glow to Arc Discharge, 521
Bruce, Maurice : Chronicle and Commentary, *review*, 151
  Empires in Transition, *review*, 908
Bruckner, Prof. V., and Kovács, Dr. J. : Addition of Maleic Anhydride to Anethole, 651
Bruckshaw, Dr. J. G. : The Main Geomagnetic Field, 463
Bryological Society, British : Annual General Meeting, 802
Bryson, Dr. Lyman : Science and Freedom, 577
Buchanan, A. S., and Heymann, Dr. E. : Electrokinetic Potential and Surface Structure of Barium Sulphate, 649, 691
Buddenbrock, Prof. W. von : Request for reprints of papers, 514
Budó, Prof. A. : Dielectric Relaxation of Molecules containing Rotating Polar Groups, 133
Bull, G. A. : Meteorological Factors in Radio-Wave Propagation, 146
Bullard, Dr. E. C.: The Main Geomagnetic Field, 462
Bullen, Prof. K. E. : The Bikini Bomb and the Seismology of the Pacific Region, 62
Bunker, H. J. : Hygiene of Beer Production and Consumption, 1025
Bunn, C. W. : Crystal Structure of Polyvinyl Alcohol, 929
Bunton, Dr. C. A. : Awarded a Commonwealth Fund Fellowship, 1006
Bunton, Dr. C. A., and others : Formation of Hydroxy Peroxides, 172
Burch, Dr. C. R. : The Reflecting Microscope, 732
Burgess, R. E. (Thomas, Dr. H. A.) : Survey of Existing Information and Data on Radio Noise over the Frequency Range 1–30 Mc./s., 107
Burkitt, Miles : Archæology at Oxford, *review*, 459
Burland, Miriam S., and others : Combined Radar, Photographic and Visual Observations of the Perseid Meteor Shower of 1947, 278
Burn, Prof. J. H., and Dutta, N. K. : Acetylcholine and Body Temperature, 18
Burström, Prof. H. : Trace Elements in Plant Physiology, 364
Burt, Sir Cyril, and others : The Trend of National Intelligence, *review* by Dr. Julian Blackburn, 37
Burton, Prof. H., and Duffield, J. A. : The Melanin Problem—a Synthesis of 5 : 6-Dihydroxy-indole and its Derivatives, 725
Burton, K. : Higher Fatty Acid Dehydrogenase of Mammalian Liver, 606
Burtt, A. W. : Appointed chief chemist, Singapore, 966
Bushnell, Dr. G. H. S. : North American Archæology, *review*, 501
  The Navaho (Clyde Kluckhohn and Dorothea Leighton), *review*, 545
  Latin American Cultures, 697
Buston, Dr. H. W. : Title of reader in biochemistry in the University of London conferred on, 924
Busvine, Dr. J. R. : Recent Mosquito Eradication Campaigns, 189
Butcher, Devereux : Exploring our National Parks and Monuments, *review* by Frances Pitt, 376
Butcher, Dr. R. W. : Some Problems of Water Buttercups, 735
Butler, Dr. C. G. : Honey Farming (R. O. B. Manley), *review*, 544
Butler, F. H. C. : The Field Study and Conservation of the British Fauna, 409
Butler, Sir Harold : Peace or Power, 414
Butler, J. R. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
Butler, O. I. : Appointed senior lecturer in charge of the Department of Electrical Engineering in the University of Sheffield, 471
Butler, R. W. : Appointed veterinary officer, Tanganyika, 637
Buxton, Prof. Patrick A. : The Louse, second edition, *review* by Dr. A. D. Imms, 418
  Tsetse Flies and the Development of Africa, 802
Byrd, Admiral Richard : Awarded the Vega Medal of the Geographic Society of Sweden, 430

CACAO Research Institute : The West African (O. J. Voelcker), 117
Cahn, R. W., and others : Mechanical Behaviour of Crystal Boundaries in Metals, 682
Cahn, Prof. T. : Physiology and Biochemistry of Fats and Lipoids, 534
Cain, A. J., and Cushing, D. H. : Second Occurrence and Persistence of the Amphipod *Orchestia bottæ* M. Edwards in Britain, 483
Calcutt, G., and Newhouse, J. P. : Inhibition of the Photodynamic Action of 3 : 4 Benzpyrene, 53
Calcutta Statistical Association : Publication of a *Bulletin*, 124
Calhoun, Hermione Grant (Dougherty, Dr. Ellsworth C., and) : Possible Significance of Free-living Nematodes in Genetic Research, 29
Callan, H. G. : Ribose Nucleic Acid in the *Drosophila* Egg, 440
Calvinist Lawyers, Society of, and the Christian Society of Scientists and Physicians in the Netherlands : Discussion on Atomic Energy, 123
Cameron, Prof. A. T. : Recent Advances in Endocrinology, sixth edition, *review*, 376
Cameron, J. F. : Honorary degree of the University of Cambridge conferred on, 965
Campbell, D. D. : Appointed agricultural officer, Uganda, 471
Campbell, Leon, and Jacchia, Luigi : The Story of Variable Stars, *review* by H. S. J., 460
Campbell, Dr. Neil, and Khanna, Nandoomal : Reduction of 1 : 4-Diketones, 54
Canada, National Research Council of : Thirteenth Annual Report, 491
  Formation of a Radio and Electrical Engineering Division under B. G. Ballard, 513
  Establishment of a Committee on Corrosion Research, 553
  Post-doctorate Fellowships in Pure Chemistry, 555
  Publications of the, second edition, 595
Cancer Campaign, British Empire (Genetical Society of Great Britain and the) : Symposium on the Genetics of Cancer, 843
Cancer Hospital, Royal : Appointment of Dr. Eric Boyland to the University of London chair of biochemistry, 347
Cannon, Prof. H. Graham : The Field Study and Conservation of the British Fauna, 408
Caplan, Dr. Anthony : 'Consolidated Gold' Fields of South Africa, Ltd. Gold Medal awarded jointly to J. K. Lindsay and, 924
Capper, Pass and Son, Ltd. : Awards to the Institution of Mining and Metallurgy and the Institute of Metals for papers on metallurgy, 347
Caribbean Commission : First Annual Report, 555
Carmichael, H. : Promoted to the grade of Senior Principal Scientific Officer, 195
Carnegie United Kingdom Trust : Thirty-third Annual Report, 232
Carpenter, N., and others : Atomic Oxygen and Dissociation in Flame Gases, 726
Carr-Saunders, Sir Alexander, and others : The Trend of National Intelligence, *review* by Dr. Julian Blackburn, 37
Carson, A. S., and others : Bond-Strength of C—Cd in Cadmium Methyl and of C—I in Methyl Iodide, 725
Carstairs, Dr. G. M. : Awarded a Commonwealth Fund Fellowship; 1006
Carter, Dr. Kenneth : Made a director of Laboratories Glaxo (Argentina) S.A., 717
Carter, Dr. S. R. : 'Plasthetics', *review*, 581
Cass (Sir John) Technical Institute, London : Course for Teachers of Chemistry, 595
Cassels, J. M. (Latham, R., and) : Scattering of Neutrons by Lead, 282
Cassidy, F. A. : Appointed senior inspector of mines, Nigeria, 51
Casteret, Norbert : My Caves, translated by R. L. G. Irving, *review*, 830
Castle, W. B., and others : Nomenclature of the anti-*Rh* Typing Sera, 492
Catcheside, Dr. D. G. (Allsopp, C. B., and) : Chemical Breakage of Chromosomes, 1011
Cattley, J. G. : Sex Reversal in Copepods, 937
Caullery, Prof. Maurice : Elected a foreign member of the Royal Society, 921 ; work of, 921
Cave-Browne-Cave, Wing-Comdr. T. R. : The Draining of Binley Lake and its Ecological Consequences, 420
Cavendish Laboratory : Organisation and Work of the (Sir Lawrence Bragg), 627
  Summer School in Metal Physics, 637
  Summer School in Electron Microscopy, 758
Cawley, Dr. C. M. : Promoted to the grade of Senior Principal Scientific Officer, 195
Cazal, Dr. Pierre : Awarded a grant from the Lady Tata Memorial Fund, 966
Central African Council : Appointment of Dr. J. E. Keyston as research secretary, 230
Central Electricity Board : Twentieth Annual Report, 822
Ceylon, National Museums of : Administration Report for 1946, 346
Chadwick, Sir James : Pre-elected Master of Gonville and Caius College, Cambridge, 882. 964 ; work of, 964
Chak, I. M., and Giri, Dr. K. V. : Regeneration of Prothrombin Activity by Carbon Dioxide, 354
Challenger Society : Grants in aid of research in Marine Biology or Oceanography, 595
  Grant from the Development Fund to assist in paying expenses of oceanographers attending joint meetings, 843
Challinor, Dr. S. W., and others : Effect of Ion-Exchange Treatment on the Stability of Apple Juice, 1023
Chalmers, Dr. B., and others : Mechanical Behaviour of Crystal Boundaries in Metals, 682
Chalvet, O., and others : Isotope Exchange and Molecular Structure, 901
Chamberlin, Prof. R. T. : *Death* of, 387
Champernowne, D. G. : Appointed professor of statistics in the University of Oxford, 966
Champion, Prof. H. G. : Preservation of the *Kauri* in New Zealand, 72
  The Future of the New Forest, 547
  Afforestation as a World Problem, 902
Chance, Britton : The Enzyme-Substrate Compounds of Catalase and Peroxides, 914
Chance, M. R. A. : Aggression, a Component of Post-Epileptic Automatism in *Peromyscus*, 101
Chang, Dr. Min-Chueh : Transplantation of Fertilized Rabbit Ova—the Effect on Viability of Age, *in vitro* Storage Period, and Storage Temperature, 978
Chapman, D. : Human Factors in Industry, 792
Chapman, Prof. Herman H., and Meyer, Prof. Walter H. : Forest Valuation, *review* by J. J. MacGregor, 831
Chapman, Prof. Sydney : Variation of Geomagnetic Intensity with Depth, 52
  The Earth's Surface Magnetic Field and its Secular Change, 160
  Obituary of Prof. David Enskog, 193
  The Main Geomagnetic Field, 462
Chapman, Prof. V. J. : Preservation of the *Kauri* in New Zealand, 72
Chard, S. J. (Cullinane, Dr. N. M., and) : Mechanism of Substitution in the Naphthalene Nucleus, 690
Chargaff, Prof. E. : Physiology and Biochemistry of Fats and Lipoids, 534
Charlwood, P. A., and Thomson, A. : Electrophoretic Patterns of Lamb Serum Before and After Transfer of Colostrum, 59
Chasmar, R. P. : High-Frequency Characteristics of Lead Sulphide and Lead Selenide Layers, 281
Chasmar, R. P. (Moss, T. S., and) : Spectral Response of Lead Selenide, 244
Chaston, J. C. : Stress Corrosion, 891
Chater, C. W. (Clayson, D. H. F., and) : Cleaning and Sterilization of Plant and Utensils in the Food Industry, 1025
Chatham House Study Group : Discussion on Atomic Energy, its International Implications, 741
Chatterjee, Dr. D. : Early History of the Royal Botanic Garden, Calcutta, 362
  Botanical Nomenclature of the Shaddock or Pomelo, 770
Chaudhuri, B. : Extensive Penetrating Showers, 680
Chaworth-Musters, J. L. : *Obituary* by H. W. Parker, 755
Chemical Industry, Society of : Annual General Meeting in Edinburgh, 306
  John Gray Jubilee Scholarship, 595
Chemical Industry, Society of, and others : Conference on the Rheological Properties of Textile Materials, 307, 737
Chemical Industry, Society of (Food Group), and the Royal Sanitary Institute : Discussion on the Cleaning and Sterilizing of Plant in the Food Industry, 1025

Chemical Research Laboratory, Teddington : To be open to visitors, 758
Chemical Society : Sir Frederick Gowland Hopkins Memorial Lecture to be delivered by Sir Edward Mellanby, 164
  Grants from the Research Fund, 514
Chemical Society (Leeds Area Local Section), and others : Conference on Rheological Properties of Textile Materials, 307, 737
Chemistry, Royal Institute of : Annual General Meeting, 347
  Anniversary Meeting, 716
Chemistry, Royal Institute of (Leeds Area Local Section), and others : Conference on the Rheological Properties of Textile Materials, 307, 737
Chemistry Research Board : Appointment of A. L. Bacharach, Prof. H. J. Emeléus and Prof. D. M. Newitt as members, 924
Cheng, Kai Chia (Born, Prof. Max, and) : Theory of Superconductivity, 968, 1017
Cherry, E. C. : Awarded the Coopers Hill War Memorial Prize and Medal for 1946 of the Institution of Electrical Engineers, 90
Cherry, E. C., and others : An Electrolytic Tank for Exploring Potential Field Distributions, 846
Cheshire, Group-Capt. G. L., and others : Atomic Challenge, a Symposium, *review*, 995
Chester, D. N. : The Efficiency of the Central Government, 496
Chester, Dr. K. Starr : The Nature and Prevention of Cereal Rusts as Exemplified in the Leaf Rust of Wheat, *review* by P. H. Gregory, 220
Chesters, Prof. C. G. C. : Mycological Education, 507
Chevallier, Prof. A. : Physiology and Biochemistry of Fats and Lipoids, 535
Chevenard, Prof. P. A. J. : Elected an Honorary Member of the Institute of Metals, 16
Childe, Prof. V. Gordon : Science in Social Affairs, 68
  Megalithic Tombs in Scotland and Ireland, 841
Chipperfield, P. N. J. (Crisp, D. J., and) : Occurrence of *Elminius modestus* (Darwin) in British Waters, 64
Chippindale, H. G. : Resistance to Inanition in Grass Seedlings, 65
Chorley, Lord : Importation of Books into Britain, 304
Christensen, L. Korsgaard (Jacobsen, C. F., and) : Influence of Temperature on the Urea Denaturation of β-Lactoglobulin, 30
Christian Society of Scientists and Physicians in the Netherlands (Society of Calvinist Lawyers and the) : Discussion on Atomic Energy, 123
Chrysler Corporation, and others : Conference on Mechanical Wear, 758
Chu, C. M. : Enzymic Action of Viruses and Bacterial Products on Human Red Cells, 606
Church Assembly : The Church and the Atom, a Study of the Moral and Theological Aspects of Peace and War, 990
Churchill, Winston : Honorary degree of the University of Cambridge conferred on, 965
Ciba Symposia, 88
Civil Engineers, Institution of : James Alfred Ewing Medal for 1947 awarded to Sir John Cockcroft, 592
  Election of officers for 1948–49, 924
Civil Service, Scientific : Promotion of Individual Research Workers, 195
Clapham, Prof. A. R. : Ecology in relation to Critical Groups, 734
  Some Taxonomic Problems in *Galium* and *Juncus*, 734
Clar, Dr. E. : Synthesis of Ovalene, 238
Clark, Dr. A. M. : Insulating Materials and Methods for Use at Low Temperatures, 323
Clark, Grahame : Archæology and Society, second edition, *review* by Prof. C. F. C. Hawkes, 583
Clark, Dr. Hubert Lyman : The Echinoderm Fauna of Australia, 32
Clark, Prof. W. E. Le Gros : African Fossil Primates discovered during 1947, 667
Clarke, K., and others : The Melanin Problem—a Synthesis of 5 : 6-Dihydroxyindole, 525
Clarke, Robert : Hearing in Cetacea, 979
Clay, Harold : Industrial Co-operation, 571
Clayson, D. H. F., and Chater, C. W. : Cleaning and Sterilization of Plant and Utensils in the Food Industry, 1025
Cleaver, R. E. L. : Awarded a Commonwealth Fund Fellowship, 1006
Clément, Dr. G. : Physiology and Biochemistry of Fats and Lipoids, 534
Clements, Prof. Guy Roger, and Wilson, Prof. Levi Thomas : Manual of Mathematics and Mechanics, second edition, *review*, 789
Clemmesen, Dr. Johannes : Awarded a grant from the Lady Tata Memorial Fund, 966
Cleveland Museum of Natural History : The Museum in Education, 677
Clifton, A. N. : Awarded a Branch Prize of the Royal Aeronautical Society, 593
Clifton, Charles E., and others (edited by) : Annual Review of Microbiology, *review* by Sir Paul Fildes, 995
Clinch, Dr. Phyllis E. M., and others : Transmission of a Disease Resembling Virus Yellows through the 'Seed' of Sugar Beet, 28
Cloos, Prof. H. : Ground Blocks of the Continents and Ocean Bottoms, 71
Clothworkers, Worshipful Company of : Further grant of £10,000 to the Textile Industries Department of the University of Leeds, 1006
Coal Board (National) : Scientific Aspects of the Work of the (John Crossland), 546
Coal Tar Research Association : Formation of the, 757
  Election of Dr. E. V. Evans as president, 757
  Election of Dr. D. McNeil as director of research, 757
Coal Utilization Research Association, British : Publication of a *Quarterly Gazette*, 841
Coates, Prof. J. E. : Retirement from the chair of chemistry at University College, Swansea, 1004 ; work of, 1004
Coats, Ltd., J. and P. : Research Fellowships in chemistry or physics at the University of Glasgow and the Royal Technical College, Glasgow, 164
Cochran, Dr. W. : The Fourier Method of Crystal Structure Analysis, 765
Cochrane, Air Marshal the Hon. Sir Ralph : Awarded the Edward Busk Memorial Prize of the Royal Aeronautical Society, 593
Cockcroft, Sir John : Data for Nuclear Physics, *review*, 418
  Awarded the James Alfred Ewing Medal for 1947 of the Institution of Civil Engineers, 592 ; work of, 592
Cockcroft, Sir John, and others : Atomic Challenge, a Symposium, *review*, 995
Cockerell, Prof. T. D. A. : *Death* of, 194 ; *obituary* by Robert B. Benson, 829
Codrington, K. de B. : Appointed to the University of London chair of Indian archæology at the Institute of Archæology and at the School of Oriental and African Studies, 430
Cohen, Abraham : Time Study and Common Sense, *review* by J. Leigh, 910
Cohen, Dr. John : Science in Social Affairs, 68
Cohen, Morris R. : A Preface to Logic, *review* by Prof. A. D. Ritchie, 623
Cohen, S. G. : Interaction of Fast Neutrons with Indium, 475
Coker, R. E. : This Great and Wide Sea, *review*, 38
Cole, David F. : Osmotic Work performed by the Renal Tubules, 640
Cole, Prof. F. J. : Early English Naturalists, *review*, 373
Cole, G. D. H. : The Intelligent Man's Guide to the Post-War World, *review* by Maurice Bruce, 151
  Local and Regional Government, 825
Colebrook, F. M. : Scientific Radio, 793
Coles, M. (Fraenkel, Dr. G., with the assistance of Blewett, M., and) : B_T, a New Vitamin of the B-Group and its relation to the Folic Acid Group, and other Anti-Anæmia Factors, 981
Collier, Donald, and others : Indians before Columbus, *review* by Dr. G. H. S. Bushnell, 501
Collier, Dr. H. O. J., and others : Pharmacological Activities in different Rodent Species of *d*-Tubocurarine Chloride and the Dimethyl Ether of *d*-Tubocurarine Iodide, 817
Collinge, Dr. W. E. : Presentation of his collection of terrestrial Isopoda to the Yorkshire Museum, 51
Collins, F. D., and others : Chemistry of Visual Processes, 424
Colonial Agricultural, Animal Health and Forestry Research, Committee for : Second Annual Report, 143
Colonial Medical Research Committee : Second Annual Report, 143
Colonial Microbiological Research Institute, Trinidad : Opening of the, 675
Colonial Office : The Colonial Empire (1939–1947), 332
Colonial Office Advisory Committee on Education in the Colonies : Report on Education for Citizenship in Africa, 948
Colonial Primary Products Committee : Interim Report, 779
Colonial Products Research Council : Fourth Annual Report, 142
Colonial Research Committee : Fourth Annual Report, 141
Colonial Service : Appointments and Promotions, 51, 471, 637, 802, 966
Colonial Social Science Research Council : Third Annual Report, 142
Colston Research Society : Symposium on Cosmic Rays, 125
Colvin, Brenda : Land and Landscape, *review* by Prof. L. Dudley Stamp, 868
Colvin, Brenda, and Tyrwhitt, Jaqueline : Trees for Town and Country, *review* by Sir Edward Salisbury, 497
Comline, R. S., and Whatley, F. R. : Inactivation of Flavine Adenine Dinucleotide by Tissue Extracts, 350
Commerce, International Chamber of : Brochure No. 123, Economic Conditions of Germany To-day and its International Repercussions, 659
Commerce, Ministry of (Northern Ireland) : Formation of a Council of Scientific Research and Development, 162
Commonwealth of Australia : Twentieth Annual Report of the Council for Scientific and Industrial Research, 999
Commonwealth of Australia, National Geographic Society and the Smithsonian Institution : Scientific Expedition to Arnhem Land, 195
Commonwealth of Nations, British : Opening of Scientific Liaison Offices, 923
Commonwealth Economic Committee : Industrial Fibres, 961
Commonwealth Fund : Awards of Fellowships, 1006
Communications on Applied Mathematics (New Journal issued by the Institute for Mathematics and Mechanics of New York University), 636
Compton, Dr. Karl T. : Awarded the Public Welfare Medal for 1947 of the U.S. National Academy of Sciences, 50 ; work of, 50
Conant, Dr. J. B. : On Understanding Science, 865
Consiglio Nazionale delle Ricerche, Pavia : Congress on Genetics at the Centro di Genetica, 966
Constant, H. : Elected a Fellow of the Royal Society, 466
Conway, Prof. Edward J. : Microdiffusion Analysis and Volumetric Error, revised edition, *review*, 583
Conway, Dr. H. D. : Aircraft Strength of Materials, *review*, 503
Cook, Dr. : Mycological Education, 508
Cook, Dr. A. H. : Title of University of London reader in organic chemistry conferred on, 637
Cook, Prof. J. W. : Documentation of Organic Chemistry, *review*, 415
  Colchicine, its Chemical and Biological Properties, 554
  A Text-Book of Practical Organic Chemistry (Dr. Arthur I. Vogel), *review*, 995
Cook, Prof. J. W., and Schoental, Dr. R. : Oxidation of Anthracene by Osmium Tetroxide, 237
Cook, Richard K. : Equations of Piezo-electricity, 524
Cook, Dr. W. R. Ivimey (McLean, Dr. R. C., and) : Practical Field Ecology, 158
Cooper, A. R. : Load Dispatching and the British Grid System, 822
Cooper, C., and others : Final Values of Elements of the Geomagnetic Field at 5-Degree Intervals of Latitude and Longitude, Epoch 1945, 161
  The Earth's Main Magnetic Field and its Secular Change, 1905–1945, 161
Cooper, J. P. : Resistance to 'Inanition' in Grass Seedlings, 894
Cooper, Dr. L. H. N. : A Submerged Ancient Cliff near Plymouth, 280
Cooper, Dr. L. H. N., and Steven, G. A. : An Experiment in Marine Fish Cultivation, 631
Cooper, Dr. R., and Prowse, Dr. W. A. : Radio Physics, 795
Cooper, Dr. R. (Prowse, Dr. W. A., and) : Gas Discharges at Centimetre Wave-lengths, 310
Cope, Dr. C. L. : Human Factors in Industry, 791
Cope, Dr. F. W. : Awarded a Murchison Fund of the Geological Society, 122
Copeland, Dr. D. H., and others : Nutrition in relation to Cancer, 106
Copeland, Melvin T., and Towl, Asst. Prof. Andrew R. : The Board of Directors and Business Management, *review* by E. F. L. Brech, 869
Copsey, E. H., and others : Empirical Data on Hilbert's Inequality, 361
Corbet, Dr. A. S. : *Death* of, 799 ; *obituary* by N. D. Riley, 1003
Cori, Prof. Carl F. : Awarded the Willard Gibbs Medal for 1948 by the Chicago Section of the American Chemical Society, 388
Cornish, Dr. Vaughan : *Death* of, 714 ; *obituary*, 839
Coryell, Prof. C. D. : Isotope Exchange and Molecular Structure, 901
Cosmic Ray Laboratory : New Italian (Opened by the Italian Centre for Research in Nuclear Studies), 254
Cosslett, Dr. V. E. : The Electron Microscope, *review* by G. D. P., 955
Cosslett, Dr. V. E., and Markham, Dr. Roy : Structure of Turnip Yellow Mosaic Virus Crystals in the Electron Microscope, 250
Cossor, Ltd., A. C. : Simultaneous Recording of Related Oscillograph Traces, 89

Cotereau, H., and others : Influence of Vitamin P (Vitamin C_2) upon the Amount of Ascorbic Acid in the Organs of the Guinea Pig, 557
Cott, Dr. Hugh B. : Edibility of the Eggs of Birds, 8
Cottin, M., and Varjadebian, B. : Isotope Exchange and Molecular Structure, 901
Coulson, Prof. C. A. : Free Valence in Organic Reactions, 901
Courrier, Robert : Appointed 'secretaire perpétuel' for the physical sciences of the Paris Academy of Sciences, 966
Courtauld, S. : *Death* of, 15
Courtauld's Scientific and Educational Trust Fund : Formation of the, 593
Cowan, H. J. : Appointed lecturer in civil engineering in the University of Sheffield, 471
Cowley, J. M., and Walkley, Allan : Reaction between Manganous Ion and Manganese Dioxide, 173
Cowling, Prof. T. G. : Appointed professor of applied mathematics in the University of Leeds, 307, 468 ; work of, 468
  The Main Geomagnetic Field, 464
  Cosmic Rays, *review*, 785
Cowling, Prof. T. G., and Borger, R. : Electrical Conductivity of the Ionospheric *D*-Layer, 515
Cox, Prof. A. H. : Awarded the Lyell Medal of the Geological Society, 122
Cox, D. R. : Fibre Movement in the Drafting Process, 737
Cox, Dr. H. Roxbee : Elected president of the Royal Aeronautical Society for 1948–49, 853
  Appointed chief scientist at the Ministry of Fuel and Power, 1007
Cox, S. M. : Annealing of Glass, 401, 813
Craggs, Dr. J. D., and others : X-Radiation from a 20-MeV. Betatron, 1022
Craig, D. P., and Maccoll, Allan : The Non-Benzenoid Aromatic Hydrocarbon Pentalene, 481
Craigie, Dr. James : Awarded the Medal of Freedom by the Government of the United States, 215
Crammer, Dr. J. L. : Paper Chromatography of Flavine Nucleotides, 349
Crammer, R. W. : Written Expression in Science, 533
Crawford, B. H. : Degree of D.Sc. of the University of London conferred on, 924
Cripps, Sir Stafford : Elected a Fellow of the Royal Society under Statute 12, 843
  Honorary degree of the University of Cambridge conferred on, 965
Crismon, Jefferson M., and others (edited by) : Annual Review of Physiology, Vol. 9, *review* by Dr. O. A. Trowell, 542
Crisp, —. : Interaction of Water and Porous Materials, 630
Crisp, D. J., and Chipperfield, P. N. J. : Occurrence of *Elminius modestus* (Darwin) in British Waters, 64
Crook, E. M., and Sheffield, F. M. L. : Plant Virus Diseases, 945
Crossland, John : Scientific Aspects of the Work of the National Coal Board, 546
Crow, Sir Alwyn : The Rocket as a Weapon of War in the British Forces, 329
Crowdy, S. H. : Treatment of Apple Canker Lesions with Plant-growth Substances, 320
Crowther, Prof. J. A. : Atomic Energy, *review*, 4
  A Short History of Science, *review*, 260
  Discovery of Radioactivity, 609
Crowther, J. G., and Whiddington, R. : Science at War, *review* by S. Weintroub, 907
Cruz-Coke, Prof. Edouardo : At the opening of the Fourth South American Chemical Congress, 655
  Appointed a member of the Pontifical Academy of Science, 922
Crystallography : British National Committee for, 390
Crystallography, International Union of : First General Assembly and International Congress, 124, 390, 801
  Appointment of a Provisional Executive Committee of the American Section, 801
Csáky, Tihamér Z. (Virtanen, Prof. Artturi I., and) : Formation of Oxime-Nitrogen in *Torula*-Yeast Fed with Potassium Nitrate, 814
Cuffe, Robert C. : Lightning Arrester Discharge Currents, 885
Cullen, Dr. William : Honorary membership of the Institution of Mining and Metallurgy conferred on, 923
Cullinane, Dr. N. M., and Chard, S. J. : Mechanism of Substitution in the Naphthalene Nucleus, 690
Cullis, Prof. W. C. : Elementary Physiology, *review*, 828
Cullwick, Prof. E. G. : An Anomaly in Electromagnetic Theory, 969
Cumming, M. C. (Munro, Dr. H. N., and) : Nitrogen Metabolism after Fracture, 560
Cummins, J. E. : Appointed chief scientific liaison officer for Australia in London, 1007
Cunningham, Admiral Sir John : Elected an honorary member of the Institution of Electrical Engineers, 122
Cunningham, Admiral of the Fleet Lord : Honorary degree of doctor of laws of the University of Sheffield conferred on, 555
Curnow, C. E. (Bannon, J., and) : Structure of Calcium Fluoride Films Evaporated on Polished Glass Surfaces, 136
Cushing, D. H. (Cain, A. J., and) : Second Occurrence and Persistence of the Amphipod *Orchestia bottæ* M. Edwards in Britain, 483
Cwilong, Dr. B. : Sublimation in the Atmosphere over the Oceans, 62
Cymerman, Dr. J. : Appointed lecturer in organic chemistry in the University of Sydney, 471

DAIN, J., and others : 30-MeV. Electron Synchrotron, 504
Dale, Sir Henry : Awarded the Medal of Freedom with Silver Palm by the Government of the United States, 215
Dale, Sir Henry, and others : Atomic Challenge, a Symposium, *review*, 995
Dalfsen, J. W. van, and others : Complexity of Fresh *Hevea* Latex, 177
Dallemagne, Prof. M. J. : The Theory of Primary Calcification in Bone, 115
Dallemagne, Prof. M. J. (Govaerts, Dr. J., and) : Influence of Folliculin on Bone Metabolism, Studied by means of Radiophosphorus, ${}^{32}_{15}P$, 977
Dalziel, Dr. J. M. : *Obituary* by Dr. F. R. Irvine, 920
Dam, Prof. Henrik : Dicumarol Poisoning and Vitamin K Deficiency in relation to Quick's Concept of the Composition of Prothrombin, 1010
Dance, H. R. and I. W. : An Introduction to Filmstrips, *review* by Lieut.-Colonel Eric Lowe, 830
Dangeard, Prof. P. A. C. : *Death* of, 48 ; *obituary* by Dr. B. Barnes, 878
Daniel, Peter M., and others : Studies of the Renal Circulation, *review*, 663
Daniel, R. R. (Bhabha, Dr. H. J., and) : Meson Scattering with Nuclear Excitation, 883
Danish Institution of Civil Engineers : Opening of new headquarters, 124
Darby, J. F., and Swan, J. B. : Scattering of D—D Neutrons by Deuterium, 22
Darke, S. J. (Jacoby, Dr. F., and) : Animal Tissue Culture with a Synthetic Medium, 768
Darling, Dr. F. Fraser : Natural History in the Highlands and Islands, *review* by Prof. A. D. Peacock, 457
Darlington, Dr. C. D. : Awarded the Trail Award and Medal for 1947 of the Linnean Society of London, 51, 882
Darwin, Sir Charles : Use of Equivalent Metric Values in Scientific Papers, 144
  Awarded the Medal of Freedom with Bronze Palm by the Government of the United States, 215
Daudel, R. and Mme., and others : Isotope Exchange and Molecular Structure, 901
David, Prof. W. T. : *Death* of, 839
David, Prof. W. T., and others : Atomic Oxygen and Dissociation in Flame Gases, 726
David, Prof. W. T. (Leah, Dr. A. S., and) : A Bunsen Flame as a Column of Luminous Gas, 524
Davidson, Sir John : Elected president of the Institution of Civil Engineers for 1948–49, 924
Davies, J. G. (Ellyett, C. D., and) : Velocity of Meteors Measured by Diffraction of Radio Waves from Trails during Formation, 596
Davies, J. H. : Appointed an assistant lecturer in economics in the University of Sheffield, 1007
Davies, O. L., and others : A Method for Estimating Percentage Germination of Fungal Spores, 642
Davies, R. E. : Appointed honorary lecturer in biochemistry in the University of Sheffield, 307
Davies, R. G. (Eaton, Dr. J. K., and) : Toxicity of Azo-Compounds and other Substances to the Fruit Tree Red Spider Mite, 644
Davies, R. H. : A Simple Moving-Boundary Apparatus, 1021
Davis, Dr. J. G. : Cleaning and Sterilizing of Dairy and Ice Cream Plant, 1025
Davis, Watson : Proposed Central Publication of Scientific Papers, 896
Davy, M. J. B. : *Obituary* of Orville Wright, 269
  Obituary of Griffith Brewer, 510
  Obituary of G. L. Overton, 921
Dawes, Dr. Ben : The Trematoda of British Fishes, *review* by Dr. G. Lapage, 222
  A Rare Cœlom-Dwelling Trematode, 642
Dawson, Dr. I. M., and McFarlane, Dr. A. S. : Structure of an Animal Virus, 464
Dawson, R. M. C. (Richter, Dr. D., and) : Brain Lactate in Emotion, 205
Dawson, W. J. : Awarded the Bessemer Gold Medal for 1948 of the Iron and Steel Institute, 512
De Castro, Prof. A. : Appointed a member of the Pontifical Academy of Science, 922
Dean, R. F. A., and Holman, W. I. M. : Nicotinic Acid in Human Blood Cells at Birth, 439
Debenham, Prof. Frank : Awarded the Victoria Medal for 1948 of the Royal Geographical Society, 553
Debray, M., and others : Abnormalities in the *F*-Region of the Ionosphere at Calcutta, 24
Dee, Prof. P. I. : Nuclear Physics in Photographs, *review*, 333
Demers, P., and others : Comparison of Cross-sections for the Capture of 220 and 900 keV. Neutrons, 727
Deming, Prof. Horace G. : Fundamental Chemistry, second edition, *review* by Dr. S. H. Harper, 992
Dempsey, Dr. T. G., and others : *p*-Aminosalicylic Acid in the Treatment of Tuberculosis, 435
Den Hartog, Prof. J. P. : Mechanical Vibrations, third edition, *review* by A. L. P., 503
Dennis, R. W. G. : Distribution Patterns in European Basidiomycetes with reference to some British Species, 1015
Desch, Dr. C. H. : Elected a Fellow of the Institute of Metals, 16
  The Flow of Glaciers, 820
Design for Freedom Committee : Design for Recovery, 660
Deslandres, Dr. H. A. : *Death* of, 194 ; *obituary* of, 303
Desnuelles, Prof. P. : Physiology and Biochemistry of Fats and Lipoids, 534
Deuel, Dr. H., and others: Reaction of Boric Acid with Polysaccharides, 96
Development Fund : Grant to the Challenger Society to assist in paying expenses of oceanographers attending joint meetings, 843
Dewberry, Elliot B. : Food Poisoning, second edition, *review*, 540
Dewsnap, N. (Wood, Dr. W. A., and) : Internal Stresses in Metals, 682
Dias, M. Vianna (Brown, Dr. G. L. and) : Sensitivity of a South American Frog to Curare, 234
Dienes, Prof. P. : Retirement from the chair of mathematics at Birkbeck College, 756 ; work of, 756
Dienes, Dr. Z. P. : Appointed to a lectureship in mathematics at University College, Leicester, 514
Dieterlen, Mme. G. : Les Ames des Dogons, *review* by G. I. Jones, 622
Dijkstra, Dr. L. J., and Snoek, Dr. J. L. : Effect of Lattice Distortions on the Mean Rate of Propagation of Large Barkhausen Discontinuities, 886
Dilke, M. H., and others : Catalytic Poisons and Magnetic Susceptibility, 804
Dingemanse, Dr. Elizabeth, and others : Isolation of a New Androstenol-3(α)-on-17 from the Urine of a Patient with Adrenal Cancer, 848
Dingle, Prof. Herbert : Lorentz-like Transformations, 209
Distèche, A. : Use of Solubility Curves at Varying *p*H and Constant Ionic Strength for the Precipitation and Crystallization of Proteins, 130
Divekar, P. V., and others : A New Sulpha Compound ('6257') and its Use in Human Cholera Infection, 395
Diver, Capt. C. : The Field Study and Conservation of the British Fauna, 409
Dixon, Dr. M. : Reactions of Lachrymators with Enzymes and Proteins, 226
  Biochemical Reactions of Chemical Warfare Agents, 225
Dmochowski, Dr. L., and others : Ultracentrifugation and Electron Microscope Studies of Tissues of Inbred Strains of Mice, 759
Dobb, Maurice : Soviet Economic Development since 1917, *review* by Maurice Bruce, 908

Dodd, Norris E. : Appointed director-general of the United Nations Food and Agriculture Organisation, 637
Dodds, Prof. E. C. : *Obituary* of Prof. James McIntosh, 713
Dodgson, K. S., and Williams, Dr. R. Tecwyn : Isolation of Stilbœstrol Monoglucuronide from Human Urine, 604
Doisy, Prof. Edward A. : Appointed a member of the Pontifical Academy of Science, 922
Dollar, Dr. A. T. J. : Recording Crevices in Plane Surfaces by Pigment-fillings held in Cellulose Acetate Moulds, 358
Dollfus, Dr. Robert Ph. : Parasites (animaux et vegétaux) des helminthes, *review* by Dr. G. Lapage, 662
Don, P., and others : Isolation in Chick Embryos of a Filtrable Agent possibly related etiologically to Lumpy Skin Disease of Cattle, 526
Donald, C. M. : Pastures and Pasture Research, second edition, *review* by Dr. John Grainger, 747
Doodson, Dr. A. T. : Rivers—a National Heritage, *review*, 911
Dorey, Dr. S. F. : Elected a Fellow of the Royal Society, 466
Dormer, Dr. K. J., and Street, Dr. H. E. : Secondary Thickening in Excised Tomato Roots, 483
Dostrovsky, Dr. I., and others : Fractional Distillation and its Application in the Concentration of the Heavy Isotopes of Oxygen and Hydrogen, 858
Doudoroff, Dr. Michael, and others : Arsenolysis and Phosphorolysis of the Amylose and Amylopectin Fractions of Starch, 96
Dougherty, Dr. Ellsworth C., and Calhoun, Hermione Grant : Possible Significance of Free-Living Nematodes in Genetic Research, 29
Douglas, Hon. Lewis W. : Honorary degree of doctor of laws of the University of Sheffield conferred on, 555
Dowson, Dr. W. J. (Volcani, Z., and) : A Plant Disease caused by a Spore-forming Bacterium under Natural Conditions, 980
Drennan, D. H. : Appointed agricultural officer, Tanganyika, 51
Drever, Prof. James : The Psychology of Industry, second edition, *review* by T. H. Hawkins, 955
Drew, Dr. Kathleen M. : Genetics and Algal Life-Histories, 223
Drewe, E. C., and Maurice, D. : Solar Noise, 167
Drinkwater, Dr. J. W., and Glendinning, W. G. : Awarded the George Taylor (of Australia) Gold Medal of the Royal Aeronautical Society, 593
Druce, Dr. Gerald : University of Prague Sexcentenary Celebrations, 670
Drucker, Dr. Philip : Some Implications of the Ceramic Complex of La Venta, 594
Drummond, Sir Jack : Awarded the Medal of Freedom with Silver Palm by the Government of the United States, 215
  Presented by the Netherlands Ambassador with the Insignia of Commander in the Order of Orange-Nassau (Civilian Division), 307
Drury, Dr. A. N. : Sir Charles Sherrington and Diphtheria Antitoxin, 266
Dryden, J. S., and Meakins, R. J. : Treatment of Glass and Steatite Ceramic with Quaternary Ammonium Compounds for the Improvement of Electrical Insulation Resistance, 23
Du Toit, Dr. A. L. : *Death* of, 387 ; *obituary* by Sir Edward Bailey, 426
Dubouloz, Prof. P. : Physiology and Biochemistry of Fats and Lipoids, 535
Duckworth, R. B., and others : A Method for Estimating Percentage Germination of Fungal Spores, 642
Duckworth, Dr. W. L. H. : Some Complexities of Human Structure, 628
Duffield, J. A. (Burton, Prof. H., and) : The Melanin Problem—a Synthesis of 5 : 6-Dihydroxy-ondole and its Derivatives, 725
Dufraisse, Charles : Elected a member of the Paris Academy of Sciences in the Section of Chemistry, 514
Dufrenoy, Dr. Jean, and Pratt, Prof. Robertson : Evidence for an Electrostatic Field on Penicillin Assay Plates, 849
Duncan, Prof. W. J. : Potential Theory of Aerofoils, *review*, 703
  Mechanical Admittances and their Applications to Oscillation Problems, *review* by Prof. W. G. Bickley, 954
Dundee Royal Infirmary : The Early Days of (Dr. Henry J. C. Gibson), 555
Dunham, Dr. K. C. : Mineral Resources of the United States, *review*, 991
Dunlop, Dr. George : Food Production from Hill Grazing Land, 585
Dunn, Dr. J. A. : Scientific Research in India, 513
Dunsheath, Dr. Percy (edited by) : Industrial Research, 1947, *review* by R. Brightman, 705
Dunsmuir, Dr. R., and others : Pinhole Radiography of Magnetrons, 244
Duperier, Dr. A. : Height of Meson Formation, 645
Dustin, Jun., Dr. P. (Parmentier, R., and) : Early Effects of Hydroquinone on Mitosis, 527
Dutta, N. K. (Burn, Prof. J. H., and) : Acetylcholine and Body Temperature, 18
Duveen, Denis I. : Humour and Humanism in Chemistry, *review*, 869
Dyer, Dr. Bernard : *Death* of, 270 ; *obituary* by G. Taylor, 386
Dyers and Colourists, Society of : Appointment of Dr. Cyril J. W. Hooper as editor and general secretary, 347
Dyers and Colourists, Society of (and others) : Conference on the Rheological Properties of Textile Materials, 307, 737

EALES, Dr. N. B. : Recent Research in Marine Biology, 737
East African Industrial Research Board : Report for 1946, 122
Eastman Kodak Research Laboratories : Retirement of Dr. S. E. Sheppard, 270
Eaton, Dr. J. K., and Davies, R. G. : Toxicity of Azo-Compounds and other Substances to the Fruit Tree Red Spider Mite, 644
Ebaugh, Cameron D. : Education in Guatemala, 945
Eckersley, T. L. : Triple Splitting of Ionospheric Rays, 597
Eddy, Prof. Samuel, and others : Guide to the Study of the Anatomy of the Shark, *Necturus*, and the Cat, second edition, *review* by Dr. P. D. F. Murray, 955
Ede, Chuter : University Representation in the House of Commons, 468
Eden, Anthony : Honorary degree of doctor of laws of the University of Sheffield conferred on, 555
Edgerley, L. F. : Appointed assistant conservator of forests, Mauritius, 471
Edisbury, Dr. J. R., and others : Units and Useful Range in Photo-electric Colorimetry, 247
Edlund, Torbjörn : Absorption of Protein and Bacteria from Normal and Infected Joints, 102
Edney, Dr. E. B. : Biology in Colonial Universities, 506
Education in Industry and Commerce, National Advisory Council for : Appointment of Sir Ronald Weeks as chairman, 801
  Elections to the Standing Committee, 923
Educational Film Groups, National Federation of : First Annual Conference, 965
Educational Foundation for Visual Aids : Appointment of John A. Harrison as director, 802
Edwards, —. : Sociology of Mental Disease, 407
Edwards, Dr. G. : History of Anæsthesia, *review*, 458
Edwards, Joseph, and others : The Artificial Insemination of Farm Animals, edited by Enos J. Perry, *review* by Dr. Arthur Walton, 831
Edwards, J. P. : Appointed deputy director of forestry, Malaya, 471
Edwards and Co., Ltd., W. : High-Vacuum Equipment, 676
Egedal, J. : Daily Variation of the Horizontal Magnetic Force at the Magnetic Equator, 443
Egerton, Sir Alfred : Awarded the Medal of Freedom with Silver Palm by the Government of the United States, 215
  Insulating Materials and Methods for Use at Low Temperatures, 323
  Degree of D.Sc. of the University of London conferred on, 347
  To accept the chairmanship of the Scientific Advisory Council of the Ministry of Fuel and Power, 1007
Ekbote, R. B., and Sahasrabuddhe, K. R. : Shrivelled Wheat Grain from Rust-Affected Crop as Seed, 442
Eldridge, Prof. John A. : College Physics, third edition, *review* by S. Weintroub, 954
Electrical Engineers, Institution of : Coopers Hill War Memorial Prize and Medal for 1946 awarded to E. C. Cherry, 90
  Page Prizes for 1947 awarded to D. T. Hollingsworth and M. K. Taylor, 90
  Election of Sir Thomas Purves and Admiral Sir John Cunningham as honorary members, 122
  Faraday Medal awarded to Prof. M. L. E. Oliphant, 122
Electrical Engineers, Institution of (Radio Section), and the British National Committee for Scientific Radio : Convention on Scientific Radio, 233, 793
Electrical Engineers, Institution of (Research Committee of the) : British Research in the Radio Field, 943
Electrical and Allied Industries Research Association, British : Establishment of a new Section on Power Generation, 162
  Twenty-seventh Annual Report, 492
Electricity Board, Central : Twentieth Annual Report, 822
Electronics, Institution of : Third Annual Exhibition by the North-West Section, 924
Eley, Dr. D. D., and others : Catalytic Poisons and Magnetic Susceptibility, 804
Elliott, A., and MacNeice, G. G. : Transmission of the Atmosphere in the 1-5 Micron Region, 516
Elliott, W. H. : Adenosinetriphosphate in Glutamine Synthesis, 128
Elliott, W. H., and Gale, Dr. E. F. : Glutamine-synthesizing System of *Staphylococcus aureus*, its Inhibition by Crystal Violet and Methionine-sulphoxide, 129
Ellis, Dr. Oliver C. de C. : Extinction of Petrol Fires by Methyl Iodide, 402
Ellison, Dr. M. A. : Solar and Terrestrial Relationships, *review*, 951
Ellyett, C. D., and Davies, J. G. : Velocity of Meteors Measured by Diffraction of Radio Waves from Trails during Formation, 596
Elmore, D. T. : Separation of Pyrimidine Nucleosides by Synthetic Resin Ion-Exchangers, 931
Elsden, Dr. S. R. : Appointed senior lecturer in microbiology in the University of Sheffield, 16
Elsevier's Encyclopædia of Organic Chemistry (edited by E. Josephy and F. Radt), Series 3, Carboisocyclic Condensed Compounds, Vol. 13, Tricyclic Compounds, *review* by Prof. J. W. Cook, 415
Elton, G. A. H. : Theory of the Streaming Potential, 847
Emeléus, Prof. H. J. : Appointed a member of the Chemical Research Board, 924
Emery, Dr. J. L. : Appointed honorary lecturer in pathology in the University of Sheffield, 16
Ende, Prof. M. van den, and others : Isolation in Chick Embryos of a Filtrable Agent possibly related etiologically to Lumpy Skin Disease of Cattle, 526
Engel, Dr. A. von (Stott, F. D., and) : Optical Transmission of a Colloidal Solution in a Magnetic Field, 728
Engel, Dr. R. W., and others : Nutrition in relation to Cancer, 106
Engineers, Society of : Simms Gold Medal awarded to J. G. Milton, 346
  Bessemer Premium awarded to C. D. Mitchell, 346
  Nursey Premium awarded to R. Cecil Smart, 346
  Bernays Premium awarded to Bernard Payne, 346
  Election of E. E. Turner as president, 346
Engle, Earl T. (edited by) : The Problem of Fertility (Proceedings of the Conference on Fertility held under the auspices of the National Committee on Maternal Health), *review*, 113
Engström, Dr. A., and Jakus, M. A. : Intracellular Determination of Protein by X-Ray Microspectrography, 168
Ennion, Dr. E. A. : The Field Study and Conservation of the British Fauna, 409
Enoksson, Bertil : Influence of Solvent Movement on Sedimentation, 934
Enquiry, No. 1, 757
Enskog, Prof. David : *Obituary* by Prof. S. Chapman, 193
Erdös, Thomas (Snellman, Olle, and) : Effect of Calcium Ions on the Charge of Myosin, 526
Erdtman, Prof. Holger, and Gripenberg, Dr. Jarl : Antibiotic Substances from the Heart Wood of *Thuja plicata* Don., 719
Eriksson, H. A. S. : Energy of the Ground-State of Helium-like Atoms, 393
Erkama, Dr. J. : Trace Elements in Plant Physiology, 364
Essen, Dr. L. : Scientific Radio, 793
Estevez, J. M. J. : Contact Laminated Plastics, *review*, 788
European Periodicals Publicity and Advertising Co., Ltd. : First Post-war Exhibition of German Books, Periodicals and Newspapers, 595
Evans, C. C., and Sugden, Prof. S. : Exchange Reactions and Electrolytic Dissociation, 901
Evans, E. A. : Elected president of the Institute of Petroleum for 1948–49, 758
Evans, E. Price (Tansley, A. G., and) : Plant Ecology and the School, 158
Evans, Dr. E. V.: Elected president of the Coal Tar Research Association, 757
  The Gas Industry in Britain, 832

- Evans, Dr. U. R. : Written Expression in Science, 533
- Eve, Prof. A. S. : *Death* of, 510 ; *obituary* by Sir George Thomson, 838
- Everett, A. J., and others : Formation of Hydroxy Peroxides, 172
- Everett, Dr. D. H. : Appointed to the chair of chemistry at University College, Dundee, 715 ; work of, 715
- *Evolution*, an International Journal of Organic Evolution, No. 1, 162
- Ewens, Dr. R. V. G. : Constitution of certain Binuclear Metallic Carbonyls and Nitrosyls, 530
- Exhibition of 1851, Commissioners of the : Awards of Senior Scholarships, 966
- *Experimental Psychology, Quarterly Journal of* : To be published by the Experimental Psychology Group, 272
- Experimental Psychology Group : To publish a new journal, the *Quarterly Journal of Experimental Psychology*, 272
- l'Exploration de la Mer, Conseil Permanent International pour : Discussion on Climatic and Ecological Ghanges in Northern Waters, 428
- Exton, Jr., William : Audiovisual Aids to Instruction, *review* by Lieut.-Colonel Eric Lowe, 745

- FAGELSTON, I. : Promoted to the grade of Senior Principal Scientific Officer, 195
- Fairley, Dr. N. Hamilton : Medical Diseases in Hot Climates, *review*, 499
- Fallot, Prof. Paul : Elected a member of the Section of Mineralogy of the Paris Academy of Sciences, 802
- Falls, Capt. Cyril, and others : Atomic Challenge, a Symposium, *review*, 995
- Falmouth, Viscount : Elected chairman of the Imperial College of Science and Technology, 17
- Family Planning Association of Great Britain : International Congress on Population and World Resources in relation to the Family, 882
- Fankuchen, Dr. I., and others : Structure of Cyclo-octatetraene, 165
- Fanning, Leonard M. : American Oil Operations Abroad, *review* by H. B. Milner, 186
- Faraday, Dr. Joseph Escott (compiled by) : Faraday's Encyclopedia of Hydrocarbon Compounds, Vol. 4, C_8, *review*, 583
- Faraday Society : General Discussion on the Interaction of Water and Porous Materials, 307, 629
- Faraday Society, and others : Symposium on Internal Stresses in Metals and Alloys, 70
- Faragó, P. S. : Electron Multiplier Tube of Large Effective Cathode Surface Area, 60
- Farmer, E. H. : Elected a Fellow of the Royal Society, 466
- Farnworth, A. J., and Speakman, Prof. J. B. : Action of Sulphuryl Chloride on Wool, 850
  - Chemical Mechanism of Permanent Set, 890
- Fast, J. F. (Snoek, Dr. J. L., and) : Metastable States of Nickel Characterized by a High Initial Permeability, 887
- Feather, Prof. N. : A Revised Sargent Diagram, 431
- Federation of British Industries : Special meeting of the Industrial Research Committee at the Royal Institution in honour of Sir Robert Robinson and Sir Edward Appleton, 508
- Federation of British Industries (Industrial Research Committee) and the Industrial Association of Wales and Monmouthshire : Joint regional conference on Industry and Research in Wales, 233
- Feibleman, James : The Revival of Realism, Critical Studies in Contemporary Philosophy, *review* by Prof. A. D. Ritchie, 623
- Feigl, Prof. Fr. : Inner-Complex Salts of Trivalent Thallium, 436
- Feindel, W. H., and others : Intravenous Methylene Blue, a New Method for Studying the Nervous System, 318
- Fell, Dr. E. W. : Appointed senior assistant in metallurgy at the Bradford Technical College, 272
- Fell, Dr. Honor B. : Awarded the Trail Award and Medal for 1942 of the Linnean Society of London, 51, 882
- Ferguson, W. S. : A Possible Relation between the Action of Clover Juice on Isolated Muscle and 'Bloat' in Cattle, 816
- Fernandes, F., and others : A New Sulpha Compound ('6257') and its Use in Human Cholera Infection, 395
- Feversham, Earl of : Sociology of Mental Disease, 408
- Fiennes, R. N. T.-W.- : Control of Cattle Trypanosomiasis, 602
- Fildes, Sir Paul : Honorary degree of the University of Cambridge conferred on, 965
  - Annual Review of Microbiology (edited by Charles E. Clifton, Sidney Raffel and H. Albert Baker), Vol. 1, *review*, 995
- Finalayson, W. : Appointed assistant conservator of forests, Tanganyika, 966
- Finch, Prof. G. I. : Elected president of the Physical Society for 1948–49, 758
  - Radio Physics, 795
- Findlay, Dr. J. D., and Yang, S. H. : Capillary Distribution in Cow Skin, 1012
- Finney, D. J. : Probit Analysis, *review* by Prof. J. H. Gaddum, 417
- Finnish Institute for the Exploration of the Sea : Appointment of Dr. Risto Jurva as director, 347
- Fischer, Dr. Albert : Amino-Acid Metabolism of Tissue Cells *in vitro*, 1008
- Fisher, James : Bird Recognition, I, Sea-Birds and Waders, *review* by Frances Pitt, 831
  - Orientation of Birds on Migratory and Homing Flights, 998
- Fisher, Prof. R. A. : Mathematical Theory of Tetraploidy, 758
- Fisher, R. B., and others : Quantitative Paper Chromatography, 764
- Fisher, W. A. P. : Photo-Elasticity in Mechanical Engineering, 329
  - A Large Field Compensator of the Berek Type, 848
- Fisheries School at Cronulla, New South Wales (G. A. Steven), 986
- Fishwick, V. C. : Dairy Farming, *review* by S. B., 544
- Fitter, R. S. R. : The Field Study and Conservation of the British Fauna, 409
- Fleming, Sir Alexander : Elected a member of the Athenæum under Rule II, 125
  - The Assaying of Penicillin, 287
  - Awarded the Medal for Merit by the Government of the United States, 800
  - Awarded the Grand Cross of Alfonso X, and an honorary degree of the University of Madrid conferred on, 966
- Fleming, Sir Arthur : The War Effort of a Great Engineering Organisation *review*, 113
- Fletcher, J. R. : Appointed inspector of mines, Malaya, 802
- Fleure, Prof. H. J. : Some Aspects of British Civilization, *review* by D. B. Harden, 746
- Fleure, J. L. : Appointed survey probationer, Malaya, 637
- Fleury, Prof. P. : Physiology and Biochemistry of Fats and Lipoids, 535
- Flint, Prof. H. T. : *Obituary* of Prof. Max Planck, 13
- Flockhart, N. B. : Appointed agricultural officer, North Borneo, 51
- Florence, Prof. P. Sargant : Recent Sociological Periodicals, 450
- Florey, Sir Howard : Awarded the Medal for Merit by the Government of the United States, 800
  - Appointed a member of the Advisory Council on Scientific Research and Technical Development, 924
- Fluegge, S. : An Introduction to Nuclear Physics, *review* by Sir John Cockcroft, 418
- Fogarty, M. P. : Plan your own Industries, 183
- Foinette, E. H. (Jenkins, C., and) : Chemistry for Schools, Part 3, *review* by Dr. S. H. Harper, 992
- Folkers, K., and others : Anti-Pernicious Anæmia Factor, 676
- Folley, Dr. S. J., and French, T. H. : Respiratory Quotient of the Mammary Gland, 933
- Food and Health, Ministries of : Awarded a Lasker Group Award by the American Public Health Association, 16
- Fooks, Dr. Ernest : X-Ray the City !, *review* by R. Brightman, 297
- Ford, Dr. Hugh : Appointed to the University of London readership in applied mechanics at the Imperial College of Science and Technology, 924
- Foreign Office : Publication and distribution of the first volumes of the F.I.A.T. Review of German Science, 389
- Forest Research Institute, Dehra Dun : Forest Leaflets dealing with the Vegetable Tanning Materials of India, 255
- Forest Research Institute of Sweden : *Meddelandan*, Vol. 35 (1946), 781
- Forestry Commission : Report of the New Forest Committee for 1947, 547
- Forrest, Dr. H. S., and Walker, Dr. James : Condensation of 2 : 4 : 5-Triamino-6-hydroxy-pyrimidine with Glucose and Fructose, 308
  - Reductone and the Synthesis of Pteridines, 721
- Forster, A. : Promoted to the grade of Senior Principal Scientific Cfficer, 195
- Forsyth, Dr. W. G. C. : Colour Reagents for the Paper Chromatography of Sugars, 239
- Fortes, Dr. M. : Science in Social Affairs, 69
  - The Dynamics of Clanship among the Tallensi, *review* by Dr. A. I. Richards, 111
- Foster, A. H. : Appointed veterinary officer, Nigeria, 966
- Foster, Dr. G. E. (Beesley, A. E., and) : Effect of Colchicine Treatment on the Alkaloidal Content of *Datura metel*, 561
- Foulkes, E. C. (Lemberg, R., and) : Reaction between Catalase and Hydrogen Peroxide, 131
- Fowler, Dr. G. J. : Scientific Research in India, 513
- Fowler, R. : Awarded the Williams Prize for 1947 of the Iron and Steel Institute, 512
- Fowles, G. : The Place of the History of Science in Education, 572
- Fox, Sir Cyril : Retirement from the directorship of the National Museum of Wales, 840 ; work of, 840
- Foxon, G. E. H. : Appointed to the University of London readership in biology at Guy's Hospital Medical School, 51
- Fraenkel, Dr. G., with the assistance of Blewett, M., and Coles, M. : B_T, a New Vitamin of the B-Group and its relation to the Folic Acid Group, and other Anti-Anæmia Factors, 981
- Francis, R. J. (Hicks, J. S., assisted by) : Low-Pressure Laminating of Plastics, *review* by J. M. J. Estevez, 788
- Francis, V. J. : Mathematics for Electrical Engineering, *review*, 541
- Francis, Dr. W. L. : Operational Research in Government Departments, 585
- Frank, Prof. Nathaniel H. (Slater, Prof. John C., and) : Mechanics, *review* by J. H. Pearce, 376
- Frankel, Dr. J. J. : Occurrence of Triolite, 63
- Frankl, Dr. E. K. : Photo-Elasticity in Mechanical Engineering, 329
- Franklin (Benjamin) : A Descendant of, *review* by Lieut.-Colonel H. D. Anthony, 909
- Franklin, Prof. K. J. : Preparation of a biography of Sir Joseph Barcroft, 164
- Franklin, Prof. K. J., and others : Studies of the Renal Circulation, *review*, 663
- Franks, Sir Oliver : Elected a member of the Athenæum under Rule II, 125
- Franzinetti, C., and Payne, R. M. : Emission of Li^8 in the Explosive Disintegration of Nuclei, 735
- Fraser, Dr. Francis Charles : Appointed a deputy keeper in the Department of Zoology of the British Museum (Natural History), 270
- Fraser, H. : Appointed senior assistant conservator of forests, Tanganyika, 637
- Frazer, Prof. A. C. : Physiology and Biochemistry of Fats and Lipoids, 534
- Frazer, H., and others : Empirical Data on Hilbert's Inequality, 361
- Freeman, J. A., and Turtle, E. E. : Insect Pests of Flour, 554
- Freeman, Peter : Appointed research assistant to the professor of engineering in the University of Sheffield, 1007
- Freeman, S. M., and Weissenberg, K. : Some New Anisotropic Time Effects in Rheology, 324
- French, Eleanor : Social Studies of the Elderly, 253
- French, T. H. (Folley, Dr. S. J., and) : Respiratory Quotient of the Mammary Gland, 933
- French Association of Scientific Workers : Organization of an International Holiday Centre at Morzine, 1007
- French National Demographic Institute (French National Union for Prevention of Depopulation and the) : Conference on Scientific Research on Ageing in the Population of France, 163
- French National Institute of Agronomic Research : To organise the Seventh International Sericultural Congress, 307
- French National Union for Prevention of Depopulation and the French National Demographic Institute : Conference on Scientific Research on Ageing in the Population of France, 163
- Friedlander, Dr. G., and Grunberg, L. : 'Low-Temperature' Oxidation of Higher Hydrocarbons at Atmospheric Pressure, 360
- Frisch, Prof. O. R. : Elected a Fellow of the Royal Society, 467
  - Meet the Atoms, *review* by Prof. P. B. Moon, 582
- Fröhlich, Dr. H. : Superconductivity, *review*, 37
  - Appointed to the chair of theoretical physics in the University of Liverpool, 715 ; work of, 715

Fry, Dr. Dennis : The Borderline of Psychology, Physics and Music, 590
Fry, D. W., and others : 30-MeV. Electron Synchrotron, 504
Fryer, Sir John : Elected a Fellow of the Royal Society, 467
Fu, F. Y., and others : Pharmacology of Ch'ang Shan (*Dichroa febrifuga*), a Chinese Antimalarial Herb, 400
Fuchs, Dr. J. : Blackett's Hypothesis of the Magnetic Field of Rotating Bodies, 598
Fuel, Institute of (Institute of Petroleum and the) : Joint Conference on Modern Applications of Liquid Fuels, 677, 1007
Fuel and Power, Ministry of : Appointment of Dr. H. Roxbee Cox as chief scientist, 1007
  Acceptance by Sir Alfred Egerton of the chairmanship of the Scientific Advisory Council, 1007
Fuel Efficiency Committees : Reconstitution of the, 634
Fuller, B. R. : Appointed assistant conservator of forests, Nyasaland, 471
Fulton, A. : Appointed director of veterinary services, Sierra Leone/Gambia, 802
Fulton, Dr. J. D., and Joyner, J. P. : Natural Amœbic Infections in Laboratory Rodents, 66
Furnivall, J. S. : Colonial Policy and Practice, a Comparative Study of Burma and Netherlands India, *review* by Maurice Bruce, 908
Furse, Peggy : Awarded the Bronze Star by the Government of the United States, 716
Fussell, G. E. : Village Life in the Eighteenth Century, *review* by Sir John Russell, 701

GAARENSTROOM, J. H., and de Jongh, S. E. : Contribution to the Knowledge of the Influences of Gonadotrophic and Sex Hormones on the Gonads of Rats, *review* by Prof. S. Zuckerman, 221
Gabe, M., and others : Influence of Vitamin P (Vitamin C$_2$) upon the Amount of Ascorbic Acid in the Organs of the Guinea Pig, 557
Gabor, Dr. D. : A New Microscopic Principle, 777
Gabrielsen, Dr. E. K. : Threshold Value of Carbon Dioxide Concentration in Photosynthesis of Foliage Leaves, 138
Gaddum, Prof. J. H. : Probits, *review*, 417
Gaitskell, Hugh : Opening of the Wolverhampton Industrial Centenary Exhibition, 634
Gale, Dr. E. F. : The Chemical Activities of Bacteria, *review* by Dr. H. K. King, 78
Gale, Dr. E. F. (Elliott, W. H., and) : Glutamine-synthesizing System of *Staphylococcus aureus*, its Inhibition by Crystal Violet and Methionine-sulphoxide, 129
Gallop, J. W., and others : 30-Me-V. Electron Synchrotron, 504
Gamow, Prof. George : Atomic Energy in Cosmic and Human Life, *review* by Prof. J. A. Crowther, 4
Ganay, Mme. Solange de : Les Devises des Dogons, *review* by G. I. Jones, 622
Gardikas, C., and others : Choleglobin Formation in the Erythrocyte, 607
Garlick, Dr. G. F. J., and Gibson, A. F. : Luminescence Efficiency Changes in Zinc Sulphide Phosphors below Room Temperature, 359
Garlick, Dr. G. F. J. (Wilkins, Dr. M. H. F., and) : Relation between Photoconduction and Luminescence in Zinc Sulphide, 565
Garnett, Wilfred J. : Visual Aids, Notes on some Modern Apparatus, 124
Garnham, P. C. C. (Shortt, Prof. H. E., and) : Pre-erythrocytic Stage in Mammalian Malaria Parasites, 126
Garrod, Prof. D. A. E. : *Obituary* of Prof. G. C. MacCurdy, 47
Gärtner, August (1848–1934), 593
Gawn, R. W. L. : Aspects of the Locomotion of Whales, 44
Gaydon, Dr. A. G. : Dissociation Energies, 731
Gaydon, Dr. A. G. (Pannetier, Dr. G., and) : Band Spectrum of ClO in Flames, 242
General Register Office : Series of publications under the title of Studies on Medical and Population Subjects, 17
General Motors Corporation, and others : Conference on Mechanical Wear, 758
Genetical Society of Great Britain : Election of Prof. R. C. Punnett and Prof. A. H. Sturtevant as honorary members, 595
Genetical Society of Great Britain and the British Empire Cancer Campaign : Symposium on the Genetics of Cancer, 843
Geographic Society of Sweden : Award of the Vega Medal to Admiral Richard Byrd, 430
Geographical Society, Royal : Founder's Medal awarded to Wilfred Thesiger, 553
  Patron's Medal awarded to Thomas H. Manning, 553
  Victoria Medal awarded to Prof. Frank Debenham, 553
  Murchison Grant awarded to Robert W. Steel, 553
  Back Grant awarded to Alan J. Marshall, 553
  Cuthbert Peek Grant awarded to Dr. Donald F. Thomson, 553
  Gill Memorial awarded to William E. W. Williams, 553
Geological Society of London : Wollaston Medal awarded to Sir Edward Bailey, 122
  Murchison Medal awarded to Dr. J. Phemister, 122
  Lyell Medal awarded to Prof. A. H. Cox, 122
  Prestwich Medal awarded to the Abbé Henri Breuil, 122
  Wollaston Fund awarded to Dr. J. G. C. Anderson, 122
  Murchison Fund awarded to Dr. F. W. Cope, 122
  Lyell Fund (in two moieties) awarded to Dr. Dorothy Rayner and W. D. Ware, 122
  Awards from the Daniel-Pidgeon Fund made to Dr. J. S. Webb and to W. S. McKerrow, 1007
George, Dr. E. P., and Jason, A. C. : High-Altitude Measurements on Cosmic Rays—Penetrating Cosmic Ray Showers, 248
George, Dr. E. P., and Trent, P. T. : High-Altitude Measurements on Cosmic Rays—Penetrating Bursts, 248
German Chemists in the British Zone, Society of : Annual Meeting, 758
Géro, E., and others : Influence of Vitamin P (Vitamin C$_2$) upon the Amount of Ascorbic Acid in the Organs of the Guinea Pig, 557
Gerritsen, H. J. (Melchers, W. J., en) : Koper als onmisbaar element voor plant en dier, *review*, 624
Ghosh, S. N., and others : Abnormalities in the F-Region of the Ionosphere at Calcutta, 24
Gibson, A. G. (Garlick, Dr. G. F. J., and) : Luminescence Efficiency Changes in Zinc Sulphide Phosphors below Room Temperature, 359
Gibson, Dr. Henry J. C. : The Early Days of Dundee Royal Infirmary, 555
Giese, Arthur C., and others (edited by) : Annual Review of Physiology, Vol. 9, *review* by Dr. O. A. Trowell, 542
Gilbert, A. : Appointed lecturer in psychology in the University of Sheffield, 1007
Gilbert, J. C. : Appointed senior lecturer in economics in the University of Sheffield, 1007
Gillet, S. : Appointed director of agriculture, Kenya, 471
Gillin, John : Moche, a Peruvian Coastal Community, 697
Gilmour, J. S. L. : Wild Flowers of the Chalk, *review*, 188
  The Study of Critical British Groups, 733
Gils, G. E. van, and others : Complexity of Fresh *Hevea* Latex, 177
Gimpera, Prof. Pedro Bosch : Appointed director of the Philosophy and Humanistic Studies Section of U.N.E.S.C.O., 304
Giovanelli, R. G. : Emission of Enhanced Microwave Solar Radiation, 133
Giri, Dr. K. V. (Chak, I. M., and) : Regeneration of Prothrombin Activity by Carbon Dioxide, 354
Girls' Clubs and Mixed Clubs, National Association of : Summer School for Youth Leaders on the Club Programme and Informal Education, 924
Gisiger, Dr. L. : Trace Elements in Plant Physiology, 365
Glaciological Society, British, and others : Discussion on the Flow of Glaciers, 819
Glanville, Prof. S. R. K. : Growth and Nature of Egyptology, 346
Glascock, Raymond (Arrol, Dr. W. J., and) : Microsynthesis of C^{14}-Labelled Ethyl Iodide, 932
Glasgow Art Gallery and Museum : Publication of booklets on Habitat Groups, 90
Glendinning, W. G. (Drinkwater, Dr. J. W., and) : Awarded the George Taylor (of Australia) Gold Medal of the Royal Aeronautical Society, 593
Godding, Robert, and others : Colonial Administration by European Powers, 372
Godward, Dr. M. B. E. : The Iron Alum Acetocarmine Method for Algæ, 203
Godwin, Dr. H. : The Ecological Approach to Botany, 157
Gold, T. (Pumphrey, Dr. R. J., and) : Phase Memory of the Ear, a Proof of the Resonance Hypothesis, 640
Gold, Dr. V. (Baxter, E. G., and) : A Simple Moving-Boundary Apparatus, 403
Gold Coast Legislative Council (Martin Wight), 371
Goldschmidt, H. J. : Structure and Properties of Metals, 263
Goldsmith, Maurice : The Government Social Survey, 573
Gonville and Caius College, Cambridge : Pre-election of Sir James Chadwick as Master, 882, 964
Good, P. : Scientific Radio, 793
Good, Prof. Ronald : The Geography of the Flowering Plants, *review* by Sir Edward Salisbury, 704, 857
Goodacre, C. L., and others : *p*-Aminosalicylic Acid in the Treatment of Tuberculosis, 435
Goodall, Dr. D. W., and Gregory, Dr. F. G. : Chemical Composition of Plants as an Index of their Nutritional Status, 406
Goodeve, Sir Charles : Operational Research, 377, 609
  Operational Research in the Research Associations, 584
Goodstein, Dr. R. L. : Appointed to the chair of mathematics at University College, Leicester, 344
Goodwin, T. W., and Srisukh, S. : The Carotenoids of the Locust Integument, 525
Gordon, Seton : Gathered Nature Stories, *review*, 744
  Fisherman and Nature Lover, *review*, 951
Gorer, Dr. Peter A. : Awarded a grant from the Lady Tata Memorial Fund, 966
Gorter, Prof. C. J., and others : Magnetic Observations and Thermometry in the Region of Millidegrees Absolute, 678
Gorvin, John H. : *p*-Hydroxybenzil, 208
Gould, Dr. A. J. : Appointed senior lecturer in the Department of Glass Technology in the University of Sheffield, 307
Gould, F. A. : Use of Equivalent Metric Values in Scientific Papers, 144
Govaerts, Dr. J., and Dallemagne, Prof. M. J. : Influence of Folliculin on Bone Metabolism, Studied by Means of Radiophosphorus, $^{32}_{15}$P, 977
Goward, F. K., and others : 30-MeV. Electron Synchrotron, 504
Graham, Ernest S. : Honorary degree of doctor of laws of the University of Sheffield conferred on, 555
Graham, R. : The Study of Critical British Groups, 735
Grainger, Dr. John : Pastures and Pasture Research (C. M. Donald), second edition, *review*, 747
Grant, M. W. : Metabolic Aspects of Convalescence, 535
Gray, C. H., and Kekwick, Dr. R. A. : Bilirubin-Serum Protein Complexes and the van den Bergh Reaction, 274
Gray, Ernest : Ciliate Protozoan Fauna of Soil and Inland Waters, 854
Gray, Prof. J. : Aspects of the Locomotion of Whales, 199
Greaves, H. R. G. : The Civil Service in the Changing State, 496
Green, A. T. : Operational Research in the Research Associations, 584
Green, Harriet C., and others : Visible Speech, *review* by Dr. W. G. Radley, 334
Green, Dr. H. S. : Liquid Helium II, 391
Green, Ltd., J. Barcham : 105 Lens Tissue, 514
Greenkeeping Research, Board of : Reappearance of the *Journal* of the, 757
Greenly, Sir John : Elected a Fellow of the Institute of Metals, 16
Greenough, G. B. : Internal Stresses in Metals, 683
Greenslade, R. M., and others : New Formulation of D.D.T. with Selective Properties, 484
Greenstein, Dr. Jesse P. : *Obituary* of Prof. J. Masson Gulland, 87
Greenwood, A. N. : Appointed lecturer in electrical engineering in the University of Leeds, 1006
Greer, E. N., and others : Action of Nitrogen Trichloride on Proteins—Production of Toxic Derivative, 126
Gregory, Prof. F. G., and Purvis, Dr. O. N. : Reversal of Vernalization by High Temperature, 859
Gregory, Prof. F. G. (Goodall, Dr. D. W., and) : Chemical Composition of Plants as an Index of their Nutritional Status, 406
Gregory, Lewise W., and others : What People Are, a Study of Normal Young Men, *review*, 502
Gregory, P. H. : Cereal Rusts, *review*, 220
Greig, Prof. J. : Radio Research in Britain, 943
Greig, P. A. : Appointed agricultural development officer, Nigeria, 51

Greig, Sir Robert : *Obituary* by Dr. W. G. Ogg, 120
Gridgeman, N. T., and others : Units and Useful Range in Photo-electric Colorimetry, 247
Griffith, Sir William T. : Awarded the Simms Gold Medal of the Royal Aeronautical Society, 593
Griffiths, Dr. Ezer : Insulating Materials and Methods for Use at Low Temperatures, 323
  Microcalorimetry (Prof. W. Swietoslawski), *review*, 460
  Methods of Measuring Temperature, third edition, *review* by S. Weintroub, 624
Griffiths, H. V., and others : Meteor Whistles, 478
Griffiths, J. D. (Rose, L., and) : Stress-Strain Characteristics of Viscose Rayon in relation to Anisotropy, 737
Griffiths, Dr. J. H. E. : Radio Physics, 795
Gripenberg, Dr. J., and others : Effect of Ionic Charges on the Energy and Entropy of Activation of Heterolytic Reactions, 480
Gripenberg, Dr. J. (Erdtman, Prof. Holger, and) : Antibiotic Substances from the Heart Wood of *Thuja plicata* Don., 719
Groen, Dr. P. : Internal Waves in certain Types of Density Distribution, 92
Gross, Dr. George L., and others : Mathematical Theory of Rocket Flight, *review* by Dr. R. A. Rankin, 3
Grossbard, Erna : Production of an Antibiotic Substance on Wheat Straw and other Organic Materials and in the Soil, 614
Grummitt, Dr. W. E., and Wilkinson, Dr. G. : Fission Products of U^{233}, 520
Grunberg, L., and Nissan, Dr. A. H. : Critical Temperature and Molecular Weight of *n*-Paraffins, 170
Grunberg, L. (Friedlander, Dr. G., and) : 'Low-Temperature' Oxidation of Higher Hydrocarbons at Atmospheric Pressure, 360
Grüneberg, Dr. Hans : Animal Genetics and Medicine, *review* by Prof. C. H. Waddington, 543
Grunwald, Dr. Ernest M. : Awarded a Frank B. Jewett Fellowship for 1948–49 by the American Telephone and Telegraph Co., 429
Guerrero, A. H., and Williams, Dr. R. Tecwyn : The Tollens Naphthoresorcinol Reaction for Uronic Acids, 930
Gueterbock, Colonel P. G. : Internal Stresses in Metals and Alloys, 70
Guildford Health Committee : Attempt to combat infection of Food and Drink, 635
Gulland, Prof. J. Masson : *Obituary* by Dr. Jesse P. Greenstein, 87
Gulland, the late Prof. J. Masson, and Jordan, Dr. D. O. : Structure of Yeast Ribonucleic Acid, 561
Gunn, Dr. D. L. : Aircraft Attack on Locusts, 342
Gupta, Dr. M. C. Sen, and Sen, K. C. : A Text Book of Physical Chemistry, new edition, *review*, 460
Gupta, Dr. S. (Majumdar, R. C., and) : The Meson Field and the Equation of Motion of a Spinning Particle, 410
Gurjar, Prof. L. V. : Ancient Indian Mathematics and Vedha, *review* by Prof. E. H. Neville, 580
Gurney, C. : Delayed Fracture of Glass under Tension, Torsion and Radial Pressure, 729
  The Flow of Glaciers, 821
Gurton, O. A. (Bowden, Dr. F. P., and) : Birth and Growth of the Explosion in Solids initiated by Impact, 348
Guy's Hospital Medical School : Appointment of G. E. H. Foxon to the University of London readership in biology, 51
  Appointment of James Whillis to the University of London chair of anatomy, 924

HABERMAN, Dr. Sol (Hill, Dr. Joseph M., and): Two Examples of Sera containing the Anti-*d* Agglutinin Predicted by Fisher and Race, 688
Haddow, T. D. : Awarded a Commonwealth Fund Fellowship, 1006
Haig-Brown, Roderick : A River Never Sleeps, *review* by Seton Gordon, 951
Hailey, Lord, and others : Colonial Administration by European Powers, 372
Haissinsky, M. : Isotope Exchange and Molecular Structure, 901
Halban, Dr. H., and others : Comparison of Cross-sections for the Capture of 220 and 900 keV. Neutrons, 727
Halberstadt, E. S., and others : Formation of Hydroxy Peroxides, 172
Haldane, J. B. S. : Science Advances, *review* by R. Brightman, 747
Hall, Noel : Industrial Co-operation, 571
Hall, Victor E., and others (edited by), Annual Review of Physiology, Vol. 9, *review* by Dr. O. A. Trowell, 542
Hamburger, Dr. Viktor : Embryology of Monsters, 88
Hamilton, Prof. Donald R., and others : Klystrons and Microwave Triodes, *review* by Prof. J. T. Randall, 952
Hamilton, J. E. : Effect of Present-day Whaling on the Stock of Whales, 913
Hamlin, H. W. : Appointed assistant conservator of forests, Tanganyika, 802
Hammond, Dr. John : Presented by the Netherlands Ambassador with the insignia of Commander in the Order of Orange-Nassau (Civilian Division), 307
Hanby, W. E., and others : Synthetic Polyglutamic Acid, 132
Hancock, J. L., and others : Ovarian Activity in the Pregnant Mare, 355
Hanson, A. H. : Appointed lecturer in the Departments of Social Studies and Extra-Mural Studies in the University of Leeds, 16
Hanson, Jean : Formation and Breakdown of Serpulid Tubes, 610
Harden, D. B. : Geographical Approach to the History of the British Isles, *review*, 746
Harding, J. R. : South African Museums Association—Annual General Meeting, 984
Hardy, Prof. G. H. : *Obituary*, 797
Hardy, J. K. : Promoted to the grade of Senior Principal Scientific Officer, 195
Hargreaves, Dr. A. : Structure and Properties of Metals, 264
Hargreaves, Dr. G. R. : Sociology of Mental Disease, 407
Harper, Dr. S. H. : Chemistry from the School to the University, *review*, 992
Harpum, J. R. : Appointed geologist, Tanganyika, 51
Harris, Betty M. B. : Material for Visual Education, *review* by Colonel Eric Lowe, 40
Harris, Dr. E. J., and Bishop, P. O. : Low-Frequency Noise from Thermionic Valves working under Amplifying Conditions, 971
Harris, G. C. M., and others : A Method for Estimating Percentage Germination of Fungal Spores, 642
Harris, G. W. : Electrical Stimulation of the Neurohypophysis in the Conscious Animal, 739
Harris, Prof. H. A. : Man's Organs of Speech, 628
Harris, J. I., and Work, T. S. : Synthetic Pentapeptides related to Gramicidin-*S*, 804
Harris, Dr. J. O., and Robson, A. H. : Structure of Urea, 98
Harris, Percy W. : Elected president of the Royal Photographic Society, 471
Harris, Dr. R. J. C., and Thomas, J. F. : Isolation and Separation of the Pyrimidine Nucleosides of Yeast Ribosenucleic Acid, 931
Harris, Prof. T. M. : Elected a Fellow of the Royal Society, 467
Harris, jun., William J. : Comparison of Metallographic and X-Ray Measurements of Retained Austenite, 315
Harrison, Dr. E. P. : *Obituary*, 963
Harrison, John A. : Appointed director of the Educational Foundation for Visual Aids, 802
Harrison, Dr. R. G. : Vascular Patterns in the Testis, with particular reference to *Macropus*, 399
Hartley, F. R., and Wylie, Dr. A. W. : Preparation of Rare-Earth Chlorides, 241
Hartley, Dr. G. S. : Appointed research manager of Pest Control, Ltd., 595
Hartley, Dr. Harold : Engineers and the Community, 1005
Hartley, K., and others : Bond-Strength of C—Cd in Cadmium Methyl and of C—I in Methyl Iodide, 725
Hartley, R. L. : Appointed agricultural education officer, Fiji, 637
Hartogh-Katz, S. Lore, and others : Isolation of a New Androstenol-3(α)-on-17 from the Urine of a Patient with Adrenal Cancer, 848
Hartree, Prof. D. R. : Calculating Machines, 712
Hartridge, Prof. H. : Retirement from the University of London chair of physiology at St. Bartholomew's Hospital Medical College, 49
  Appointed director of the Medical Research Council's Research Unit on the Physiology of Vision, 49 ; work of, 49
Hartshorn, Dr. L. : Scientific Radio, 793
Hartshorne, Dr. N. H. : A Simple Universal Model for Representing the Optic Orientation of Biaxial Crystals, 94
  Appointed lecturer in chemical microscopy in the University of Leeds, 307
Harvard University : Retirement of Dr. E. D. Merrill from the Arnold professorship of botany, 964
Harwood, A. F. (edited by) : British Bee Plants, 470
Haskell, Gordon : Corn (*Zea Mays* L.) in the United States, 42
Haslewood, Dr. G. A. D., and Wootton, Veryan : Bile Acids of the Whale, 356
Hassall, C. H. : Subtilin *C*, an Antibiotic Concentrate from *Bacillus subtilis*, 317
Hassid, Dr. W. Z., and others : Arsenolysis and Phosphorolysis of the Amylose and Amylopectin Fractions of Starch, 96
Hat and Allied Feltmakers' Research Association, British : Grant of £1,000 for research in the Textile Industries Department of the University of Leeds, 1006
Hausmann, W., and Smith, Dr. A. E. Wilder : Isomerization of Dienœstrol, 892
Havas, L. J., and Kahan, J. : Hormone-Mimetic and other Responses of the Silkworm (*Bombyx mori* L.) to some Polyploidogenic Agents, 570
Hawk, Dr. Philip B., and others : Practical Physiological Chemistry, twelfth edition, *review*, 830
Hawkes, Prof. C. F. C. : Archæology and the History of Europe, *review* by Miles Burkitt, 459
  Archæology and Society (Grahame Clark), second edition, *review*, 583
Hawkes, Dr. Leonard : Title of University of London professor of geology conferred on, 637
Hawking, Dr. Frank : Pre-erythrocytic Stage in Mammalian Malaria Parasites, 175
Hawkins, Prof. H. L. : *Obituary* of Sir Franklin Sibly, 672
Hawkins, R. D., and others : Effect of Thyroid Deficiency on the Level of Pseudo-Cholinesterase in the Plasma of Rats, 639
Hawkins, T. H. : A Handbook of Sociology (Prof. William F. Ogburn and Prof. Meyer F. Nimkoff), *review*, 188
  Industrial Co-operation, 571
  The Psychology of Industry (Prof. James Drever), second edition, *review*, 955
  The Right Way to Understand the Countryside (Stanley A. Manning), *review*, 995
Haworth, Sir Norman : Retirement from the Mason chair of chemistry in the University of Birmingham, 1007
Hay-Barclay, H. A. : Appointed regional assistant director of veterinary services, Nigeria, 802
Haywood, R. W. : The Electricity Grid in Great Britain, 822
  Fundamentals of Heat Engines, *review*, 829
Health Education, Central Council for : Summer School in Health Education, 842
Heard, Brian E. : Appointed an assistant lecturer in pathology in the University of Sheffield, 1007
Heath, Clark W., and others : What People Are, a Study of Normal Young Men, *review*, 502
Heath, D. F., and Linnett, Dr. J. W. : Interaction Terms in Molecular Vibrations, 243
  A Suggested New Force Field for Molecular Vibrations, 314
Heath, J., and others : New Formulation of D.D.T. with Selective Properties, 484
Heath, Dr. O. V. S. : Studies in Stomatal Action—Control of Stomatal Movement by a Reduction in the Normal Carbon Dioxide Content of the Air, 179
Heath, Dr. O. V. S., and Williams, Dr. W. T. : Studies in Stomatal Action—Adequacy of the Porometer in the Investigation of Stomatal Aperture, 178
Heathcote, J. G., and others : Action of Nitrogen Trichloride on Proteins—Production of Toxic Derivative, 126
Heatley, Dr. N. G. : The Assaying of Penicillin, 285, 286
Hecht, Prof. Selig : *Death* of, 303 ; *Obituary* by Dr. M. H. Pirenne, 673
Heenan, J. N. D. : Awarded the Medal of Freedom with Bronze Palm by the Government of the United States, 215
Hegner, Prof. Robert, assisted by Hegner, Jane Z. : Parade of the Animal Kingdom, *review* by Dr. Edward Hindle, 501

Heidmann, J. (Leprince-Ringuet, L., and) : Anomalous Distribution of Nuclear Disintegration in Photographic Emulsions Exposed to Cosmic Rays—Double Stars, 844
Heilbron, Sir Ian : Awarded the Medal of Freedom with Bronze Palm by the Government of the United States, 215
  The Role of Chemistry in combating Tropical Diseases, 956
Heitler, Prof. W. H. : Elected a Fellow of the Royal Society, 467
  Radiation Damping and Velocity of Light, 678
Helson, G. A. H., and others : Plant Virus Diseases, 945
Hematology, International Society of : Bi-annual Meeting in Buffalo, 636
Hemke, Prof. Paul E. : Elementary Applied Aerodynamics, *review*, 544
Hemphill, R. E. (Reiss, Dr. M., and) : Cholinesterase Activity in Cerebro-Spinal Fluid, 18
Henbest, Dr. H. B. : Elected to a Beit Fellowship for Scientific Research at the Imperial College of Science and Technology, 51
  Synthesis of Dehydro-β-Ionone, 481
Henderson, R. : Appointed agricultural officer, Malaya, 51
Hendrix, W. C., and others : The Earth's Main Magnetic Field and its Secular Change 1905–1945, 161
  Final Values of Elements of the Geomagnetic Field at 5-Degree Intervals of Latitude and Longitude, Epoch 1945, 161
Henkin, Dr. Leon A. : Awarded a Frank B. Jewett Fellowship for 1948–49 by the American Telephone and Telegraph Co., 429
Henrici, Dr. A. T. (the late) : Molds, Yeasts and Actinomycetes, second edition by Dr. Charles E. Skinner, Dr. Chester W. Emmons and Dr. Henry M. Tsuchiya, *review*, 40
Henriques, Dr. F. : Appointed lecturer in social anthropology in the University of Leeds, 1006
Herbstreit, Jack W., and Johler, Joseph R. : Frequency Variation of the Intensity of Cosmic Radio Noise, 515
Herman, L., and Herman, R. : Mechanism of the Emission Spectrum of Active Nitrogen, 1018
Herring, H. R. : Appointed senior assistant conservator of forests, Tanganyika, 637
Herring, Prof. P. T. : *Obituary* of Prof. E. Waymouth Reid, 591
  Retirement from the Chandos chair of physiology in the University of St. Andrews, 922 ; work of, 922
Herz, Dr. R. H. : Electron Tracks in Photographic Emulsions, 928
Herzberg, Prof. G., and Herzberg, L. : Production of Nitrogen Atoms in the Upper Atmosphere, 283
Herzberg, Prof. G., and Walker, G. R. : Initiation of High Explosives, 647
Hetherington, Sir Hector : Honorary degree of the University of Cambridge conferred on, 965
Hevesy, Prof. G. v. : Isotope Exchange and Molecular Structure, 901
Hewitt, Dr. E. J. : Trace Elements in Plant Physiology, 364
  Relation of Manganese and some other Metals to the Iron Status of Plants, 489
Hewitt, Dr. E. J. (Wallace, Prof. T., and) : Effects of Calcium Deficiency on Potato Sets in Acid Soils, 28
Hewson, Dr. E. Wendell, and Longley, Richard W. : Meteorology, Theoretical and Applied, *review* by Prof. P. A. Sheppard, 625
Hey, J. S. : Radio Noise, 795
Hey, R. W., and others : Cambridge Archæological Expedition to Cyrenaica, 327
Heymann, Prof. E. (Buchanan, A. S., and) : Electrokinetic Potential and Surface Structure of Barium Sulphate, 649, 691
Heywood, R. B. : Some Modern Applications of Photo-Elasticity, 329
Heyworth, G. : Rebuilding Europe's Fat Supplies, 123
Hickling, Dr. C. F. : Fish Farming in the Middle and Far East, 748
Hickling, Prof. H. G. A. : Retirement from the chair of geology at King's College, Newcastle-upon-Tyne, 1003 ; work of, 1003
Hickman, M. J. : Insulating Materials and Methods for Use at Low Temperatures, 323
Hicks, J. S., assisted by Francis, R. J. : Low-Pressure Laminating of Plastics, *review* by J. M. J. Estevez, 788
Hieger, Dr. I. : Progress of Cancer Research, 385
Higson, L. E. : The Place of the History of Science in Education, 572
Hilger, Ltd., Adam : Amalgamation with E. R. Watts and Son, Ltd., 345
Hill, Dr. Joseph M., and Haberman, Dr. Sol : Two Examples of Sera containing the Anti-*d* Agglutinin Predicted by Fisher and Race, 688
Hill, Air Chief Marshal Sir Roderic : Appointed rector of the Imperial College of Science and Technology, 471
Hill, R. D. (Martin, Dr. L. H., and): A Manual of Vacuum Practice, *review*, 665
Hill, Dr. W. C. Osman : An Undescribed Structure in the Rodent Rhinarium, 276
Himsworth, Prof. H. P. : *Obituary* of Dr. Charles Bolton, 86
  Appointed a member of the Medical Research Council, 390
Hindle, Dr. Edward : Animal Parade, *review*, 501
Hindley, H. Rostron : Use of 'Calyx' Burner to Determine Combustion Conditions, 395
Hird, Dr. Alan J. : Demonstration of the Heart Beat, 321
Hirst, Prof. E. L., and others : Separation and Identification of Methylated Sugars on the Paper Chromatogram, 720
Historical Association, and others : Discussion on the Place of the History of Science in Education, 347, 572
History of Science, British Society for the, and others : Discussion on the Place of the History of Science in Education, 347, 572
Hobson, P. T., and Osmond, W. P. : Ferro-magnetic Structure of Cold-Worked Austenitic Stainless Steels, 562
Hoch-Ligeti, Cornelia : Effect of Feeding 2-Acetaminofluorene on the Adreno-Gonadal System of Rats, 58
Hockenhull, Donald : Mustard-gas Mutation in *Aspergillus nidulans*, 100
Hodgkin, A. L. : Elected a Fellow of the Royal Society, 467
Hogarth, C. A. : Variation of Thermo-electric Power of Electronic Semi-Conductors with Vapour Pressure, 60
Högland, Hans : Foraminifera in the Gullmar Fjord and the Skagerak, 513
Hollingsworth, D. T. : Awarded a Page Prize for 1947 of the Institution of Electrical Engineers, 90
Hollingworth, Prof. J. : Electronics in Industry, *review*, 582
Holman, Ralph T. (Bergström, Prof. Sune, and) : Total Conjugation of Linoleic Acid in Oxidation with Lipoxidase, 55
Holman, W. I. M. (Dean, R. F. A., and) : Nicotinic Acid in Human Blood Cells at Birth, 439
Holmberg, Dr. C. G., and Laurell, C.-B. : Histaminolytic Activity of a Copper Protein in Serum, 236
Holmyard, Dr. E. J. : Training for Chemists, 31
  The Place of the History of Science in Education, 572
Homans, L. N. S., and others : Complexity of Fresh *Hevea* Latex, 177
Honeycombe, R. W. K., and Boas, Dr. W. : The Disordering of β-Brass by Cold Work, 612
Hooper, Dr. Cyril J. W. : Appointed editor and general secretary of the Society of Dyers and Colourists, 347
Hooper, F. C. : Industrial Co-operation, 571
Hopkins, Donald P. : Chemicals, Humus and the Soil, *review*, 39
Hopwood, Dr. A. Tindell : The Royal Academy, 1948, 876
Horkheimer, Max : Eclipse of Reason, *review* by A. D. R., 664
Horner, R. G., and Purslow, E. T. : Dependence of Anomaloscope Matching on Viewing-Distance or Field-Size, 484
Horney, Dr. Karen : Our Inner Conflicts, *review* by Dr. Clifford Allen, 830
Horsley, R. R. H. : Appointed inspector of mines, Malaya, 966
Horváth, Dr. J. I. : An Asymptotic Solution of the Fundamental Equation of the Statistical Atom Theory, 26
Hothersall, A. W. : Promoted to the grade of Senior Principal Scientific Officer, 195
Hough, J. M. : Interpretation of Data from Electrical Resistivity Geophysical Surveys, 812
Hough, L., and others : Separation and Identification of Methylated Sugars on the Paper Chromatogram, 720
Hough, Romeyn Beck : Handbook of the Trees of the Northern States and Canada East of the Rocky Mountains, *review* by Sir Edward Salisbury, 497
House of Commons : University Representation in the, 259 ; (O. Peake), 468 ; (Herbert Morrison), 468 ; (Chuter Ede), 468
Houstoun, Dr. R. A. : A Simple Way of Photographing Spectra, 973
Howard, Dr. H. W. : Chromosome Number of *Cardamine pratensis*, 277
Howarth, Frank : A Radioactive Local Anæsthetic, 857
Howe, G. Melvyn : Agro-Climatic Analogues, 983
Howells, Prof. William : Mankind So Far, *review*, 579
Howes, Frank : A Proposed Institute of Recorded Sound, 493
Howitt, Dr. F. O. : Bibliography of the Technical Literature on Silk, *review* by Prof. J. B. Speakman, 790
Hoyle, S. T. : Appointed senior agricultural officer, Lilongwe Experimental Station, Nyasaland, 471
Huang, K. C., and others : Pharmacology of Ch'ang Shan (*Dichroa febrifuga*), a Chinese Antimalarial Herb, 400
Hubbard, C. E. : The Study of Critical British Groups, 735
Hubinont, Dr. P. O.: Action of Heating on *Rh*-Positive Human Red Cells, 642
Huddleston, Sir Arthur : *Death* of, 303
Hudson, Dr. Douglas Rennie : Amalgamation of some Alloys of Gold, Silver and Copper, 288
  Mechanics of Packings of Granular Material, 512
Hugh-Jones, Dr. P. : Human Factors in Industry, 791
Hughes, Dr. E. B. : Cleaning and Sterilizing of Plant in the Food Industry, 1025
Hughes, Prof. E. D. : Appointed to the University of London chair of chemistry at University College, London, 430, 511 ; work of, 511
  Electronic Theory and Chemical Reactions (R. W. Stott), second edition, *review*, 503
Hughes, Prof. E. D., and others : Effect of Ionic Charges on the Energy and Entropy of Activation of Heterolytic Reactions, 480
  Fractional Distillation and its Application in the Concentration of the Heavy Isotopes of Oxygen and Hydrogen, 858
Hughes, Dr. L. E. C. : Radio Engineering (Dr. E. K. Sandeman), Vol. 1, *review*, 706
Human Relations, No. 1, 450
Humphrey, G. F., and Mann, Dr. T. : Citric Acid in Semen, 352
Hunter, R. B. : Awarded a Commonwealth Fund Fellowship, 1006
Huntley, H. E. : Production of Helium by Cosmic Rays, 356
Huntsman, Dr. A. G. : Salmon and Animal Migration, 300
Hurst, Dr. C. C. : *Obituary* by Prof. R. C. Punnett, 46
Huskins, Prof. C. Leonard : Chromosome Multiplication and Reduction in Somatic Tissues, 80
Hussein, F. : The Study of Critical British Groups, 735
  Chromosome Number of *Cardamine pratensis*, 1015
Hutchinson, A. O., and others : Effect of Under-nutrition and Alterations in Diet on the Choline Esterase Activity of Serum, 56
Hutchinson, Dr. John : Retirement from the Royal Botanic Gardens, Kew, 799
Hutchinson, Dr. J. B., and others : Action of Nitrogen Trichloride on Proteins—Production of Toxic Derivative, 126
Hutchinson, Dr. William C. : Appointed a lecturer in physiological chemistry in the University of Glasgow, 16
Hutson, L. R. : Appointed veterinary officer, Department of Science and Agriculture, Barbados, 802
Hutton, Prof. J. H. : Exhibition of Indian Art, 119
  Archéologie du Pacifique-nord (Dr. André Leroi-Gourhan), *review*, 545
Huxley, Dr. L. G. H. : A Survey of the Principles and Practice of Wave Guides, *review* by Dr. R. L. Smith-Rose, 334
  Electrons (+ and —), Protons, Photons, Neutrons, Mesotrons and Cosmic Rays (Robert Andrews Millikan), revised edition, *review*, 789
Hydromechanics Research Association, British : Formation of the, 230
Hylean Amazon, International Institute of the : Conference for the creation of an, 879

ILAND, C. N. : Effect of Antibacterial Analogues of Vitamin K on *M. tuberculosis*, 1010
Imms, Dr. A. D. : Biology of the Louse, *review*, 418
Imperial Chemical Industries, Ltd. : Research Fellowships in the University of Cambridge, 90
Imperial College of Science and Technology, London : Election of Viscount Falmouth as chairman, 17
  Title of University of London reader in surveying conferred on Alfred Stephenson, 51
  Election of H. B. Henbest to a Beit Fellowship for Scientific Research under Sir Ian Heilbron, 51
  Degree of D.Sc. of the University of London conferred on Sir Alfred Egerton, 347

  Appointment of Air Chief Marshal Sir Roderic Hill as rector, 471
  Summer School in Relaxation Methods, 717
  Appointment of Dr. Hugh Ford to the University of London readership in applied mechanics, 924
  Title of reader in biochemistry in the University of London conferred on Dr. H. W. Buston, 924
Imperial Institute : Exhibition of War Office Teaching Aids, 164
  Annual Report for 1947, 985
India, Government of : Creation of a Department of Scientific Research, 1004
Indian Research Fund Association : Report of the Scientific Advisory Board for 1946, 696
Indian Society for Quality Control : Formation of the, 595
Industrial Association of Wales and Monmouthshire (Industrial Research Committee of the Federation of British Industries and the) : Joint regional conference on Industry and Research in Wales, 233
Ing, Dr. H. R. (Barlow, Dr. R. B., and) : Curare-like Action of Polymethylene *bis*-Quaternary Ammonium Salts, 718
Ingold, Prof. C. K. : Isotope Exchange and the Mechanism of Heterolytic Substitution, 901
Ingold, Prof. C. K., and others : Effect of Ionic Charges on the Energy and Entropy of Activation of Heterolytic Reactions, 480
Ingold, Prof. C. T. : Mycological Education, 508
Ingram, G. B., and Southern, H. K. : Polarographic Determination of the Gamma-isomer of Benzene Hexachloride, 437
Innes, Roy : Science in Social Affairs, 69
International Advisory Committee for Radio: Conference at Stockholm, 695
International Chamber of Commerce : Brochure No. 123, Economic Conditions of Germany To-day and its International Repercussions, 659
International Council of Scientific Unions : Report of the Executive Committee, July 1947, 677
International Institute of the Hylean Amazon : Conference for the creation of an, 879
International Joint Committee on Rheology : First Meeting, 104
  Officers for the Year 1947–48, 104
International Journal of Opinion and Attitude Research, Vol. 1, 450
International Scientific Radio Union : Conference at Stockholm, 695
International Society of Hematology : Bi-annual Meeting in Buffalo, 636
International Society of Zootechny (Meeting of the Swiss Zootechnical Society to discuss the formation of an), 322
International Understanding, British Society for (Allied Circle, Amsterdam, and the) : Study Conference on the Overseas Territories of Western Europe, 843
International Union of Biological Sciences : Symposium on Trace Elements in Plant Physiology, 364
International Union of Crystallography : First General Assembly and International Congress, 124, 390, 801
  Appointment of a Provisional Executive Committee of the American Section, 801
International Wool Secretariat : Gift of £10,000 to the University of Leeds for equipment for the new Textile Laboratories, 305
Inventors, Society of (Birmingham Branch) ; Second Annual Exhibition, 1007
Irish Chemical Association : Summer School in Chemistry at University College, Dublin, 390
Iron and Steel Institute : Bessemer Gold Medal for 1948 awarded to W. J. Dawson, 512
  Sir Robert Hadfield Medal for 1948 awarded to A. Preece, 512
  Williams Prize for 1947 awarded to R. Fowler, 512
  Hatfield Memorial Lecture (Prof. Robert E. Mehl), 592
Iron and Steel Institute, and others : Symposium on Internal Stresses in Metals and Alloys, 70
Iron and Steel Research Association, British : To erect accommodation in Sheffield, 307
  Retirement of R. H. Myers as head of the Steelmaking Division, 595
  Appointment of Dr. A. H. Leckie as head of the Steelmaking Division, 595
Irvine, Dr. F. R. : *Obituary* of Dr. J. M. Dalziel, 920
Irving, H. : Appointed agricultural chemist, Nigeria, 471
Irving, Dr. H., and others : Reversion, a New Procedure in Absorptiometry, 805
Italian Centre for Research in Nuclear Studies : New high-altitude research laboratory on Monte Rosa, 254
Iversen, Dr. Simon : Awarded a Scholarship from the Lady Tata Memorial Fund, 966

JABLONS, Dr. Benjamin : A Vasodilator, Adrenolytic Substance in Aglomerular Fish Kidney, 100
Jacchia, Luigi (Campbell, Leon, and) : The Story of Variable Stars, *review* by H. S. J., 460
Jackson, Prof. Cecil : Relationship of Glioma to Encephalitis in the Domestic Fowl, and an Associated Parasitic Agent, 441
Jackson, J. A. D. : Appointed assistant conservator of forests, Nigeria, 51
Jackson, Prof. Willis, and Saxton, Dr. J. A. : Radio Physics, 795
Jacob, H. : A Planned Auxiliary Language, *review*, 665
Jacobsen, C. F., and Christensen, L. Korsgaard : Influence of Temperature on the Urea Denaturation of β-Lactoglobulin, 30
Jacoby, Dr. F., and Darke, S. J. : Animal Tissue Culture with a Synthetic Medium, 768
Jakus, M. A. (Engström, Dr. A., and) : Intracellular Determination of Protein by X-Ray Microspectrography, 168
Jamalainen, Prof. E. A. : Trace Elements in Plant Physiology, 365
James, Prof. Hubert M., and others (edited by) : Theory of Servomechanisms, *review* by Prof. A. Porter, 994
James, Walter H., and others : Elements of Mechanism, sixth edition, revised by Prof. Venton Levy Doughtie, *review* by F. G. W. Brown, 79
James, Dr. W. O. : Demonstration and Separation of Noradrenaline, Adrenaline and Methyladrenaline, 851
Jameson, Sir Wilson : Honorary degree of the University of Cambridge conferred on, 965
Jang, Dr. C. S., and others : Pharmacology of Ch'ang Shan (*Dichroa febrifuga*), a Chinese Antimalarial Herb, 400
Jánossy, Prof. L. : Cosmic Rays, *review* by Prof. T. G. Cowling, 785
Japan, National Research Council of : Observations during the Annular Eclipse of the Sun on May 8–9, 196, 389, 879
Jason, A. C. (George, Dr. E. P., and) : High Altitude Measurements on Cosmic Rays—Penetrating Cosmic Ray Showers, 248
Jeans, Sir James : The Growth of Physical Science, *review* by Prof. J. A. Crowther, 260
  Request by Prof. E. A. Milne for letters or papers by, 677
Jech, C. : Surface Radiography with Alpha Rays, 314
Jeffrey, Fred P., and others : The Artificial Insemination of Farm Animals, edited by Enos J. Perry, *review* by Dr. Arthur Walton, 831
Jellyman, P. E., and Milne, A. J. : A Large Field Compensator for Measurement of Birefringence, 477
Jenkins, C., and Foinette, E. H. : Chemistry for Schools, Part 3, *review* by Dr. S. H. Harper, 992
Jenkins, H. G. : Biological Applications of Ultra-violet and Infra-red Radiation, *review*, 542
Jenkins, James A. : Awarded a Frank B. Jewett Fellowship for 1948–49 by the American Telephone and Telegraph Co., 429
Jennergren, Carl Gustav : Band Spectrum of Aluminium Bromide, 315
Jensen, Aage Bohus : Animal Tissue Cells in Protein-Free Media, 273
Jensen, Robert, and others : A New Extraction Procedure for the Preparation of Heparin, 639
Jerusalem Historical and Philosophical Society, 124
Jewett, Dr. F. B. : The Future of Scientific Research in the Post-War World, 35
Jewkes, Prof. J. : Appointed professor of economic organisation in the University of Oxford, 966
Joekes, A. M., and others : Colonial Administration by European Powers, 372
Johler, Joseph R. (Herbstreit, Jack W., and) : Frequency Variation of the Intensity of Cosmic Radio Noise, 515
John, Dr. D. Dilwyn : Echinoderm Fauna of Australia, 32
  Appointed a deputy keeper in the Department of Zoology of the British Museum (Natural History), 270
  Appointed director of the National Museum of Wales, 840 ; work of, 840
Johns, D. L. : Appointed research officer (entomologist), Tanganyika, 51
Johnson and Sons, Ltd. : Universal and Comparator Test-papers for the Measurement of *p*H Values, 823
Johnson, Dr. P., and others : Ultracentrifugation and Electron Microscope Studies of Tissues of Inbred Strains of Mice, 759
Joliot-Curie, Mme. : Isotope Exchange and Molecular Structure, 901
Jones, Sir B. Melvill : Awarded the Medal of Freedom with Silver Palm by the Government of the United States, 215
  Awarded the Gold Medal of the Royal Aeronautical Society, 593
Jones, Elwyn, and Mitchell, Dugald : Spread of Detonation in High Explosives, 98
Jones, E. W. Knight : *Elminius modestus*, another Imported Pest of East Coast Oyster Beds, 201
Jones, G. Carleton : Awarded the Gold Medal of the Institution of Mining and Metallurgy, 923
Jones, G. I. : Dogon Personality, *review*, 622
  Divination in Dahomey, *review*, 663
Jones, Dr. G. O. : Annealing of Glass, 813
Jones, Dr. G. P. : Appointed professor of economics in the University of Sheffield, 553 ; work of, 553
Jones, Dr. J. K. N., and others : Separation and Identification of Methylated Sugars on the Paper Chromatogram, 720
Jones, Park J. : Petroleum Production, Vol. 3, Oil Production by Water, *review* by H. B. Milner, 666
Jones, Dr. T. I. : Scientific Radio, 793
Jones, T. J. : Electron Emission from Oxide-coated Cathodes under Electron Bombardment, 846
Jones, W. M., and Barer, Dr. Robert : Electron Microscopy of the Sarcolemma, 1012
Jones, W. R., and others : *Streptococcus fæcalis* in *E. histolytica* Infections, 936
Jongh, S. E. de (Gaarenstroom, J. H., and) : Contribution to the Knowledge of the Influences of Gonadotrophic and Sex Hormones on the Gonads of Rats, *review* by Prof. S. Zuckerman, 221
Jonxis, Dr. J. H. P. : Fœtal Hæmoglobin and Erythroblastosis, 850
Jordan, A. : Appointed honorary lecturer in clinical biochemistry in the University of Sheffield, 307
Jordan, Dr. D. O. : Awarded a Commonwealth Fund Fellowship, 1006
Jordan, Dr. D. O. (Gulland, the late Prof. J. Masson, and) : Structure of Yeast Ribonucleic Acid, 561
Jordan, J., and Bobtelsky, Dr. M. : *p*H of Trisodium Citrate Solutions stored under Customary Laboratory Conditions, 240
Jørgensen, Dr. Holger : Studies on the Nature of the Bromate Effect, 294
Josephy, E., and Radt, F. (edited by) : Elsevier's Encyclopædia of Organic Chemistry, Series 3, Carboisocyclic Condensed Compounds, Vol. 13, Tricyclic Compounds, *review* by Prof. J. W. Cook, 415
Joshi, A. B. (Ramanujam, Dr. S., and) : Chromosome Number of *Sesamum laciniatum* Klein, 99
Journal of the Institute of Navigation, No. 1, 389
Jowitt, Lord : Elected a member of the Athenæum under Rule II, 125
Joyner, L. P. (Fulton, Dr. J. D., and) : Natural Amœbic Infections in Laboratory Rodents, 66
Judge, Arthur W. : Modern Gas Turbines, *review* by E. G. Sterland, 910
Jurva, Dr. Risto : Appointed director of the Finnish Institute for the Exploration of the Sea, 347

KABDEBÓ, Dr. Helene (Bálint, Dr. Peter, and) : Premortal Increase in the Output of Sodium and Chlorine in Fasting Rats, 57
Kahan, J. (Havas, L. J., and) : Hormone-Mimetic and other Responses of the Silkworm (*Bombyx mori* L.) to some Polyploidogenic Agents, 570
Kahane, Dr. M. : Physiology and Biochemistry of Fats and Lipoids, 535
Kalmus, Dr. H. : Simple Experiments with Insects, *review* by Dr. V. B. Wigglesworth, 955

Kamecki, Prof. J., and Kotlinski, A. : Determination of Silicate Inclusions in Steel, 402

Kamen, Prof. M. D. : Radioactive Tracers in Biology, *review* by Prof. F. A. Paneth, 456

Kamen, Prof. M. D., and others : Kinetic Studies on Isotopic Exchange Reactions, 901

Kaplan, Dr. Deborah (Koch, Dr. Walter, and) : Units and Useful Range in Photo-electric Colorimetry, 247

Karády, Dr. S., and Kovács, Dr. A. : An Adaptation Mechanism of the Organism to Damage—the Role of 'Resistine', 688

Karagounis, Prof. G. : Separation of Polar from Non-Polar Molecules, 855

Karplus, Robert : Awarded a Frank B. Jewett Fellowship for 1948–49 by the American Telephone and Telegraph Co., 429

Kassanis, B. (Bawden, Dr. F. C., and) : Plant Virus Diseases, 945

Kastler, Prof. A., and Montarnal, R. : Phase-Contrast in Polarized Light, 357

Kastner, L. J. : Appointed to the chair of mechanical engineering at University College, Swansea, 1004 ; work of, 1004

Katz, Dr. Joseph, and others : Arsenolysis and Phosphorolysis of the Amylose and Amylopectin Fractions of Starch, 96

Kaufman, H. S., and others : Structure of Cyclo-octatetraene, 165

Kayas, G. (Süe, P., and) : The Behaviour of some perfect Cobalt Complexes in Szilard-Chalmers Reactions, 901

Keaney, George A. : Awarded an American Association for the Advancement of Science—George Westinghouse Science Writing Award for 1947, 125

Keen, R. : Wireless Direction Finding, fourth edition, *review* by Dr. R. L. Smith-Rose, 375

Keesing, Prof. Felix M. : Native Peoples of the Pacific World, *review* by M. C. B., 419

Kekwick, Dr. R. A. (Gray, C. H., and) : Bilirubin-Serum Protein Complexes and the van den Bergh Reaction, 274

Kelemen, Dr. Andrew : Awarded a grant from the Lady Tata Memorial Fund, 966

Kellogg, Dr. A. Remington : Appointed director of the U.S. National Museum, 965

Kemp, Philip : Alternating Current Electrical Engineering, seventh edition, *review* by J. G., 297

Kempster, J. W. : Our Rivers, *review* by Dr. A. T. Doodson, 911

Kench, Dr. J. E., and others : Choleglobin Formation in the Erythrocyte, 607

Kendall, David G. : Oscillatory Time-Series, *review*, 187

Kendall, J. T., and Yeo, D. : Magnetic Susceptibility of Mica, 476

Kendall, Maurice G. : Contributions to the Study of Oscillatory Time-Series, *review* by David G. Kendall, 187
  Sequential Analysis (Prof. Abraham Wald), *review*, 790

Keneford, J. R., and others : Cinnoline Derivatives as Chemotherapeutic Agents for *Trypanosoma congolense* Infections, 603, 758

Kennard, E. H. (Richtmyer, F. K., and) : Introduction to Modern Physics, fourth edition, *review* by Prof. L. F. Bates, 912

Kennedy, J. W., and others : Kinetic Studies on Isotopic Exchange Reactions, 901

Kenney, John F. : Mathematics of Statistics, Part 1, second edition, *review* by P. A. Moran, 544

Kenney, R. A., and others : Effect of Renin on Pulmonary Artery Pressure, 893

Kensler, Dr. C. J., and others : Nutrition in relation to Cancer, 106

Kent, Dr. P. W., and others : Conversion of *D*-Arabinose into 2-Deoxy *D*-Ribose and 3-Deoxy *D*-Xylose, 21

Kent-Jones, Dr. D. W., and Amos, Dr. A. J. : Modern Cereal Chemistry, fourth edition, *review* by A. L. Bacharach, 293

Keogh, Dr. E. V., and others : Adsorption of Bacterial Polysaccharides to Erythrocytes, 687

Kerkham, R. K. : Appointed senior agricultural officer, Uganda, 966

Kerkkonen, Heikki K. (Virtanen, Prof. Artturi I., and) : Structure of Plasteins, 888

Kermode, C. W. D. : Appointed assistant conservator of forests, Tanganyika, 637

Keyston, Dr. J. E. : Appointed research secretary to the Central African Council, 230
  Awarded the Medal of Freedom with Bronze Palm by the Government of the United States, 390

Keyworth, Dr. W. G. : Mycological Education, 507

Khanna, Nandoomal (Campbell, Dr. Neil, and) : Reduction of 1 : 4-Diketones, 54

Khorana, H. G., and others : The Melanin Problem—a Synthesis of 5 : 6-Dihydroxyindole, 525

Kidder, George W., and others : Nutrition in relation to Cancer, 106

Kidson, Dr. Edward : Meteorology of the Australasian Antarctic Expedition, 1911–14 (Scientific Reports, Series B; Vol. 7), 709

Kieffer, F., and others : Isotopic Exchange Reactions and Electronic Structure of Substituted Aromatic Hydrocarbons, 901

Kieser, Margaret E., and others : Effect of Ion-Exchange Treatment on the Stability of Apple Juice, 1023

Kimmins, Dr. C. W. : *Death* of, 122, 230

King, H.M. the : Birthday Honours List, 963

King, Dr. Alexander : Awarded the Medal of Freedom with Silver Palm by the Government of the United States, 215
  Operational Research in Government Departments, 585

King, Dr. Basil C. : Appointed lecturer in geology in the University of Glasgow, 16

King, Charles Glen, and others : Nutrition in relation to Cancer, 106

King, E. Bolton : Appointed director of the Science Department of the British Council, 674 ; work of, 674

King, Dr. H. K. : Enzymes in Bacteria, *review*, 78

King, J. M. B. : Mycological Education, 507
  Awarded an Agricultural Research Council Postgraduate Scholarship, 16

King, R., and others : Mechanical Behaviour of Crystal Boundaries in Metals, 682

King's College, London : Appointment of Dr. H. E. Rose to the University of London readership in mechanical engineering, 637

King's College, Newcastle-upon-Tyne : Post-graduate course in Chemical Engineering, 965
  Fuel Technology course, 965
  Retirement of Prof. H. G. A. Hickling from the chair of geology, 1003
  Appointment of Dr. T. S. Westoll to the chair of geology, 1003

Kipps, A., and others : Isolation in Chick Embryos of a Filtrable Agent possibly related etiologically to Lumpy Skin Disease of Cattle, 526

Kirk, J. A. : Awarded a Branch Prize of the Royal Aeronautical Society, 593

Kirk, R. : Extermination of *Aedes aegypti* in Khartoum, 139

Kirkbride, Chalmer G. : Chemical Engineering Fundamentals, *review* by Prof. H. E. Watson, 911

Kirke, H. L. : The Borderline of Psychology, Physics and Music, 589
  Studio Acoustics, 732

Kirrmann, Prof. A. : Chimie organique, 1, Chimie organique générale, 2, Fonctions simples, *review* by Dr. S. H. Harper, 992

Kisby, C. : Appointed lecturer in textile design in the University of Leeds, 1006

Klein, Prof. O. : Mesons and Nucleons, 897

Klerk, D. de, and others : Magnetic Observations and Thermometry in the Region of Millidegrees Absolute, 678

Kling, Dr. André : *Obituary*, 87

Kluckhohn, Clyde, and Leighton, Dorothea : The Navaho, *review* by Dr. G. H. S. Bushnell, 545

Klyne, Dr. W. : The *C/D* Ring Union in Œstrone and Equilenin, 434, *errata*, 514

Knight, Prof. Edgar W., and Adams, Agatha Boyd (edited by) : University of North Carolina Graduate School Research and Publications, *review*, 705

Knipp, Prof. Julian K., and others : Klystrons and Microwave Triodes, *review* by Prof. J. T. Randall, 952

Knoop, Prof. Douglas : Retirement from the chair of economics in the University of Sheffield, 471
  Gift of money to the University of Sheffield to endow an economics prize, 471

Knowles, J. P. : Appointed veterinary officer, Nigeria, 966

Knoyle, J. Mary : Perithecia of Oak Mildew, 938

Koch, H. P. : Configuration of Synthetic Œstrogens, 309

Koch, Dr. J. : Mass-Spectrographic Separation of Isotopes of Gaseous Elements, 566

Koch, Dr. Walter, and Kaplan, Dr. Deborah : Units and Useful Range in Photo-electric Colorimetry, 247

Koller, Dr. P. C. : Awarded a David Anderson-Berry Prize of the Royal Society of Edinburgh, 716

Koniuszy, F. R., and others : Anti-Pernicious Anæmia Factor, 676

Kopp, George A., and others : Visible Speech, *review* by Dr. W. G. Radley, 334

Kosak, Alvin I. : Awarded a Frank B. Jewett Fellowship for 1948–49 by the American Telephone and Telegraph Co., 429

Kotlinski, A. (Kamecki, Prof. J., and) : Determination of Silicate Inclusions in Steel, 402

Kovács, Dr. A. (Karády, Dr. S., and) : An Adaptation Mechanism of the Organism to Damage—the Role of 'Resistine', 688

Kovács, Dr. J. (Bruckner, Prof. V., and) : Addition of Maleic Anhydride to Anethole, 651

Kraft, James Lewis : Adventure in Jade, *review*, 786

Kraft, Prof. Dr. Victor : Mathematik, Logik und Erfahrung, *review* by F. I. G. Rawlins, 666

Kramer, L. M. J. : Mycological Education, 508

Krishna, Dr. Daya : Shrinkage of Animal Cells due to Fixatives, 202

Kuiper, Dr. G. P. : Atmosphere of Mars, 594

Kuper, J. B. Horner, and others : Klystrons and Microwave Triodes, *review* by Prof. J. T. Randall, 952

Kuscer, I. : The Floating Thread, a Surface Phenomenon on Flowing Water, *erratum*, 51

Kushnir, Tuviah : Chromosomal Evolution in the European Mole-Cricket, 531

LA TOUCHE, C. J. : A *Chaetomium*-like Thermophile Fungus, 320

Lacassagne, Antoine : Radiophysiologie expérimentale, cancer et hormones, 6, Étude de la cancérisation par les substances chimiques exogènes, *review* by Prof. E. Boyland, 621

Lack, Charles H. : Staphylokinase, an Activator of Plasma Protease, 559

Lacroix, Prof. Alfred : *Death* of, 555 ; *obituary* by Dr. W. Campbell Smith, 962

Lagercrantz, Carl : Photo-electric Counting of Individual Microscopic Plant and Animal Cells, 25

Laird, Marshall : *Trypanosoma heptatretae* sp. n., a Blood Parasite of the Hagfish, 440

Lal, Lalji : New Bands in the Schumann-Runge System of the Oxygen Molecule, 477

Lambek, C. : An Analysis of Volitional Life, translated from the Danish by Agnete Kortsen, *review* by Dr. Clifford Allen, 789

Lambert, Johann Heinrich : Mathematische Werke, Band 1, Arithmetik, Algebra und Analysis, 1, herausgegeben von Andreas Speiser, *review* by Prof. E. H. Neville, 186

Lambert, John, and Muir, T. A. : Practical Chemistry, *review* by Dr. S. H. Harper, 992

Lambert, Dr. J. M. : The Study of Critical British Groups, 735

Lampitt, Dr. L. H. : Ice Cream, *review*, 500

Landsberg, P. T. : Lorentz-like Transformations, 208

Lane, Prof. Alfred C. : *Death* of, 1003

Lane, J. A. : Meteorological Factors in Radio-Wave Propagation, 146

Lane, Prof. R. E. : Human Factors in Industry, 791

Lange, Isabelle, and others : The Earth's Main Magnetic Field and its Secular Change 1905–1945, 161
  Final Values of Elements of the Geomagnetic Field at 5-Degree Intervals of Latitude and Longitude, Epoch 1945, 161

Langfeld, Prof. Herbert S. : Appointed a member of the Pontifical Academy of Science, 922

Langley, S. J. : Appointed an assistant lecturer in economics in the University of Sheffield, 1007

Lapage, Dr. G. : Research on the Trematoda, *review*, 222
  The Common Cold, 328
  Experimental Study of Human Health, *review*, 336
  'Little Fleas' and 'Lesser Fleas', *review*, 662
  Medical Research during War-time, 998

Laporte, Lucile, and others : The Earth's Main Magnetic Field and its Secular Change 1905–1945, 161

Final Values of Elements of the Geomagnetic Field at 5-Degree Intervals of Latitude and Longitude, Epoch 1945, 161
Large, —. : Mycological Education, 508
Lark-Horovitz, Dr. Karl : Elected a trustee of Science Service, Washington, D.C., 842
Larke, Sir William : Tribute to Sir Edward Appleton at the special meeting of the Industrial Research Committee of the Federation of British Industries at the Royal Institution, 509
Larralde, J., and others : Effect of Insulin on Intestinal Glucose Absorption in Alloxan Diabetic Rats, 932
Laser, Dr. H. : Hæmolytic System in the Blood of Malaria-infected Monkeys, 560
Lasswell, Prof. H. D. : The Dynamics of Power and Personality, 654
The Analysis of Political Behaviour, *review* by Prof. D. W. Brogan, 950
Latham, R., and Cassels, J. M. : Scattering of Neutrons by Lead, 282
Lattimore, S. : The Mass of σ-Mesons, 518
Laue, M. von : Theorie der Supraleitung, *review* by Dr. H. Frölich, 37
Lauer, Henri, and others : Servo-mechanism Fundamentals, *review*, 294
Laurell, C.-B. (Holmberg, Dr. C. G., and) : Histaminolytic Activity of a Copper Protein in Serum, 236
Laurenson, J. A. : Appointed assistant conservator of forests, Sierra Leone/Gambia, 51
Laurentie, H., and others: Colonial Administration by European Powers, 372
Lavollay, Prof. J. : Trace Elements in Plant Physiology, 364
Lawler, Mrs. Sylvia D., and others : *Rh* Genes Allelomorphic to *C*, 316
Lawrence, Dr. A. S. C. : War-time Rheological Investigations for the British Armed Services, 252
Lawrence, Prof. E. O. : Elected an honorary fellow of the Physical Society, 843
Lawrence, Peter : A Study of Japanese Culture, *review*, 77
Lawson, Dr. Robert W. : Blinking, its Role in Physical Measurements, 154
Lawson, Wilfrid : Title of reader in biochemistry in the University of London conferred on, 924
Lay, A. W. : Use of High-frequency Current in Surgery, 167
Le Breton, E. : Physiology and Biochemistry of Fats and Lipoids, 534, 535
Le Rütte, W. A. : Chromatic Aberration of Electrostatic Lenses, 392
Lea, Charles : Awarded the Medal of Freedom with Bronze Palm by the Government of the United States, 215
Leach, Dr. E. R. : Political Testament of an Anthropologist, *review*, 457
Leach, E. W. : Appointed director of agriculture, Trinidad, 637
Leaf, George : Appointed a lecturer in physiological chemistry in the University of Glasgow, 16
Leah, Dr. A. S., and David, Prof. W. T. : A Bunsen Flame as a Column of Luminous Gas, 524
Leckie, Dr. A. H. : Appointed head of the Steelmaking Division of the British Iron and Steel Research Association, 595
Lees, Dr. G. M. : Elected a Fellow of the Royal Society, 467
Lees, Dr. Howard, and Meiklejohn, Jane : Trace Elements and Nitrification, 398
Lees, Rev. John : Feeding Times of British Birds, 802
Lehany, F. J., and Yabsley, D. E. : A Solar Noise Outburst at 600 Mc./s. and 1200 Mc./s., 645
Leicester City Boys' School : Conference on Written Expression in Science, 533
Leigh, J. : Scientific Management, *review*, 910
Leighton, Dr. A. H. : The Governing of Men, 578
Leighton, Dorothea (Kluckhohn, Clyde, and) : The Navaho, *review* by Dr. G. H. S. Bushnell, 545
Lemberg, R., and Foulkes, E. C. : Reaction between Catalase and Hydrogen Peroxide, 131
Lenard, Prof. P. : *Addendum* to *obituary* of (Prof. E. N. da C. Andrade), 48
Leprince-Ringuet, L., and Heidmann, J. : Anomalous Distribution of Nuclear Disintegration in Photographic Emulsions Exposed to Cosmic Rays—Double Stars, 844
Leroi-Gourhan, Dr. André : Archéologie du Pacifique-nord, *review* by Prof. J. H. Hutton, 545
Lesnick, Robert, and others : Servo-mechanism Fundamentals, *review*, 294
Lester-Smith, Dr. E. : The Assaying of Penicillin, 285, 286
Purification of Anti-pernicious Anæmia Factors from Liver, 638, 676
Lester-Smith, Dr. E., and others : Studies with Radioactive Penicillin, 1009
Lett, Sir Hugh : Honorary degree of the University of Cambridge conferred on, 965
Lewis, D. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
Lewis, G. M. : Appointed a lecturer in natural philosophy in the University of Glasgow, 16
Lewis, S. E. : Inhibition of SH Enzymes by Methyl Bromide, 692
Lewis, Prof. W. C. McC. : Retirement from the Grant-Brunner chair of inorganic and physical chemistry in the University of Liverpool, 756 ; work of, 756
Lewis, Wilmarth S. : The Yale Collections, *review* by Dr. L. Harrison Matthews, 79
Lewis, W. V. : The Flow of Glaciers, 820
Li, T. T., and Perkins, D. H. : Anomalous Distribution of Nuclear Disintegration in Photographic Emulsions Exposed to Cosmic Rays—Double Stars, 844
Library, National Central : To compile a Union Catalogue of German Books and Periodicals, 1006
Library Association : First meeting of the Medical Sub-section, 90
Liempt, Dr. J. A. M. van : Brightness of the New Moon, 27
Liesegang, Prof. R. E. : *Obituary* by Prof. E. K. Rideal, 230
Lilongwe Experimental Station, Nyasaland : Appointment of S. T. Hoyle as senior agricultural officer, 471
Lima, Dr. Octavio Rodrigues, and Pereira, Dr. Oswaldo Geili : Pregnancy Test using the Male Toad, 676
Lincoln College, Oxford : Gift of £50,000 from Lord Nuffield for research fellowships in science and allied medicine, 16
Lindahl, Per Eric : Principle of a Counter-streaming Centrifuge for the Separation of Particles of Different Sizes, 648
Lindsay, J. K. : Consolidated Gold Fields of South Africa, Ltd. Gold Medal awarded jointly to Dr. Anthony Caplan and, 924
Linnean Society of London : Award of the Trail Award and Medal for 1942 to Dr. Honor B. Fell, 51, 882
Award of the Trail Award and Medal for 1947 to Dr. C. D. Darlington, 51, 882
Linnean Gold Medal for 1948 awarded to Dr. Agnes Arber, 272, 882
Synopses of the British Fauna, 594
Anniversary Meeting, 882
Election of officers for 1948–49, 882
Discussion on Orientation of Birds on Migratory and Homing Flights, 996
Linnett, Dr. J. W. (Heath, D. F., and) : Interaction Terms in Molecular Vibrations, 243
A Suggested New Force Field for Molecular Vibrations, 314
Linnett, Dr. J. W., and Wheatley, P. J. : A Correlation between Molecular Vibrations and Bond-forming Orbitals, 971
Linton, Prof. Ralph : The Cultural Background of Personality, *review* by Prof. T. H. Pear, 622
Lipson, Dr. H. : Structure and Physical Properties of Metals, 263
Lister, John : *Obituary*, 194
Little, W. J. C. : Appointed agricultural officer, Nigeria, 51
Liu, Y. H., and others : Stressed Aluminium, 681
Livingston, Prof. Burton E. : *Death* of, 230
Livingstone, Sir Richard : Honorary degree of the University of Cambridge conferred on, 965
Llewellyn, Dr. D. R., and others : Fractional Distillation and its Application in the Concentration of the Heavy Isotopes of Oxygen and Hydrogen, 858
Lloyd, Major-General Cyril : The Present Outlook in Army Education, 262
Lloyd, Dr. Ll. : Biological Aspects of Water Pollution, 876
Local Government Boundary Commission : Second Annual Report, 825
Lock, G. W. : Appointed senior research officer, Tanganyika, 802
Lockley, R. M. : Letters from Skokholm, *review* by Frances Pitt, 5
Lockyer (Norman) Observatory : Transfer to the University College of the South-West, Exeter, 15, 861
Lodge, A. S. : Capture of Negative Mesons by Nuclei, 809
Lodge, Prof. R. C. : Plato's Theory of Education, *review*, 376
Löhnis, Dr. Marie P. : Trace Elements in Plant Physiology, 365
London Passenger Transport Board : Fourteenth Annual Report, 942
Long Ashton Research Station : Annual Report for 1946, 862
Longley, Richard W. (Hewson, Dr. E. Wendell, and) : Meteorology, Theoretical and Applied, *review* by Prof. P. A. Sheppard, 625
Longuet-Higgins, M. S. (Barber, N., and) : Water Movements and Earth Currents—Electrical and Magnetic Effects, 192
Loring, Hubert S., and others (edited by) : Annual Review of Biochemistry, Vol. 16, *review*, 870
Loubser, J. H. N. (Bleaney, Dr. B., and) : Collision Broadening of the Ammonia Inversion Spectrum at High Pressures, 522
Loughnane, J. B., and others : Transmission of a Disease Resembling Virus Yellows through the 'Seed' of Sugar Beet, 28
Lourie, Dr. E. M., and others : Cinnoline Derivatives as Chemotherapeutic Agents for *Trypanosoma congolense* Infections, 603, 758
Lourie, Dr. E. M. (Williamson, J., and): 'Melarsen' and 'Melarsen Oxide', 103
Lousley, J. E. : Critical British Groups of Flowering Plants, 733
Lovell, Dr. A. C. B. : Combined Radar, Photographic and Visual Observations of the Perseid Meteor Shower of 1947, 280
Scientific Radio, 794
Lovell, Dr. Bernard (edited by) : Electronics and their Application in Industry and Research, *review* by Dr. T. E. Allibone, 702
Lowe, Lieut.-Colonel Eric : Material for Visual Education (Betty M. B. Harris), *review*, 40
Citizenship and Current Affairs in Army Education, 444
Audiovisual Aids in the U.S. Armed Forces, *review*, 745
An Introduction to Filmstrips (H. R. and I. W. Dance), *review*, 830
Local Government and the Citizen, *review*, 870
Lowe, Willoughby P. : The End of the Trail, *review* by Frances Pitt, 222
Lowenstein, Dr. Otto : Oscillographic Analysis of the Non-Acoustic Functions of the Vertebrate Ear, 652
Luck, J. Murray, and others (edited by) : Annual Review of Biochemistry, Vol. 16, *review*, 870
Luckiesh, Dr. Matthew : Light, Vision and Seeing, fourth printing, *review* by Dr. R. W. Pickford, 40
Applications of Germicidal, Erythemal and Infra-red Energy, *review* by H. G. Jenkins, 542
Lundegårdh, Prof. : Interaction of Water and Porous Materials, 630
Lundy Field Society : First Annual Report, 345
Luttinger, Dr. Joaquin M. : Awarded a Frank B. Jewett Fellowship for 1948–49 by the American Telephone and Telegraph Co., 429
Lynch, Dr. G. Roche : Elected president of the Royal Institute of Chemistry, 716
Lynn-Allen, E. (Brown, P. E., and) : Breeding of Avocets in Britain, 271
Lysgaard, L. : Recent Climatic Fluctuations, 442

MCARDLE, Dr. B. : Water Requirements under Desert Conditions, *review*, 744
Macaulay, J. W. : Appointed senior veterinary research officer, Northern Rhodesia, 802
Macbeath, A. M. : Awarded a Commonwealth Fund Fellowship, 1006
McBryde, Felix Webster : Cultural and Historical Geography of Southwest Guatemala, 697
McBurney, C. B. M., and others : Cambridge Archæological Expedition to Cyrenaica, 327
Maccabæans, Society of : Meldola Medal for 1947 awarded to Dr. J. Baddiley, 715
McCallum, A. M. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
McCance, Prof. R. A. : Elected a Fellow of the Royal Society, 467
McCance, Prof. R. A., and others : Effect of Under-nutrition and Alterations in Diet on the Choline Esterase Activity of Serum, 56
Maccoll, Allan (Craig, D. P., and) : The Non-Benzenoid Aromatic Hydrocarbon Pentalene, 481
MacCurdy, Prof. G. C. : *Obituary* by Prof. D. A. E. Garrod, 47
McCusker, C. B. A. : Apparent Emission of Positive Electrons from β-Emitters, 564
MacDonald, Dr. D. K. C. : Radio Noise, 794
MacDonald, Dr. D. K. C., and Mendelssohn, Dr. K. : Electrical Resistivity of Alkali Metals below 20° K., 972

Mace, Prof. C. A. : Incentives in Industry, 429
Macelwane, Rev. James B. : When the Earth Quakes, *review* by Lieut.-Colonel E. Tillotson, 459
McFarlane, Dr. A. S. (Dawson, Dr. I. M., and) : Structure of an Animal Virus, 464
Macfarlane, Dr. G. G. : Meteorological Factors in Radio-Wave Propagation, 146
McGaughey, C. A., and Sellers, K. C. : Microflora of the Rumen, 1014
Macgregor, A. G. : Appointed research assistant in the Department of Pharmacology and Therapeutics in the University of Sheffield, 471
MacGregor, J. J. : Forest Valuation (Prof. Herman H. Chapman and Prof. Walter H. Meyer), *review*, 831
Macheboeuf, Prof. M. : Physiology and Biochemistry of Fats and Lipoids, 534
McIntosh, A. E. S. : Appointed deputy director of agriculture, Federation of Malaya, 802
McIntosh, Prof. James : *Obituary* by Prof. E. C. Dodds, 713
MacIver, Prof. R. M. : The Web of Government, 579
Mackay, Dr. Ian F. S. : Demonstration of the Heart Beat, 771
Mackay, Margaret E., and Maycock, W. d'A. : Sodium Citrate Concentration in Ether-extracted Plasma, 235
McKay, R., and others : Transmission of a Disease Resembling Virus Yellows through the 'Seed' of Sugar Beet, 28
MacKenna, Dr. R. M. B. : Modern Trends in Dermatology, *review* by Dr. James Marshall, 788
MacKenzie, A. F. : Appointed senior agricultural officer, Sierra Leone, 51
McKerrow, W. S. : To receive an Award from the Daniel-Pidgeon Fund of the Geological Society of London, 1007
McKinley, Dr. D. W. R., and others : Combined Radar, Photographic and Visual Observations of the Perseid Meteor Shower of 1947, 278
Mackinney, Gordon, and others (edited by) : Annual Review of Biochemistry, Vol. 16, *review*, 870
McLean, Prof. Franklin C., and others : Failure of Sulphanilamide to Inhibit Calcification of Bone, 273
McLean, Dr. R. C., and Cook, Dr. W. R. Ivimey : Practical Field Ecology, 158
MacLellan, G. D. S. : Awarded a Commonwealth Fund Fellowship, 1006
Macmillan, R. H. : British Rocket Weapons Research, 329
  London's Transport System, 942
Macnab, Gwen M. : A Polysaccharide from Hydatid Cyst Fluid, 310
MacNair, A. J. : Appointed temporary agricultural (cocoa survey) officer, Gold Coast, 802
MacNalty, Sir Arthur : Local Government, *review* by Lieut.-Colonel Eric Lowe, 870
  Obituary of Sir George Newman, 1001
MacNeice, G. G. (Elliott, A., and) : Transmission of the Atmosphere in the 1-5 Micron Region, 516
McNeil, Dr. D. : Elected director of research at the Coal Tar Research Association, 757 ; work of, 757
Macpherson, D. F. : Appointed chief veterinary officer, Nyasaland, 471
Macpherson, Sir John : Development and Welfare in the West Indies, 181
Maddock, Dr. A. G. : Determination of Radioactive and Stable Tracer Isotopes, 693
Maeder, R., and Miescher, Prof. E. : Absorption Band Spectrum of S_2 in the Schumann Region, 393
Mahalanobis, Prof. P. C. : Scientific Research in India, 513
Mahler, Dr. K. : Elected a Fellow of the Royal Society, 467
Majumdar, R. C., and Gupta, Dr. S. : The Meson Field and the Equation of Motion of a Spinning Particle, 410
Majumdar, Prof. Subodh Kumar : Magnetic Susceptibility of Borax Glasses containing Crystallites of Alkali Metal Salts, Gold and Platinum, 684
Makar, R., and others : An Electrolytic Tank for Exploring Potential Field Distributions, 845
Maley, L. (Mellor, Dr. D. P., and): Order of Stability of Metal Complexes, 436
Malinowski, Bronislaw : Freedom and Civilization, *review* by Dr. E. R. Leach, 457
Management, British Institute of : Presidential Address (Sir Charles Renold), 675
Manchester College of Technology : Summer School in X-Ray Crystallography, 555
Manchester Joint Research Council : Election of Sir Raymond Streat as chairman, 272
  Election of Sir Charles Renold as honorary treasurer, 272
Manley, Gordon : Appointed to the University of London chair of geography at Bedford College, 430, 511 ; work of, 511
Manley, R. O. B. : Honey Farming, *review* by Dr. C. G. Butler, 544
Mann, Dr. T. (Humphrey, G. F., and) : Citric Acid in Semen, 352
Manning, Kenneth V., and others : College Technical Physics, *review* by S. Weintroub, 954
Manning, Stanley A. : The Right Way to Understand the Countryside, *review* by T. H. Hawkins, 995
Manning, Thomas H. : Awarded the Patron's Medal for 1948 of the Royal Geographical Society, 553
Manton, Prof. I. : Origins of Species and Migrations of Floras, *review*, 455
Manton, Dr. Sidnie M. : Elected a Fellow of the Royal Society, 467
Mardles, Dr. E. W. J. : War-time Rheological Investigations for the British Armed Services, 252
Mariani, Prof. Jean : Théorie des champs macroscopiques, 450
Mark, Prof. H., and others : Structure of Cyclo-octatetræne, 165
Markham, Dr. Roy, and others : Molecular Arrangement in Tobacco Necrosis Virus Crystals, 760
Markham, Dr. Roy (Cosslett, Dr. V. E., and) : Structure of Turnip Yellow Mosaic Virus Crystals in the Electron Microscope, 250
Marlow, G. S. W. : *Death* of, 387 ; *obituary* by Prof. Eric K. Rideal and F. I. G. Rawlins, 672
Marsh, Arnold : Smoke, *review* by F. I. G. Rawlins, 706
Marshall, Alan J. : Awarded the Back Grant for 1948 of the Royal Geographical Society, 553
Marshall, Dr. F. H. A. : Recent Advances in Sex and Reproductive Physiology (Dr. J. M. Robson), third edition, *review*, 790
  Internal Secretion, *review*, 953
Marshall, Dr. James : Dermatology, *review*, 788
Marshall, Dr. John : *Death* of, 122
Marshall, P. B. (Albert, Dr. Adrien, and) : Absence of Correlation between Respiratory Inhibition of Plasmodia by Acridines and Antimalarial Action, 1008
Marshall, Prof. T. H. : Science in Social Affairs, 69
Martin, Daniel : Appointed a lecturer in mathematics in the University of Glasgow, 16
Martin, D. D., and others : *p*-Aminosalicylic Acid in the Treatment of Tuberculosis, 435
Martin, G. R. : Modern Inorganic Chemistry, *review*, 335
Martin, Dr. L. H., and Hill, R. D. : A Manual of Vacuum Practice, *review*, 665
Martin, Paul S., and others : Indians before Columbus, *review* by Dr. G. H. S. Bushnell, 501
Martin, Dr. S. R. W. : Synthetic Resin Chemistry, *review* by Dr. P. D. Ritchie, 502
Martingell, S. E., and others : Meteor Whistles, 478
Masaryk, Dr. Jan : *Death* of, 427
Mason, I. L. : International Meeting on Animal Production, 322
Mason, R. R. : Appointed agricultural officer, Fiji, 51
Mass-Observation : Peace and the Public, 415
Massachusetts Institute of Technology : Summer Scholarships for European Students, 593, *erratum*, 637
Massachusetts Institute of Technology, and others : Conference on Mechanical Wear, 758
Massey, Y. : The Study of Critical British Groups, 735
Mather, Dr. K. : Significance of Nuclear Change in Differentiation, 872
  Appointed to the chair of genetics in the University of Birmingham, 1007
Matoltsy, A. G. : Electron Microscope Observation of Renosine, 353
Matson, Leslie E., and others : Servo-mechanism Fundamentals, *review*, 294
Mattauch, J. : Nuclear Physics Tables ; and An Introduction to Nuclear Physics, by S. Fluegge, *review* by Sir John Cockcroft, 418
Matthews : Textile Fibers, fifth edition, edited by Herbert R. Mauersberger, *review* by Dr. C. S. Whewell, 581
Matthews, Dr. L. Harrison : They Live in the Sea (Douglas P. Wilson), *review*, 40
  The Yale Collections (Wilmarth S. Lewis), *review*, 79
  The Swimming of Dolphins, 731
Matthews, R. E. F. : Plant Virus Proteins and Antibody-Antigen Reactions, 611
Matthias, Bernd T. : Dielectric Constant and Piezo-Electric Resonance of Barium Titanate Crystals, 325
Maude, John : The New Courageous, 414
Maupoil, Bernard : La Géomancie à l'ancienne Côte des Esclaves, *review* by G. I. Jones, 663
Maurice, D. (Drewe, E. C., and) : Solar Noise, 167
Mawson, C. A. : Honeydew on Lime Trees, 176
Maxted, Dr. E. B. : Modern Advances in Inorganic Chemistry, *review* by G. R. Martin, 335
Maxted, Dr. E. B., and others : Catalytic Poisons and Magnetic Susceptibility, 804
May, S., and others : Isotope Exchange and Molecular Structure, 901
Maycock, W. d'A. (Mackay, Margaret E., and) : Sodium Citrate Concentration in Ether-extracted Plasma, 235
Maynard, G., and Westlake, Aubrey T. : Mr. E. Westlake and the Geology of the Cantal Region, Central France, 485
Mayr, Ernst : Birds of the Southwest Pacific, *review* by Frances Pitt, 545
Meakins, R. J. (Dryden, J. S., and) : Treatment of Glass and Steatite Ceramic with Quaternary Ammonium Compounds for the Improvement of Electrical Insulation Resistance, 23
Mechanical Engineers, Institution of : Thomas Hawksley Lecture (Sir Alwyn Crow), 329
  Clayton Prize for 1947 awarded in two equal moieties to J. E. Sears and T. E. Beacham, 470
  Clayton Fellowships for 1948, 470
Mechanical Engineers, Institution of, and others : Symposium on Internal Stresses in Metals and Alloys, 70
Medical Association, British : First Annual Scientific Meeting since the War, 842
Medical Research Committee, Colonial : Second Annual Report, 143
Medical Research Council : Appointment of Prof. H. P. Himsworth as a member, 390
  Report for the Years 1939–45, Medical Research in War, 998
Medicine, Royal Society of, and the Scientific Film Association : Catalogue of Medical Films, 594
Meek, J. H. : Triple Splitting of Ionospheric Rays, 597
Mehl, Prof. Robert E. : Hatfield Memorial Lecture of the Iron and Steel Institute, 592 ; work of, 592
Mehrotra, B. C. : Volumetric Estimation of Thallium, 242
Mehrotra, R. C. : A New Dry Test for Gold, 321
Mehta, Rai Bahadur K. C. : Awarded the Barclay Memorial Medal of the Royal Asiatic Society of Bengal, 553
Meiklejohn, Jane (Lees, Dr. Howard, and) : Trace Elements and Nitrification, 398
Meinesz, Prof. Felix Andries Vening : Awarded the Agassiz Gold Medal and Honorarium for 1947 of the U.S. National Academy of Sciences, 861
Melchers, W. J., en Gerritsen, H. J. : Koper als onmisbaar element voor plant en dier, *review*, 624
Mellanby, Sir Edward : Sir Frederick Gowland Hopkins Memorial Lecture of the Chemical Society, 164
  Awarded the Medal of Freedom with Silver Palm by the Government of the United States, 215
Mellon Institute of Industrial Research : Establishment of a Department of Research in Physical Chemistry, 89
Mellor, Dr. D. P., and Maley, L. : Order of Stability of Metal Complexes, 436
Melville, Prof. H. W. : Appointed to the Mason chair of chemistry in the University of Birmingham, 1007
Melville, Prof. H. W., and Youngson, G. W. : Branched-Chain High Polymers, 803
Mendel, Prof. B., and others : Effect of Thyroid Deficiency on the Level of Pseudo-Cholinesterase in the Plasma of Rats, 639
Mendelssohn, Dr. K. : Low-Temperature Physics, 732
Mendelssohn, Dr. K. (MacDonald, Dr. D. K. C., and) : Electrical Resistivity of Alkali Metals below 20° K., 972
Mental Health, National Association for : Conference on Sociology of Mental Disease, 407
Menzel, Dr. Donald H., and Salisbury, Winfield W. : Audio-Frequency Radio Waves from the Sun, 91

Menzies, Gordon : Appointed director of administrative services of U.N.E.S.C.O., 304
Meredith, R. : Relaxation and Flow in Cellulose Fibres, 737
Méring, J. (Brindley, Dr. G. W., and) : Theory of the Structure of Clay Minerals—Banded X-Ray Reflexions from Clay Minerals, 774
Merrill, Allyne L., and others : Elements of Mechanism, sixth edition revised by Prof. Venton Levy Doughtie, *review* by F. G. W. Brown, 79
Merrill, Prof. E. D. : Discovery of a Living *Metasequoia* in China, 594
  Retirement from the Arnold professorship of botany at Harvard University, 964 ; work of, 964
Merriman, Dr. A. D. : Appointed registrar-secretary of the Institution of Metallurgists, 674 ; work of, 674
Metallurgists, Institution of : Appointment of Dr. A. D. Merriman as registrar-secretary, 674
Metals, Institute of : Election of Fellows and Honorary Members, 16
  Platinum Medal for 1948 awarded to Dr. Robert Crooks Stanley, 344
  Offer from Capper, Pass and Son, Ltd., of awards for papers on metallurgy, 347
  Past and Future of the, 468
  Election of Sir Arthur Smout as president, 468
Metals, Institute of, and others : Symposium on Internal Stresses in Metals and Alloys, 70
  Discussion on the Flow of Glaciers, 819
Meteorological Society, Royal : Election of officers, 197
Meyer, Prof. Walter H. (Chapman, Prof. Herman H., and) : Forest Valuation, *review* by J. J. MacGregor, 831
Miall, Dr. Stephen : *Obituary* by A. L. B. and P. J. V., 47
Michelson, A. M., and others : Synthesis of Adenosine Triphosphate, 761
Microbiological Research Institute, Colonial : Opening of the, 675
Middlesex Hospital Medical School : Title of professor of biology in the University of London conferred on Dr. J. H. Woodger, 51
  Title of reader in biochemistry in the University of London conferred on Wilfrid Lawson, 924
Mider, Dr. G. Burroughs, and others : Nutrition in relation to Cancer, 106
Miescher, Prof. E. (Maeder, R., and) : Absorption Band Spectrum of S_2 in the Schumann Region, 393
Miles, Dr. A. A. : The Assaying of Penicillin, 287
Miles, J. A. R., and Stoker, M. G. P. : Puffinosis, a Virus Epizootic of the Manx Shearwater (*Puffinus p. puffinus*), 1016
Miles, M. K. : Organisation, Meteorology and Weather Prediction, *review*, 540
Miller, D. H., and others : Effect of Renin on Pulmonary Artery Pressure, 893
Miller, Prof. Frederick R. : Appointed research professor of neurophysiology in the University of Western Ontario, 125
Miller, J., and others : Studies with Radioactive Penicillin, 1009
Miller, Dr. J. A., and others : Nutrition in relation to Cancer, 106
Miller, John Anderson : Men and Volts at War, the Story of General Electric in World War II, *review* by Sir Arthur Fleming, 113
Miller, J. L. : Modern Assembly Processes, second edition, *review* by H. W. G. H., 503
Miller, Prof. W. C. : Animal Health in British Guiana, 345
Miller, Dr. Zelma Baker, and others : Failure of Sulphanilamide to Inhibit Calcification of Bone, 273
Millikan, C. R. : Antagonism between Molybdenum and certain Heavy Metals in Plant Nutrition, 528
Millikan, Robert Andrews : Electrons (+ and —), Protons, Photons, Neutrons, Mesotrons and Cosmic Rays, revised edition, *review* by Dr. L. G. H. Huxley, 789
Millman, Dr. Peter M., and others : Combined Radar, Photographic and Visual Observations of the Perseid Meteor Shower of 1947, 278
Mills, Gervase L. : Particle-size Measurement, 313
Mills, John : The Engineer in Society, *review* by R. Brightman, 374
Milne, A. J. (Jellyman, P. E., and) : A Large Field Compensator for Measurement of Birefringence, 477
Milne, Prof. E. A. : Request for letters or papers written by Sir James Jeans, 677
  Obituary of Dr. H. W. Richmond, 877
Milne-Thomson, Prof. L. M. : Theoretical Aerodynamics, *review* by Prof. W. J. Duncan, 703
Milner, Dr. C. J., and others : Pinhole Radiography of Magnetrons, 244
Milner, H. B. : The Race for Oil, *review*, 186
  Petroleum Production, Vol. 3, Oil Production by Water (Park J. Jones), *review*, 666
  Progress in the Oil Industry during the War-Years, *review*, 703
Milton, J. G. : Awarded the Simms Gold Medal of the Society of Engineers, 346
Milward, G. E. : Skill and Management, *review* by J. Leigh, 910
Minganti, Dr. Antonio : Interspecific Fertilization in Ascidians, 643
Mining and Metallurgy, Institution of : Offer from Capper, Pass and Son, Ltd., of awards for papers on metallurgy, 347
  Gold Medal awarded to G. Carleton Jones, 923
  Honorary membership conferred on Dr. William Cullen, Dr. T. A. Rickard and Prof. S. J. Truscott, 923
  Consolidated Gold Fields of South Africa, Ltd. Gold Medal awarded jointly to Dr. Anthony Caplan and J. K. Lindsay, 924
  Symposium on the Refining of Non-ferrous Metals, 924
Minkoff, Dr. G. J., and others : Formation of Hydroxy Peroxides, 172
Misra, Dr. R. C. : Occurrence of Volcanic Bomb in the Agglomeratic Slates of Kashmir, 895
Mitchell, Dr. C. A. : *Death* of, 48
Mitchell, C. D. : Awarded the Bessemer Premium of the Society of Engineers, 346
Mitchell, Dugald (Jones, Elwyn, and) : Spread of Detonation in High Explosives, 98
Moggridge, J. I. : Appointed director, Tsetse Research Control Department, Tanganyika, 637
Moholy, Mrs. Lucia : Proposed Central Publication of Scientific Papers, 922
Montarnal, R. (Kastler, Prof. A., and) : Phase-Contrast in Polarized Light, 357
Mookerjee, Dr. Sivatosh : An Atypical Scale of *Sciæna coitor* (Hamilton), 64
Moon, J. T. : Appointed senior agricultural officer, Kenya, 471
Moon, Prof. P. B. : Atoms for the Layman, *review*, 582
Moore, W. C. : *Obituary* of Dr. George H. Pethybridge, 1002
Moran, P. A. : Mathematics of Statistics (John F. Kenney), Part I, second edition, *review*, 544
Moran, Dr. T., and others : Action of Nitrogen Trichloride on Proteins—Production of Toxic Derivative, 126
Morley, J. S., and others : Cinnoline Derivatives as Chemotherapeutic Agents for *Trypanosoma congolense* Infections, 603, 758
Morris, D. P., and others : Stressed Aluminium, 681
Morris, Harold P., and others : Nutrition in relation to Cancer, 106
Morrison, G. A., and others : Quantitative Paper Chromatography, 764
Morrison, Herbert : Address to the North Herts Labour Party, 214
  University Representation in the House of Commons, 468
Morrison, Prof. J. L. M. : Appointed a member of the Advisory Council on Scientific Research and Technical Development, 924
Morse, Prof. Frederick T. : Elements of Applied Energy, *review* by R. W. Haywood, 829
Mortensen, Dr. Theodor : Elected a *correspondant* for the Section of Anatomy and Zoology of the Paris Academy of Sciences, 272
Morton, J. : Appointed regional assistant director of veterinary services, Nigeria, 802
Morton, Prof. R. A. : *Obituary* of Prof. E. C. C. Baly, 120
Morton, Prof. R. A., and others : Chemistry of Visual Processes, 424
Morton, Prof. W. E., and Permanyer, F. : Torsional Relaxation in Textile Filaments, 737
Moss, T. S. : Spectral Sensitivity of Lead Telluride Layers, 766
Moss, T. S., and Chasmar, R. P. : Spectral Response of Lead Selenide, 244
Mott, Prof. N. F. : Appointed Henry Overton Wills professor of physics and director of the Wills Laboratory at the University of Bristol, 272
Mourant, Dr. A. E. : *Rh* Nomenclature, 492
Mozley, Alan (Taylor, E. L., and) : A Culture Method for *Lymnæa truncatula*, 894
Mudd, Dr. Stuart : Submicroscopic Structure of the Bacterial Cell, as shown by the Electron Microscope, 302
Muir, J. C. : Appointed director of agriculture, Tanganyika, 637
Muir, T. A. (Lambert, John, and): Practical Chemistry, *review* by Dr. S. H. Harper, 992
Mukherjee, Prof. J. N. : Scientific Research in India, 513
Mukherjee, R. R., and others : Some Tensile Properties of Jute, 737
Mulder, Dr. D. : Trace Elements in Plant Physiology, 365
Mulder, Dr. E. G. : Trace Elements in Plant Physiology, 364
Mullins, Dr. Lorin J. (Nickerson, Dr. Walter J., and) : Riboflavin Enhancement of Radioactive Phosphate Exchange by Yeasts, 939
Munro, Dr. H. N., and Cumming, M. C. : Nitrogen Metabolism after Fracture, 560
Munro, Prof. J. W. : The Field Study and Conservation of the British Fauna, 408
Munshi, S. K., and others : Ammonium Salts of Sulphanilamides and Sulphonic Acids, 55
Muralt, Prof. Alexander v. : Die Signalübermittlung im Nerven, *review* by Prof. J. Z. Young, 76
Murnaghan, Prof. Francis D. : Differential and Integral Calculus, Functions of One Variable, *review* by F. G. W. Brown, 261
Murphy Chemical Co., Ltd. : Insecticidal Smokes, 575
Murray (John) Expedition : Planktonic Copepods and Hydrocorals of the, 822
Murray, Dr. P. D. F. : Practical Biology for Medical and Intermediate Students (C. J. Wallis), second edition, *review*, 912
  Guide to the Study of the Anatomy of the Shark, *Necturus*, and the Cat (Prof. Samuel Eddy, Prof. Clarence P. Oliver and Prof. John P. Turner), second edition, *review*, 955
Murry, John Middleton : The Free Society, 538
Museums of Ceylon, National : Administration Report for 1946, 346
Muskett, Prof. A. E. : Mycological Education, 507
Muxart, R., and others : Isotope Exchange and Molecular Structure, 901
Mycological Society, British : Discussion on Mycological Education, 507
Myers, O. E., and others: Kinetic Studies on Isotopic Exchange Reactions, 901
Myers, R. H. : Retirement as head of the Steelmaking Division of the British Iron and Steel Research Association, 595
Myres, Sir John : Greek Fishes, *review*, 185, 272

NAFTALIN, Dr. L. : Quantitative Chromatographic Estimation of α-Amino-Acids, 763
Naples Zoological Station, 738
Naranjo V, Plutarco : Las heladas y la necrosis fria de las plantas, *review* by H. L. P., 706
Narayana Rao, D. A. A. S. (Bhagavantam, Prof. S., and) : Dielectric Constant of Diamond, 729
Nash, W. F., and others : X-Radiation from a 20-MeV. Betatron, 1022
Nath, Prof. M. C., and Brahmachari, H. D. : Relation of Intermediary Metabolites to the Lowering of the Potency of Pancreatic Insulin in the Animal System, 18
National Academy of Sciences of India : Second Symposium on the Age of the Saline Series of the Punjab, 265
National Advisory Council for Education in Industry and Commerce : Appointment of Sir Ronald Weeks as chairman, 801
  Elections to the Standing Committee, 923
National Association of Girls' Clubs and Mixed Clubs : Summer School for Youth Leaders on the Club Programme and Informal Education, 924
National Association for Mental Health : Conference on Sociology of Mental Disease, 407
National Central Library : To compile a Union Catalogue of German Books and Periodicals, 1006
National Coal Board : Scientific Aspects of the Work of the (John Crossland), 546
National Committee for Crystallography : British, 390
National Committee for Scientific Radio, British (Radio Section of the Institution of Electrical Engineers, and the) : Convention on Scientific Radio, 233
National Federation of Educational Film Groups : First Annual Conference, 965
National Foundation for Scientific Research, Brussels : Nineteenth Annual Report, 196

National Geographic Society of the United States : Observations during the Annular Eclipse of the Sun on May 8–9, 389
National Geographic Society, Smithsonian Institution and the Commonwealth of Australia : Scientific Expedition to Arnhem Land, 195
National Institute of Sciences of India : Election of new Fellows, 197
  Symposium on Scientific Research in India, 513
National Museum of Wales : Retirement of Sir Cyril Fox from the directorship, 840
  Appointment of Dr. D. Dilwyn John as director, 840
National Museums of Ceylon : Administration Report for 1946, 346
National Physical Laboratory : Meeting at the Royal Society to discuss the Use of Equivalent Metric Values in Scientific Papers, 144
  Appointment of D. G. Sopwith as superintendent of the Engineering Division, 552
  Film on the work of the Metrology Division, 717
  To have an 'Open Day' on June 21, 717
National Research Council of Canada : Thirteenth Annual Report, 491
  Formation of a Radio and Electrical Engineering Division under B. G. Ballard, 513
  Establishment of a Committee on Corrosion Research, 553
  Post-doctorate Fellowships in Pure Chemistry, 555
  Publications of the, second edition, 595
National Research Council of Japan : Observations during the Annular Eclipse of the Sun on May 8–9, 196, 389
National Research Development Corporation : Establishment of a, 700
Naval Architects, Institution of : To award a Research Scholarship offered by the Aluminium Development Association, 882
Navigation, Institute of : No. 1 of its quarterly *Journal*, 389
Neave, R. M. S. : Appointed veterinary officer, Kenya, 637
Needham, Dr. D. M. : Effects of Mustard Gas on Enzymes and Tissues, 225
  Elected a Fellow of the Royal Society, 467
Needham, Dr. Joseph : To return to his post at the University of Cambridge, 304
  Science and Society in Ancient China (Conway Memorial Lecture), 305
  Appointed honorary scientific adviser to UNESCO, 758
Nelmes, E. : The Study of Critical British Groups, 735
Nemec, Prof. B. : Trace Elements in Plant Physiology, 364
  Work of, 427
Netherlands Embassy, Royal : Insignia of Commander in the Order of Orange-Nassau (Civilian Division) presented to Sir George Beharrell, Sir Jack Drummond, Dr. John Hammond and Sir Raymond Streat, 307
Netherlands Physical Society : International Conference on the Physics of Metals, 389
Neukom, H., and others : Reaction of Boric Acid with Polysaccharides, 96
Neville, Prof. E. H. : "When the Pie was Opened ", *review*, 186
  Mathematics in India, *review*, 580
New York Academy of Sciences : Symposium on Nutrition in relation to Cancer, 106
  Conference on Physiological and Psychological Factors in Sex Behaviour, 124
New York University (Institute for Mathematics and Mechanics) : To issue a new journal entitled *Communications on Applied Mathematics*, 636
New Zealand Department of Scientific and Industrial Research : Annual Report for 1946–47, 365
Newbery, G. R., and Willshaw, W. E. : A Method of Feeding Micro-wave Power into a Resonator having a Fine Mode Structure, 519
Newhouse, J. P. (Calcutt, G., and) : Inhibition of the Photodynamic Action of 3 : 4 Benzpyrene, 53
Newitt, Prof. D. M. : Appointed a member of the Chemistry Research Board, 924
Newman, Sir George : *Obituary* by Sir Arthur MacNalty, 1001
Newman, Dr. I. V. : Aerobiology on Commercial Air Routes, 275
Newman, Prof. M. H. A. : Calculating Machines, 712
Newstead, Gordon : Triple Magneto Ionic Splitting of Rays Reflected from the F_2 Region, 312
Newton Tercentenary Celebrations, *review*, 375
Newton, R. G. : Orientation of Birds on Migratory and Homing Flights, 998
Newton, Dr. Robert R., and others : Mathematical Theory of Rocket Flight, *review* by Dr. R. A. Rankin, 3
Newton, Prof. W. H. : Introduction to Physiology, *review* by Prof. W. C. Cullis, 828
Nicholas, S. D., and Smith, Dr. F. : Acetylation of Sugars, 349
Nicholls, Mary J., and others : Starches of the Wrinkled and the Smooth Pea, 206
Nichols, Nathaniel B., and others (edited by) : Theory of Servomechanisms, *review* by Prof. A. Porter, 994
Nicholson, I. A. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
Nickerson, Dr. Walter J., and Mullins, Dr. Lorin J. : Riboflavin Enhancement of Radioactive Phosphate Exchange by Yeasts, 939
Nimkoff, Prof. Meyer F. (Ogburn, Prof. William F., and) : A Handbook of Sociology, *review* by T. H. Hawkins, 188
Nishikawara, M., and others : Effect of Thyroid Deficiency on the Level of Pseudo-Cholinesterase in the Plasma of Rats, 639
Nissan, Dr. A. H. (Grunberg, L., and) : Critical Temperature and Molecular Weight of *n*-Paraffins, 170
Noriot, Ch., et Alliot, H. : La lutte contre les termites, *review* by A. D. I., 544
Norris, D. O., and others : Plant Virus Diseases, 945
North, Dr. E. A., and others : Adsorption of Bacterial Polysaccharides to Erythrocytes, 687
Northern Ireland, Government of : Report on Sea and Inland Fisheries, 1942–44, 451
North-Western Naturalist, 923
Norwegian Polar Institute : Establishment of the, 987
Nuffield, Lord : Gift of £50,000 to Lincoln College, Oxford, for research fellowships in science and allied medicine, 16
Nye, J. F. : Internal Stresses in Metals and Alloys, 70
  Photo-elastic Investigation of Internal Stresses in Silver Chloride caused by Plastic Deformation, 367
  The Flow of Glaciers, 819

OCCHIALINI, Dr. G. P. S., and Powell, Dr. C. F. : The Artificial Production of Mesons, 551
Occhialini, Dr. G. P. S. (Bates, Dr. W. J., and) : Applications of the Reflecting Microscope to the Nuclear Plates Technique, 473
Occhialini, Dr. G. P. S. (Powell, Dr. C. F., and) : Nuclear Physics in Photographs, *review* by Prof. P. I. Dee, 333
Odell, Dr. N. E. : Exploration of the Lloyd George Mountains in the Northern Canadian Rockies, 327
Odgers, Merle M. : Alexander Dallas Bache, Scientist and Educator, 1806–1867, *review* by Lieut.-Colonel H. D. Anthony, 909
Odium, Dr. Doris M. : Sociology of Mental Disease, 408
Offord, Prof. A. C. : Appointed to the University of London chair of mathematics at Birkbeck College, 637, 757 ; work of, 757
Ogburn, Prof. William F., and Nimkoff, Prof. Meyer F. : A Handbook of Sociology, *review* by T. H. Hawkins, 188
Ogg, Prof. Alexander : *Death* of, 592 ; *obituary* by Dr. B. F. J. Schonland, 633
Ogg, Dr. W. G. : *Obituary* of Sir Robert Greig, 120
Ogston, Dr. A. G. : The Reactions of Mustard Gas in Aqueous Solution, 225
Oil Palm Research Station, Nigeria : Appointment of F. W. Toovey as officer-in-charge, 637
Oliphant, Prof. M. L. E. : Awarded the Faraday Medal of the Institution of Electrical Engineers, 122
Oliphant, Prof. M. L. E., and others : Atomic Challenge, a Symposium, *review*, 995
Oliver, Prof. Clarence P., and others : Guide to the Study of the Anatomy of the Shark, *Necturus*, and the Cat, second edition, *review* by Dr. P. D. F. Murray, 955
Oliver, J. P. : Appointed agricultural officer, Falkland Islands, 637
Olliver, C. W. : The Intelligent Use of the Microscope, *review*, 626
Olum, Dr. Paul : Awarded a Frank B. Jewett Fellowship for 1948–49 by the American Telephone and Telegraph Co., 429
Opinion and Attitude Research, International Journal of, Vol. 1, 450
Oppenheimer, Dr. J. R. : International Control of Atomic Energy, 291
O'Rahilly, R. : Appointed lecturer in anatomy in the University of Sheffield, 16
Ornithology, British Trust for : Fourteenth Annual Report, 841
Orowan, Dr. E. : The Flow of Glaciers, 820
Orton, Prof. J. H. : Elected a Fellow of the Royal Society, 467
Oser, Dr. Bernard L., and others : Practical Physiological Chemistry, twelfth edition, *review*, 830
Osmond, W. P. (Hobson, P. T., and) : Ferro-magnetic Structure of Cold-Worked Austenitic Stainless Steels, 562
Österlind, Sven : Influence of Low Bicarbonate Concentrations on the Growth of a Green Alga, 319
Overseas Scientific Relations, Inter-Departmental Committee on, 800
Overton, G. L. : *Death* of, 839 ; *obituary* by M. J. B. Davy, 921
Owen, Prof. E. A., and others : Stressed Aluminium, 681

PACHNER, Jaroslav: Discharge Tube for Nuclear Reactions with Improved Yield, 252
Page, Dr. A. : Algebra, *review*, 626
Pal, B. P., and others : Inheritance of Sex Forms of *Luffa acutangula* Roxb., 775
Palæontographical Society : One hundred and first Annual General Meeting, 717
Palais de la Découverte, Paris : Exhibition on the Life and Work of Davy and Faraday, 675
Palestine Board for Scientific and Industrial Research : Report for 1945–1948, 800
Paneth, Prof. F. A. : Scientific Research in the British Zone of Germany, 191
  Radioelements as a Tool in Scientific Research, *review*, 456
  Reactivity and Structure of Molecules, 901
Panikkar, N. Kesava, and Viswanathan, R. : Active Regulation of Chloride in *Metapenæus monoceros* Fabricius, 137
Pannetier, Dr. G., and Gaydon, Dr. A. G.: Band Spectrum of ClO in Flames, 242
Papp, G. (Bay, Z., and) : Coincidence Device of 10^{-8}-10^{-9} Sec. Resolving Power, 59
Paquot, Prof. C. : Physiology and Biochemistry of Fats and Lipoids, 535
Paris, Sheila K., and others : Pharmacological Activities in different Rodent Species of *d*-Tubocurarine Chloride and the Dimethyl Ether of *d*-Tubocurarine Iodide, 817
Paris Academy of Sciences : Election of André Boivin as a *correspondant* for the Section of Rural Economy, 272
  Election of Dr. Theodor Mortensen as a *correspondant* for the Section of Anatomy and Zoology, 272
  Election of Charles Dufraisse as a member of the Section of Chemistry, 514
  Election of Prof. Paul Fallot as a member of the Section of Mineralogy, 802
  Appointment of Robert Courrier as 'secrétaire perpétuel' for the physical sciences, 966
Parisionos, C. C. : Appointed agricultural officer, Cyprus, 471
Parker, Eric : Surrey, *review* by W. E. S., 912
Parker, H. W. : *Obituary* of J. L. Chaworth-Musters, 755
Parker, Dr. J. G. : *Death* of, 714 ; *obituary*, 838
Parmentier, R., and Dustin, jun., Dr. P. : Early Effects of Hydroquinone on Mitosis, 527
Parrot, Prof. J.-L., and others : Influence of Vitamin P (Vitamin C_2) upon the Amount of Ascorbic Acid in the Organs of the Guinea Pig, 557
Parry, Dr. D. A. : Aspects of the Locomotion of Whales, 200
Parson, Alfred Lauck : The Matter-Radiation Cycle in the Cosmos (and the Second 'Law')—the Sun's Equilibrium, 802
Parsons, D. S., and others : Quantitative Paper Chromatography, 764
Parsons, Sir Leonard : Elected a Fellow of the Royal Society, 467
Parthasarathy, Dr. N. : Origin of Noble Sugar-Canes (*Saccharum officinarum* L.), 608
Partington, Prof. J. R. : *Obituary* of Prof. Max Planck, 47
Pasquini, Prof. Pasquale : Le forze creatrici dell'uovo, *review* by C. H. W., 831

Passey, Prof. R. D., and others : Ultracentrifugation and Electron Microscope Studies of Tissues of Inbred Strains of Mice, 759
Paterson, Dr. Edith : Awarded a grant from the Lady Tata Memorial Fund, 966
Paterson, J. H. : Awarded a Commonwealth Fund Fellowship, 1006
Paterson, Dr. Ralston : Awarded a David Anderson-Berry Prize of the Royal Society of Edinburgh, 716
Paterson, T. T. : Earliest Known Prehistoric Industry, 278
Paton, Dr. W. D. M., and Zaimis, Dr. E. J. : Curare-like Action of Polymethylene *bis*-Quaternary Ammonium Salts, 718
Patterson, Miss S. J. : The Assaying of Penicillin, 285
Pauling, Prof. Linus : Nature of Forces between Large Molecules of Biological Interest, 707
    Structure of Complexes and the Influence of Structure on Exchange Reactions, 901
    Elected a foreign member of the Royal Society, 921 ; work of, 922
    General Chemistry, *review* by Dr. S. H. Harper, 992
    The Metallic State, 1019
Pawsey, Dr. J. L. : Radio Noise, 795
Payne, Bernard : Awarded the Bernays Premium of the Society of Engineers, 346
Payne, R. M., and others : X-Radiation from a 20-MeV. Betatron, 1022
Payne, R. M. (Franzinetti, C., and) : Emission of Li^8 in the Explosive Disintegration of Nuclei, 735
Peacock, Prof. A. D. : Ecological Problems of the Highlands and Hebrides, *review*, 457
Peake, O. : University Representation in the House of Commons, 468
Pear, Prof. T. H. : Personality, *review*, 622
Pearce, J. H. : Advanced Calculus (Prof. David V. Widder), *review*, 188
    Mechanics (Prof. John C. Slater and Prof. Nathaniel H. Frank), *review*, 376
Pearse, Dr. I. H. (edited by Williamson, Dr. G. Scott, and) : Biologists in Search of Material, second edition, *review* by Dr. G. Lapage, 336
Peat, Dr. Stanley : Elected a Fellow of the Royal Society, 467
Peat, Dr. Stanley, and others : Enzymic Conversion of Amylose into Amylopectin, 127
    Starches of the Wrinkled and the Smooth Pea, 206
    Photochemical Degradation of Starch, 762
Penketh, D. D. : Glycerol Dichlorhydrin and Vitamin A, 893
Penrose, Prof. Lionel, and others : The Trend of National Intelligence, *review* by Dr. Julian Blackburn, 37
Pentelow, F. T. K. : Biological Aspects of Water Pollution, 876
Pérard, Albert : Les mesures physiques, *review* by S. Weintroub, 955
Percival, Dr. F. G. : Elected a Fellow of the Royal Asiatic Society of Bengal, 553
Pereira, Dr. Oswaldo Gelli (Lima, Dr. Octavio Rodrigues, and) : Pregnancy Test using the Male Toad, 676
Perkins, D. H. : Disintegration of Highly Excited Nuclei, 486
    Awarded a Senior Scholarship by the Commissioners of the Exhibition of 1851, 966
Perkins, D. H. (Li, T. T., and) : Anomalous Distribution of Nuclear Disintegration in Photographic Emulsions Exposed to Cosmic Rays—Double Stars, 844
Perlmann, Gertrude E. : Electrophoretic Behaviour of Modified Ovalbumins, 720
Permanyer, F. (Morton, Prof. W. E., and) : Torsional Relaxation in Textile Filaments, 737
Permin, Per M. (Astrup, Dr. Tage, and) : Fibrinokinase and Fibrinolytic Enzymes, 689
Perrott, S. Wright : Surveying for Young Engineers, *review*, 79
Perry, Enos J. (edited by) : The Artificial Insemination of Farm Animals (by John W. Bartlett, George E. Taylor, Joseph Edwards, Clair E. Terrill, Victor Berliner and Fred P. Jeffrey), *review* by Dr. Arthur Walton, 831
Perry, S. V. : Awarded a Commonwealth Fund Fellowship, 1006
Perry, W. L. M. : An Improved Method for the Assay of Toxicity of Arsenicals, 975
Perutz, Dr. M. F. : Submicroscopic Structure of the Red Cell, 204
    The Flow of Glaciers, 819
Pest Control, Ltd. : Appointment of Dr. G. S. Hartley as research manager, 595
Peters, L. : Rheology in the Textile Industries, 737
Peters, L., and Speakman, Prof. J. B. : The Viscous-Elastic Properties of Wool Fibres, 737
Peters, Prof. R. A. : References in Scientific Literature, 731
Pethybridge, Dr. G. H. : *Death* of, 839 ; *obituary* by W. C. Moore, 1002
Petroleum, Institute of : Reviews of Petroleum Technology, Vol. 7 (covering 1941–45), *review* by H. B. Milner, 703
    Election of officers for 1948–49, 758
Petroleum, Institute of, and the Institute of Fuel : Joint Conference on Modern Applications of Liquid Fuels, 677, 1007
Petrow, Dr. V. : Appointed chief research chemist to British Drug Houses, Ltd., 555
Phemister, Dr. J. : Awarded the Murchison Medal of the Geological Society, 122
Philip, A. R. : Open-Hearth Furnace Models, 479
Phillips, D. M. P. : Use of Ultra-Violet Fluorescence in Paper Chromatography, 53
Phillips, F. J. S. : Appointed assistant conservator of forests, Nigeria, 51
Phillips, J. N., and Vincent, J. M. : Dosage/Response Relationships in Mould Inhibition, 210
Phillips, Prof. Ralph S., and others (edited by) : Theory of Servomechanisms, *review* by Prof. A. Porter, 994
Philp, Dr. James : Appointed director of the Vegetable Research Station, 715 ; work of, 715
Phipps, J. : Appointed entomological biologist, Tanganyika, 802
Photographic Society, Royal : Election of officers, 471
    Annual Exhibition, 801
Physical Society : Special volume on Meteorological Factors in Radio-Wave Propagation, 146
    Annual Summer Meeting, 430
    Duddell Medal for 1947 awarded to Dr. R. J. Van de Graaff, 511
    Thirty-second Exhibition of Scientific Instruments and Apparatus, 514, 732
    To arrange for separate publication of papers read before the International Conference on the Emission Spectra of the Night Sky and Auroras, 514
    Election of officers for 1948–49, 758
    Guthrie Lecture (Sir George Thomson), 800
    Election of Prof. E. O. Lawrence as an honorary fellow, 843
Physical Society (Acoustics Group) : Symposium on the Borderline of Psychology, Physics and Music, 589
Physical Society (Acoustics Group) and the Royal Institute of British Architects : International Symposium on Noise, 197
Physical Society (Low Temperature Group) : Discussion on Insulating Materials and Methods for Use at Low Temperatures, 323
Physical Society, and others : Symposium on Internal Stresses in Metals and Alloys, 70
Physics, Institute of, and others : Symposium on Internal Stresses in Metals and Alloys, 70
Physics, Institute of (Manchester and District Branch) : Conference on Semiconductors and their Applications, 430
Physics, Institute of (Manchester and District Branch) and others : Conference on the Rheological Properties of Textile Materials, 307, 737
Physics, Institute of (X-Ray Analysis Group) : Discussion on the Structure and Physical Properties of Metals, 263
Physics, Institute of (University of Bristol in co-operation with the) : Summer School in Theoretical Physics, 233
    Summer School in the Physics of Solids, 233, 636
Piaggio, Prof. H. T. H. : Magnetic Field of Massive Rotating Bodies, 450
    An Introduction to Analytical Geometry (A. Robson), Vol. 2, *review*, 705
    Algebraic Geometry, *review*, 787
Pick, W. H. : *Death* of, 48 ; *obituary*, 194
Pickford, Dr. R. W. : Darkening of Red in Protanopes, 27
    Light, Vision and Seeing (Dr. Matthew Luckiesh), fourth printing, *review*, 40
    The Borderline of Psychology, Physics and Music, 589
    Race, Pigmentation and Colour Vision, 687
Pickles, A. : Appointed entomologist, Nigeria, 471
Pierce, E. T. : Radio Noise, 794
Piggott, W. R., and others : Anomalous Effect of Ionospheric Absorption, 967
Pijper, Prof. Adrianus : Bacterial Flagella and Motility, 200
Pilot Papers : Issue for June 1947, 450
Pim, J. A. : Electrical Breakdown Strength of Air at Ultra High-Frequencies, 683
Pincus, Gregory (edited by) : Recent Progress in Hormone Research (Proceedings of the Laurentian Hormone Conference, Vol. 1), *review* by Prof. S. Zuckerman, 295
Pincus, Dr. Paul : Relation of Enamel Protein to Dental Caries, 1014
Pinder, A. R. : Awarded a Senior Scholarship by the Commissioners of the Exhibition of 1851, 966
Pinfield, G. H. : Appointed inspector of mines, Tanganyika, 471
Piper, Dr. S. H. : Appointed assistant director of the Wills Laboratory at the University of Bristol, 272
Pippard, A. B. : Radio Physics, 795
Pirenne, Dr. M. H. : *Obituary* of Prof. Selig Hecht, 673
    Chemistry of Visual Processes, 724
    Orientation of Birds on Migratory and Homing Flights, 998
Pirie, N. W. : Plant Virus Diseases, 945
Pissurlencar, Sir Panduranga S. S. : Awarded the Sir Jadunath Sarkar Gold Medal of the Royal Asiatic Society of Bengal, 553
Pitt, Frances : Day by Day on Skokholm Island, *review*, 5
    A Collector's Trail, *review*, 222
    Exploring our National Parks and Monuments (Devereux Butcher), *review*, 376
    Wonder of Wings (Nancy Price), *review*, 460
    Birds of the Southwest Pacific (Ernst Mayr), *review*, 545
    Animals and the Laboratory, *review*, 664
    Bird Recognition, I, Sea-Birds and Waders (James Fisher), *review*, 831
Planck, Prof. Max : *Obituary* by Prof. H. T. Flint, 13 ; *obituary* by Prof. J. R. Partington, 47
    Memorial Ceremony in honour of, 347
    Memorial Ceremony at Göttingen (Prof. E. N. da C. Andrade), 751
Planck, Max (Prof. E. N. da C. Andrade), 284
Planck (Max) Society for the Advancement of Scientific Research, 427 ; *errata*, 555
Plant Breeding Institute, Cambridge : Transfer from its existing site, 714
    Appointment of Dr. G. D. H. Bell as director, 714
Plant Protection, Ltd. : Good Health to the Garden, *review*, 188
    Plant Disease Charts, 389
    Insecticidal Smokes, 575
    'Agrocide' Range of Insecticides, 595
Plato's Theory of Education (Prof. R. C. Lodge), *review*, 376
Platt, H. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
Playfair (Lyon) and Technical Education in Britain (W. H. G. Armytage), 752
Plesch, Dr. P. H. : Acetylation of Sugars, 637
Plesch, Dr. P. H., and Robertson, R. H. S. : Adsorption on to Ionogenic Surfaces, 1020
Plum, Dr. Claus F. M. : Awarded a Scholarship from the Lady Tata Memorial Fund, 966
Pol, Prof. Balth. van der : The Borderline of Psychology, Physics and Music, 589
Polanyi, Prof. M. : Appointed professor of social studies in the University of Manchester, 15 ; work of, 15
Polar Institute, Norwegian : Establishment of the, 987
Polishuk, Z., and others : Variations in Spermatogenesis of Oligospermic Men, 176
Political and Economic Planning : Broadsheet No. 276, Man-Power Movements, 453
    Broadsheet No. 272, Framework of Collective Bargaining, 453
    Broadsheet on Family and Nation, 539
    Report on the British Fuel and Power Industries, 669
    Broadsheet No. 14, The Human Factor in Industry, 780
    Broadsheet No. 274, Medical Group Practice in the United States, 841
Pollard, Dr. A., and others : Effect of Ion-Exchange Treatment on the Stability of Apple Juice, 1023
Pollock, Dr. M. R. : Unsaturated Fatty Acids in Cotton Wool Plugs, 853

Polson, A. : New Amino-Acids in Bacterial Hydrolysates, 351
Pontecorvo, B. : Promoted to the grade of Senior Principal Scientific Officer, 195
Pontifical Academy of Science : Appointment of new members, 922
Pool, Dr. A. G. : Appointed to the chair of economics at University College, Leicester, 514
Poole, Dr. H. G. : Title of reader in chemistry in the University of London conferred on, 637
Poole, Dr. J. H. J., and Bremner, J. W. : Investigation of the Radioactivity of Rocks by the Photographic Method, 884
Pope, Dr. C. G. : The Assaying of Penicillin, 286
Portal of Hungerford, Lord : To continue to act as controller of production (atomic energy) in the Ministry of Supply, 514
Porter, Prof. A. : Servomechanisms, *review*, 994
Postgraduate Medical School of London : Title of professor of bacteriology in the University of London conferred on Lord Stamp, 51
Potter, Prof. M. C. : *Death* of, 510 ; *obituary* by Prof. M. Thomas, 590 ; *obituary* by Prof. N. S. Alexander, 673
Potter, Ralph K., and others : Visible Speech, *review* by Dr. W. G. Radley, 334
Pound, F. J. : Appointed deputy director of agriculture (crop husbandry), Trinidad, 802
Poupa, Dr. Otakar : Effect of Antihistamines on *Daphnia*, 235
Powell, Dr. C. F. : Appointed Melville Wills professor of physics in the University of Bristol, 272
Powell, Dr. C. F., and Occhialini, Dr. G. P. S.: Nuclear Physics in Photographs, *review* by Prof. P. I. Dee, 333
Powell, Dr. C. F., and Rosenblum, Dr. S. : A New Method for the Determination of the Mass of Mesons, 473
Powell, Dr. C. F. (Occhialini, Dr. G. P. S., and) : The Artificial Production of Mesons, 551
Powell, H. M., and Riesz, P. : Beta-quinol, an Example of the Firm Union of Molecules without the Formation of Chemical Bonds between Them, 52
Powles, J. G. : Measurement of High Permittivity Values at Centimetre Wave-lengths, 25
Pratt, Prof. Robertson (Dufrenoy, Dr. Jean, and) : Evidence for an Electrostatic Field on Penicillin Assay Plates, 849
Preece, A. : Awarded the Sir Robert Hadfield Medal for 1948 of the Iron and Steel Institute, 512
Prentice, Dr. : Mycological Education, 508
Preston, M. M'E. : Amphibian Tissue Cultures for Biophysical Research, 203
Preston, Dr. R. D. : Interaction of Water and Porous Materials, 630
Preston, Dr. R. D. (Wardrop, A. B., and) : Organisation of the Cell Walls of Tracheids and Wood Fibres, *erratum*, 90
Prettre, Prof. M. : Isotope Exchange and Molecular Structure, 901
Price, Prof. Charles C. : Mechanisms of Reactions at Carbon-Carbon Double Bonds, *review* by Dr. J. Sheridan, 626
Price, Harry : *Obituary*, 633
Price, Nancy : Wonder of Wings, *review* by Frances Pitt, 460
Prichard, Prof. H. A. : *Death* of, 48
Prichard, Marjorie M. L., and others : Studies of the Renal Circulation, *review*, 663
Prowse, Dr. W. A., and Cooper, Dr. R. : Gas Discharges at Centimetre Wave-lengths, 310
Prowse, Dr. W. A. (Cooper, Dr. R., and) : Radio Physics, 795
Prunier, F. : Quelques observations et expériences nouvelles, 780
Pryce, Dr. D. M. : Title of reader in morbid anatomy in the University of London conferred on, 924
Psychical Research, Society for : An Outline of its History (W. H. Salter), 880
Public Analysts and other Analytical Chemists, Society of (Biological Methods and Physical Methods Groups) : Discussion on the Assaying of Penicillin, 285
Public Analysts and other Analytical Chemists, Society of (Physical Methods Group) : Symposium on the Determination of Radioactive and Stable Tracer Isotopes, 693
Pugsley, H. W. : *Obituary* by Dr. J. Ramsbottom, 121
Pullman, B., and others : Isotopic Exchange Reactions and Electronic Structure of Substituted Aromatic Hydrocarbons, 901
Pumphrey, Dr. R. J., and Gold, T. : Phase Memory of the Ear, a Proof of the Resonance Hypothesis, 640
Punnett, Prof. R. C. : *Obituary* of Dr. C. C. Hurst, 46
  Elected an honorary member of the Genetical Society of Great Britain, 595
Purcell, Dr. R. H. : Promoted to the grade of Senior Principal Scientific Officer, 195
Purslow, E. T. (Horner, R. G., and) : Dependence of Anomaloscope Matching on Viewing-Distance or Field-Size, 484
Purves, Sir Thomas : Elected an honorary member of the Institution of Electrical Engineers, 122
Purvis, Dr. O. N. (Gregory, Prof. F. G., and) : Reversal of Vernalization by High Temperature, 859

QUALITY Control, Indian Society for : Formation of the, 595
Quaritch, Ltd., Bernard : Catalogue 644, Books and Periodicals relating to Mathematics, Physics and Allied Sciences, 305
  Catalogue 650, Books and Periodicals on all branches of Zoology, Geology, Palæontology and Botany, 305
  Catalogue of Books and Manuscripts issued to commemorate the One Hundredth Anniversary of the firm, 305
Quarterly Journal of Experimental Psychology : To be published by the Experimental Psychology Group, 272
Queen's University, Belfast : Summer School in Micro-Chemical Techniques, 125
Quimby, George I., and others : Indians before Columbus, *review* by Dr. G. H. S. Bushnell, 501

RABINOVITCH, J. : A Rapid Method for the Estimation of Pregnanediol, 605
Race, Dr. R. R., and others : *Rh* Genes Allelomorphic to *C*, 316
Rachinger, W. A. (Wood, Dr. W. A., and) : X-Ray Diffraction Rings from Deformed Solid Metal and Metal Powders, 93
Radhakrishna Rao, Dr. M. V. : Dietetic Hepatic Lesions and Protein Deficiency, 446
Radio, International Advisory Committee for : Conference at Stockholm, 695
Radio (Scientific), British National Committee for (Radio Section of the Institution of Electrical Engineers, and the) : Convention on Scientific Radio, 233
Radio Research Establishment : Appointment of Dr. R. L. Smith-Rose as director of research, 125, 387
Radio Union, International Scientific : Conference at Stockholm, 695
Radiology, British Institute of : Silvanus Thompson Memorial Lecture (Prof. W. T. Astbury), 514
Radley, Dr. W. G. : Physical Patterns of Speech, *review*, 334
Radt, F. (edited by Josephy, E., and) : Elsevier's Encyclopædia of Organic Chemistry, Series 3, Carboisocyclic Condensed Compounds, Vol. 13, Tricyclic Compounds, *review* by Prof. J. W. Cook, 415
Raether, Dr. H. : Refraction Effects in Electron Diffraction and in Electron Microscopy, 311
Raffel, Sidney, and others (edited by) : Annual Review of Microbiology, *review* by Sir Paul Fildes, 995
Raffetto, Lloyd Andrew, and others : The Ice Cream Industry, second edition, *review* by Dr. L. H. Lampitt, 500
Raffles Museum, Singapore : First issue of the new series of the *Bulletin*, 842
Ralph, Patricia M. : Synonymy of the Nudibranch Genera *Pellibranchus* and *Okadaia*, 528
Raman, Sir C. V. : Infra-Red Absorption Spectra of Crystals, 165
Ramanujam, Dr. S., and Joshi, A. B. : Chromosome Number of *Sesamum laciniatum* Klein, 99
Ramanujam, Dr. S., and others : Inheritance of Sex Forms of *Luffa acutangula* Roxb., 775
Ramsay, J. A. : Meteorological Factors in Radio-Wave Propagation, 146
Ramsbottom, Dr. J. : *Obituary* of H. W. Pugsley, 121
  Mycological Education, 508
  Elected president of the Society for the Bibliography of Natural History, 1006
Randall, Prof. J. T. : Microwave Electronic Valves, *review*, 952
Rangaswami Aiyangar, Rao Bahadur K. V. : Elected a Fellow of the Royal Asiatic Society of Bengal, 553
Rankin, Dr. R. A. : Exterior Ballistics of Rockets, *review*, 3
Rao, B. Ramachandra (Bhagavantam, Prof. S., and) : Diffraction of Light by Very High Ultrasonic Waves, 927
Rao, D. A. A. S. Narayana (Bhagavantam, Prof. S., and) : Dielectric Constant of Diamond, 729
Rao, Dr. M. V. Radhakrishna : Dietetic Hepatic Lesions and Protein Deficiency, 446
Raphael, Mrs. W. : Science in Social Affairs, 68
Rassack, R. C. (Angyal, Dr. S. J., and) : The Sommelet Reaction, 723
Ratcliffe, J. A. : Scientific Radio, 794
Raven, Dr. C. E. : English Naturalists from Neckham to Ray, *review* by Prof. F. J. Cole, 373
  Awarded the James Tait Black Memorial Prize for 1947 of the University of Edinburgh, 390
Rawlins, F. Ian G. : Note on the late Prof. A. N. Whitehead, 268
  Petrographic Micro-technique (A. V. Weatherhead), *review*, 626
  Aristotelian Society Supplementary Vol. 21, Explanation in History and Philosophy, *review*, 665
  Mathematik, Logik und Erfahrung (Prof. Dr. Victor Kraft), *review*, 666
  Smoke (Arnold Marsh), *review*, 706
Rawlins, F. Ian G. (Rideal, Prof. Eric K., and) : *Obituary* of G. S. W. Marlow, 672
Ray, Prof. P. : The Theory of Valency and the Structure of Chemical Compounds, *review*, 460
Ray Society : One hundred and fourth Annual General Meeting, 555
Raymond, W. D. : Appointed Government chemist, Tanganyika, 966
Raymond, W. F. : Evaluation of Herbage for Grazing, 937
Rayner, Dr. Dorothy : Awarded a moiety of the Lyell Fund of the Geological Society, 122
Rayner, R. W. : Latent Infection in *Coffea arabica* L., 245
Raynor, Dr. G. V. : To receive a Beilby Memorial Award for 1947, 231, work of, 231
  Electron Theory of Metals, 264
Read, Prof. John : The Alchemist in Life, Literature and Art, *review* by T. I. W., 787
  Humour and Humanism in Chemistry, *review* by Denis I. Duveen, 869
Reaveley, C., and Winnington, J. : Democracy and Industry, 109
Recherche scientifique, Le Centre National de la : Symposium on Physiology and Biochemistry of Fats and Lipoids, 534
Recorded Sound, Institute of : Association of Special Libraries and Information Bureaux meeting to discuss the formation of a proposed, 493
Reed, Dr. R., and others : Ultracentrifugation and Electron Microscope Studies of Tissues of Inbred Strains of Mice, 759
Reed, Dr. R. I. (Badger, Dr. G. M., and) : Relative Reactivity of Aromatic Double Bonds, 238
Reid, D. M. : Occurrence of the Amphipod *Orchestia bottæ* and other Organisms in Britain, 609
Reid, Prof. E. Waymouth : *Death* of, 555 ; *obituary* by Prof. P. T. Herring, 591
Reiss, Dr. M., and Hemphill, R. E. : Cholinesterase Activity in Cerebro-Spinal Fluid, 18
Renard, Dr. Marcel : Raman Spectra of some Synthetic Mixtures of α-Chloroacids, 354
Renold, Sir Charles : Elected honorary treasurer of the Manchester Joint Research Council, 272
  Presidential Address to the British Institute of Management, 675
Research on Ageing, British Society for : Conference, 966
Research Associations, Committee of Directors of : Conference on Operational Research in the Research Associations, 584

Research Defence Society : Stephen Paget Memorial Lecture (Prof. P. A. Buxton), 802
Research Development Corporation, National : Establishment of a, 700
Rettie, R. S., and others : A 16-MeV. Metatron, 472
Reuter, G. E. H., and Sondheimer, E. H. : Theory of the Anomalous Skin Effect in Metals, 394
Reynolds, N. : Awarded a Senior Scholarship by the Commissioners of the Exhibition of 1851, 966
Rheologists' Club, British : Papers on War-time Rheological Investigations for the British Armed Services, 252
Rheologists' Club, British, and others : Conference on the Rheological Properties of Textile Materials, 307, 737
  Discussion on the Flow of Glaciers, 819
Rheology, International Joint Committee on : First Meeting, 104
  Officers for the Year 1947–48, 104
Rhind, D., and Tin, U. : Results of the Continuous Use of an Ammonium Phosphate Fertilizer on Rice in Lower Burma, 105
Richards, Dr. A. I. : Methodology in Ethnography, *review*, 111
Richards, Dr. T. Ll. : Structure and Properties of Metals, 264
Richardson, Dr. H. O. W. : Spin-Dependence of Magnetic Dipole Gamma Radiation and the Nuclear Level Scheme of Pb^{208}, 516
Richmond, Sir Daniel : *Death* of, 799
Richmond, Dr. H. W. : *Death* of, 674 ; *obituary* by Prof. E. A. Milne, 877
Richter, Dr. D., and Dawson, R. M. C. : Brain Lactate in Emotion, 205
Richtmyer, F. K., and Kennard, E. H. : Introduction to Modern Physics, fourth edition, *review* by Prof. L. F. Bates, 912
Rickard, Dr. T. A. : Honorary membership of the Institution of Mining and Metallurgy conferred on, 923
Rickes, E. L., and others : Anti-Pernicious Anæmia Factor, 676
Riddell, R. W. : Awarded a Commonwealth Fund Fellowship, 1006
Rideal, Prof. E. K. : *Obituary* of Prof. R. E. Liesegang, 230
  Adsorption and Heterogeneous Catalysis, 461
Rideal, Prof. E. K., and Rawlins, F. I. G. : *Obituary* of G. S. W. Marlow, 672
Ridenour, Prof. Louis N. (edited by) : Radar System Engineering, *review* by Sir Robert Watson-Watt, 867
Riesz, P. (Powell, H. M., and) : Beta-quinol, an Example of the Firm Union of Molecules without the Formation of Chemical Bonds between Them, 52
Riet Lowe, Dr. van : Tanged and Winged Arrow-heads, 881
Rigby, Dr. G. R. : To receive a Beilby Memorial Award for 1947, 231 ; work of, 231
Riley, N. D. : *Obituary* of Dr. A. S. Corbet, 1003
Ripper, Dr. W. E., and others : New Formulation of D.D.T. with Selective Properties, 484
Risdon, E. J., and others : Reversion, a New Procedure in Absorptiometry, 805
Ritchie, Prof. A. D. : Science and Politics, 6
  Logical Realism, *review*, 623
Ritchie, Dr. A. E. : Appointed to the Chandos chair of physiology in the University of St. Andrews, 922 ; work of, 922
Ritchie, Dr. P. D. : Synthetic Resin Chemistry (Dr. S. R. W. Martin), *review*, 502
Rivers, Rosalind Pitt : Formation of Derivatives of Thyroxine from Derivatives of Diiodotyrosine, 308
Rivlin, R. S. : Normal Stress Coefficient in Solutions of Macromolecules, 567
Road Research Laboratory : Road Research Technical Paper No. 7, 231
Robbins, Dr. William J., and others : Nutrition in relation to Cancer, 106
Roberts, Comdr. Elliott R. : World Magnetic Data, 677
Roberts, Dr. E. R. : Determination of Radioactive and Stable Tracer Isotopes, 694
Roberts, F. M. (Bawden, Dr. F. C., and) : Plant Virus Diseases, 945
Roberts, R. O. : Appointed mineralogist, Nigeria, 471
Robertson, Prof. A., and others : The Melanin Problem—a Synthesis of 5 : 6-Dihydroxyindole, 525
Robertson, Dr. A. J. B., and Yoffe, A. : Gases Liberated from Explosions Initiated by Impact, 806
Robertson, Sir Charles Grant : *Death* of, 387 ; *obituary* by Dr. G. A. Shakespear, 510
Robertson, Dr. Forbes W. (Begg, Dr. Michael, and) : Nutritional Requirements of *Drosophila melanogaster*, 769
Robertson, J. S. : Failure of Adrenal Cortical Extracts to cause Lysis of Living Lymphocytes *in vitro*, 814
Robertson, R. H. S. (Plesch, Dr. P. H., and) : Adsorption on to Ionogenic Surfaces, 1020
Robertson, Dr. R. N., and Wilkins, Marjorie : Quantitative Relation between Salt Accumulation and Salt Respiration in Plant Cells, 101
Robinson, Dr. Alice M., and Warren, Dr. F. L. : Presence of Substances Inhibitory to Acid Phosphatase in Normal Human Urine, 397
Robinson, Prof. G. W. : Elected a Fellow of the Royal Society, 467
Robinson, H. W. : Retirement from the office of librarian of the Royal Society, 388
Robinson, J. T. (Broom, Dr. R., and) : Size of the Brain in the Ape-Man, *Plesianthropus*, 438
Robinson, Sir Robert : Structure of Cyclopropane, 176
  Special meeting of the Industrial Research Committee of the Federation of British Industries at the Royal Institution in honour of, 508
  Scope of Organic Chemistry, 508
  Honorary degree of the University of Cambridge conferred on, 965
Robinson, Sir Robert (Bailey, Dr. A. S., and) : Relation of Vomicine to Strychnine and Brucine, 433
Robinson, Dr. Victor : Victory over Pain, *review* by Dr. G. Edwards, 458
Robson, A. : An Introduction to Analytical Geometry, Vol. 2, *review* by Prof. H. T. H. Piaggio, 705
Robson, A. H. (Harris, Dr. J. O., and) : Structure of Urea, 98
Robson, Dr. J. M. : Recent Advances in Sex and Reproductive Physiology, third edition, *review* by Dr. F. H. A. Marshall, 790
Robson, Dr. W. A. : Machinery of Government, 495
  Study of Public Administration, 879
Rocard, Prof. Yves : Awarded the Holweck Prize and Medal, 552
Roche, Prof. J. : Physiology and Biochemistry of Fats and Lipoids, 535
Rockefeller Foundation : Gift of £9,000 for research at the Neuropsychiatric Research Centre, Whitchurch Hospital, Cardiff, 346
Rodda, R. L. : Appointed Inspector of mines, Nigeria, 966
Roddan, G. M. : Appointed deputy director of agriculture, Kenya, 802
Rodger, Alec : Human Factors in Industry, 792
Rogers, Dr. H. J. : Bacterial Hydrolysis and Utilization of Polysaccharide-like Substances ('Mucin') in Saliva, 815
Rogers, M. A. T., and others : *Streptococcus fæcalis* in *E. histolytica* infections, 936
Rogers, W. S. : Degree of D.Sc. of the University of London conferred on, 233
Romanes, George John (1848–94), 757
Rose, Dr. H. E. : Appointed to the University of London readership in mechanical engineering at King's College, London, 637
Rose, L., and Griffiths, J. D. : Stress-Strain Characteristics of Viscose Rayon in relation to Anisotropy, 737
Rosenblum, Dr. S. (Powell, Dr. C. F., and) : A New Method for the Determination of the Mass of Mesons, 473
Rosenhead, Prof. L. : Appointed a member of the Advisory Council on Scientific Research and Technical Development, 924
Ross, D. J. (Brandt, C. W., and) : Podocarpic Acid as a Source of an Œstrogenic Hormone, 892
Ross, L. : Appointed assistant meteorologist, Nigeria, 637
Rosser, Prof. J. Barkley, and others : Mathematical Theory of Rocket Flight, *review* by Dr. R. A. Rankin, 3
Rothamsted Experimental Station : Report on the Department of Plant Pathology for the Years 1939–45 (Dr. F. C. Bawden), 676
  A new Nematology Department to take the place of the Institute of Agricultural Parasitology, 1006
Rothé, Prof. J.-P. : Séismes et volcans, *review* by Ernest Tillotson, 296
Rounthwaite, C., and others : Atomic Oxygen and Dissociation in Flame Gases, 726
Rowlands, Dr. I. W., and others: Ovarian Activity in the Pregnant Mare, 355
Rowlands, S., and others : Studies with Radioactive Penicillin, 1009
Rowley, Dr. D., and others : Studies with Radioactive Penicillin, 1009
Rowse, A. L. : The Use of History, 866
Roy, Dr. J. N. : Scientific Research in India, 513
Royal Academy, 1948 (Dr. A. Tindell Hopwood), 976
Royal Aeronautical Society : Gold Medal awarded to Sir Bennett Melvill Jones, 593
  Silver Medal awarded to I. I. Sikorsky, 593
  Bronze Medal awarded to Miss F. B. Bradfield, 593
  Simms Gold Medal awarded to Sir William T. Griffith, 593
  George Taylor (of Australia) Gold Medal awarded to Dr. J. W. Drinkwater and W. G. Glendinning, 593
  Edward Busk Memorial Prize awarded to Air Marshal the Hon. Sir Ralph Cochrane, 593
  R.38 Memorial Prize awarded to W. M. Widgery, 593
  Branch Prize awarded to A. N. Clifton and J. A. Kirk, 593
  Election of officers for 1948–49, 843
Royal Aeronautical Society, and others : Symposium on Internal Stresses in Metals and Alloys, 70
Royal Air Force : Opening of a new School of Education, 469
Royal Aircraft Establishment, Farnborough : New Chemical and Physical Laboratory at the, 212
Royal Anthropological Institute : Huxley Memorial Lecture for 1947 (Dr. W. L. H. Duckworth), 628
Royal Asiatic Society of Bengal : Barclay Memorial Medal awarded to Ra Bahadur K. C. Mehta, 553
  Joy Gobind Law Memorial Medal awarded to Dr. Lieven Ferdinand de Beaufort, 553
  Paul Johannes Bruhl Memorial Medal awarded to Prof. S. R. Bose, 553
  Dr. Bimala Churn Law Gold Medal awarded to Dr. B. M. Barua, 553
  Sir Jadunath Sarkar Gold Medal awarded to Sir Panduranga S. S. Pissurlencar, 553
  Election of members of Council for 1948, 553
  Election of Fellows, 553
Royal Astronomical Society : 'Geophysical Discussion on the Main Geomagnetic Field, 462
  Publication of papers for the Geophysical Supplement of the *Monthly Notices*, 924
Royal Botanic Garden, Calcutta : Early History of the (Dr. D. Chatterjee), 362
Royal Botanic Gardens, Kew : Collection of Bog-mosses (*Sphagnum*) presented by W. R. Sherrin, 716
  Retirement of Dr. John Hutchinson, 799
  Appointment of Dr. N. L. Bor as assistant director, 840
Royal Cancer Hospital (Free) : Appointment of Dr. Eric Boyland to the University of London chair of biochemistry, 347
Royal Geographical Society : Founder's Medal awarded to Wilfred Thesiger, 553
  Patron's Medal awarded to Thomas H. Manning, 553
  Victoria Medal awarded to Prof. Frank Debenham, 553
  Murchison Grant awarded to Robert W. Steel, 553
  Back Grant awarded to Alan J. Marshall, 553
  Cuthbert Peek Grant awarded to Dr. Donald F. Thomson, 553
  Gill Memorial awarded to William W. Williams, 553
Royal Institute of British Architects (Acoustics Group of the Physical Society and the) : International Symposium on Noise, 197
Royal Institute of Chemistry : Annual General Meeting, 347
  Anniversary Meeting, 716
Royal Institute of Chemistry (Leeds Area Local Section), and others : Conference on the Rheological Properties of Textile Materials, 307, 737
Royal Institution : Election of Lord Brabazon of Tara as president, 347
  Special meeting of the Industrial Research Committee of the Federation of British Industries in honour of Sir Robert Robinson and Sir Edward Appleton, 508
  Anniversary Meeting of the, 717
  To make an appointment to the Dewar Research Fellowship, 802
Royal Meteorological Society : Election of officers, 197
Royal Netherlands Embassy : Insignia of Commander in the Order of Orange-Nassau (Civilian Division) presented to Sir George Beharrell, Sir Jack Drummond, Dr. John Hammond and Sir Raymond Streat, 307
Royal Observatory, Greenwich : Presented with a Transit Circle by the Government of Victoria, 271
Royal Photographic Society : Election of officers, 471
  Annual Exhibition, 801

Royal Sanitary Institute : Annual Congress of the, 1025
Royal Sanitary Institute (Food Group of the Society of Chemical Industry and the) : Discussion on the Cleaning and Sterilizing of Plant in the Food Industry, 1025
Royal Scottish Museum, Edinburgh : Annual Report for 1946, 470
Royal Society : Newton Tercentenary Celebrations, 15–19 July 1946, *review*, 375
  Retirement of H. W. Robinson from the office of librarian, 388
  Formation of a British National Committee for Crystallography, 390
  Symposium on the Physiology of Resistance to Disease in Plants, 422
  New Fellows of the, 466
  Conference on Scientific Information Services, 469
  Discussion on Calculating Machines, 712
  Election of Sir Stafford Cripps as a Fellow under Statute 12, 843
  Election of new Foreign Members, 921
  Grants from the Browne Research Fund, 966
Royal Society of Edinburgh : Election of new Fellows, 390
  Keith Prize for 1945–47 awarded to Dr. Charlotte Auerbach, 716
  Neill Prize for 1945–47 awarded to Dr. Robert Broom, 716
  David Anderson-Berry Prizes presented to Dr. Ralston Paterson and Dr. P. C. Koller, 716
Royal Society of Medicine and the Scientific Film Association : Catalogue of Medical Films, 594
Royal Statistical Society : Offer of the Frances Wood Memorial Prize for 1948, 390
Royal Technical College, Glasgow : Coats Research Fellowship in Chemistry of Physics, 164
Royal Zoological Society of Scotland, 592
Rubber Development Board, British : Publication of No. 1 of *Rubber Developments*, 89
Rubber Developments, No. 1, 89
Rubber Industry, Institution of the : Conference on Rubber Technology, 51
Rumpf, P., and others : Isotopic Exchange Reactions and Electronic Structure of Substituted Aromatic Hydrocarbons, 901
Runcorn, S. K. : Variation of Geomagnetic Intensity with Depth, 52
  The Main Geomagnetic Field, 464
Ruse, Prof. H. S. : Appointed head of the Department of Mathematics in the University of Leeds, 307, 468 ; work of, 468
Rushton, Dr. W. A. H. : Elected a Fellow of the Royal Society, 467
Russell, Bertrand, and others : Atomic Challenge, a Symposium, *review*, 995
Russell, Sir John : Early English County Life, *review*, 701
  E. S. Beaven, a Great Barley Expert, *review*, 828
  The Land of Britain and How we Use It, *review*, 906
Russell, J. F. : Internal Stresses in Metals and Alloys, 70
Rutgers University, New Brunswick : Establishment of a Serological Museum, 428
Rutter, L. : A Modified Technique in Filter-Paper Chromatography, 435
Ryde, J. W. : Elected a Fellow of the Royal Society, 467
Ryle, M. : Solar Radio Emissions and Sunspots, 136
  Radio Noise, 795

SA, J. de, and others : A New Sulpha Compound ('6257') and its Use in Human Cholera Infection, 395
Saha, Prof. M. N. : Scientific Research in India, 513
Sahasrabuddhe, K. R. (Ekbote, R. B., and) : Shrivelled Wheat Grain from Rust-Affected Crop as Seed, 442
Sahlar, A. B. : A Doubly Charged Cosmic Ray Particle, 811
Saksena, Dr. Bishambhar Dayal : Calculation of the Piezo-electric Constants of α- and β-Quartz, 283
Salisbury, Sir Edward : Trees in Prose and Picture, *review*, 497
  Plant Geography, *review*, 704, 857
  Obituary of Prof. F. O. Bower, 754
Salisbury, Winfield W. (Menzel, Dr. Donald H., and) : Audio-Frequency Radio Waves from the Sun, 91
Salmon, Dr. W. D., and others : Nutrition in relation to Cancer, 106
Sampford, M. R. : Industrial Experimentation (K. A. Brownlee), third edition, *review*, 747
Samuels, Dr. Jules : Die hormonalen Aspekte des Fortpflanzungsprozesses, *review*, 297
  Die Hormonversorgung des Fœtus, *review*, 297
Sandeman, Dr. E. K. : Radio Engineering, Vol. I, *review* by Dr. L. E. C. Hughes, 706
Sanger, Dr. Ruth, and others : *Rh* Genes Allelomorphic to *C*, 316
Sanitary Institute, Royal : Annual Congress of the, 1025
Sanitary Institute, Royal (Food Group of the Society of Chemical Industry and the) : Discussion on the Cleaning and Sterilizing of Plant in the Food Industry, 1025
Sansome, Dr. F. W. : Natural Selection of *Drosophila*, 409
Sarton, Prof. George : The Place of the History of Science in Education, 572
Saul, A. P. H. : A Proposed Institute of Recorded Sound, 493
Sawyer, W. W., and others : Empirical Data on Hilbert's Inequality, 361
Saxton, Dr. J. A. : Meteorological Factors in Radio-Wave Propagation, 146
Saxton, Dr. J. A. (Jackson, Prof. Willis, and) : Radio Physics, 795
Scarborough, Dr. Harold : Appointed lecturer with title of reader in the Department of Medicine in the University of Birmingham, 233
Scarlott, C. A. (Bendz, W. I., with the assistance of) : Electronics for Industry, *review* by Prof. J. Hollingworth, 582
Schallamach, Dr. A. : Ultrasonic Dispersion in Organic Liquids, 476
Schatzman, Dr. Evry : Spectrum of White Dwarfs, 61
Schnurmann, Dr. Robert (Bezer, Henry James, and) : Rate of Wear in the Region of the Validity of Amontons' Law, 728
Schoental, Dr. R. (Cook, Prof. J. W., and) : Oxidation of Anthracene by Osmium Tetroxide, 237
Schofield, K., and Swain, T. : Nitration of Simple Heterocycles, 690
Schönberg, Prof. Alexander, and Barakat, Mohamed Zaki : Stereochemistry of Trimeric Thioaldehydes, 722
Schönberg, Prof. Alexander, and Sina, Aly : Xanthotoxin from the Fruits of *Ammi majus* L., 481
Schonland, Dr. B. F. J. : *Obituary* of Prof. Alexander Ogg, 633
Schuftan, Dr. P. M. : Insulating Materials and Methods for Use at Low Temperatures, 323
Schurer, H. : Public Libraries in Germany, 90
Schuster, Sir George : Human Factors in Industry, 791
Schwamb, Peter, and others : Elements of Mechanism, sixth edition revised by Prof. Venton Levy Doughtie, *review* by F. G. W. Brown, 79
Science and Religion, 428
Science Masters' Association : Forty-fifth Annual Meeting, 144
Science Masters' Association (Scottish Branch) : First Annual General Meeting, 655
Science Masters' Association, and others : Discussion on the Place of the History of Science in Education, 347, 572
Science Museum : Exhibition, Darkness into Daylight, 674, 821
Science Service, Washington, D. C. : Election of Dr. Karl Lark-Horovitz and Charles E. Scripps as trustees, 842
  Election of officers, 842
Science Writers (British), Association of : Open to accept Associate Members, 272
  Forum Discussion on Science and the Press, 882
Scientific Civil Service : Promotion of Individual Research Workers, 195
Scientific Exports (Great Britain), Ltd. : Technical Bulletin No. 1, 345
Scientific Film Association : Conference on Films in Agriculture, 17
Scientific Film Association (Royal Society of Medicine and the) : Catalogue of Medical Films, 594
Scientific and Industrial Research, Department of : Appointment of Dr. R. L. Smith-Rose as director of radio research work, 125
  Series of films on Science in the Service of the Nation, 717
Scientific and Industrial Research, Department of (University of Cambridge, in co-operation with the) : Summer Course in Food Science, 1007
Scientific Radio, British National Committee for (Radio Section of the Institution of Electrical Engineers, and the) : Convention on Scientific Radio, 233
Scientific Radio Union, International : Conference at Stockholm, 695
Scientific Relations (Overseas) : Inter-Departmental Committee on, 800
Scientific Research, India : Department of, 1004
Scientific Research in Industry and Agriculture, Institute for the Encouragement of : Annual Report for 1946, 634
Scientific Research and Technical Development, Advisory Council on : Appointment of Sir Howard Florey, Prof. J. L. M. Morrison and Prof. L. Rosenhead as members, 924
Scientific Societies, South-Eastern Union of : Fifty-second Annual Congress, 882
Scientific Unions, International Council of : Report of the Executive Committee, July 1947, 677
Scientific Workers, Association of : Conference on Science in Social Affairs, 68
Scientists and Physicians in the Netherlands, Christian Society of (Society of Calvinist Lawyers and the) : Discussion on Atomic Energy, 123
Scott, B. A. : Photometric Measurement of Specific Surface, 358
Scott, Dr. I. Martin : Mycological Education, 507
Scottish Council (Development and Industry) : Address by Sir Edward Appleton on Science and the Progress of Industry, 368
Scottish Museum, Royal : Annual Report for 1946, 470
Scottish Naturalist, 923
Scottish Society for the History of Medicine : Proposed establishment of a, 555
Scottish Zoo and Wild Life, 923
Scripps, Charles E. : Elected a trustee of Science Service, Washington, D.C., 842
Sears, J. E. : Awarded a moiety of the Clayton Prize for 1947 of the Institution of Mechanical Engineers, 470
Seekles, Prof. L. : Trace Elements in Plant Physiology, 365
  Fison Lectures of the Animal Health Trust, 637, 1005
Selényi, Dr. P. : Photography on Selenium, 522
Seligman, G. : Growth of Glacier Crystals, 485
  The Flow of Glaciers, 819
Seligman, Dr. Richard : The Flow of Glaciers, 819
Sellers, K. C. (McGaughey, C. A., and) : Microflora of the Rumen, 1014
Selman, I. W. : Plant Virus Diseases, 945
Seltzer, Carl C., and others : What People Are, a Study of Normal Young Men, *review*, 502
Selye, Prof. Hans : Textbook of Endocrinology, *review* by Dr. F. H. A. Marshall, 953
Sen, K. C. (Sen Gupta, Dr. N. C., and) : A Text Book of Physical Chemistry, new edition, *review*, 460
Sen, M. K., and others : Some Tensile Properties of Jute, 737
Sen, M. K., and Woods, H. J. : X-Ray Investigation of the Structure of Jute, 768
Sen Gupta, Dr. N. C., and Sen, K. C. : A Text Book of Physical Chemistry, new edition, *review*, 460
Serological Museum of Rutgers University, 428
Seshachar, B. R. : The Nucleolus of the Apodan Sertoli Cell, 558
Sewell, Lieut.-Colonel R. B. Seymour : The Free-Swimming Planktonic Copepoda, 822
Sexton, Dr. W. A., and Templeman, Dr. W. G. : Differential Effect of 2-Benzoylbenzoic Acid and its Derivatives upon Plant Species, 974
Seymour, Charles : Honorary degree of the University of Cambridge conferred on, 965
Seymour, D. E., and others : *p*-Aminosalicyclic Acid in the Treatment of Tuberculosis, 435
Shakespear, Dr. G. A. : *Obituary* of Sir Charles Grant Robertson, 510
Shapiro, B., and others : Active Penetration of Fat into Adipose Tissue, 482
Shapley, Dr. Harlow : Galaxies, *review* by H. S. J., 460
  Re-elected president of Science Service, Washington, D.C., 842
Shattock, Dr. P. M. F. : Serological Position of *Streptococcus bovis*, 318
Shaw, H. K. A. : The Study of Critical British Groups, 735
Shaw, J. J. : *Death* of, 839 ; *obituary* by Ernest Tillotson, 920
Shaw, Thomas : Marketing Agricultural Produce, 470
Sheffield, F. M. L. (Crook, E. M., and) : Plant Virus Diseases, 945
Sheppard, Prof. P. A. : Meteorology for the Professional Meteorologist, *review*, 625
Sheppard, Dr. S. E. : Retirement from the Eastman Kodak Research Laboratories, 270 ; work of, 270
Sheridan, Dr. J. : Mechanisms of Reactions at Carbon-Carbon Double Bonds (Prof. Charles C. Price), *review*, 626

Sherlock, Sheila, and Walshe, Veryan : Effect of Under-Nutrition in Man on Hepatic Structure and Function, 604
Sherrin, W. R. : Collection of Bog-mosses (*Sphagnum*) presented to the Royal Botanic Gardens, Kew, 716
Sherrington, Sir Charles, and Diphtheria Antitoxin (Dr. A. N. Drury), 266
Shoppee, Dr. C. W. : Nature of the *C/D*-ring Union in the Œstrogenic Hormones, 207
  Appointment to the chair of chemistry at University College, Swansea, 1004 ; work of, 1004
Shortt, Prof. H. E., and Garnham, P. C. C. : Pre-erythrocytic Stage in Mammalian Malaria Parasites, 126
Sibly, Sir Franklin : *Death* of, 634 ; *obituary* by Prof. H. L. Hawkins, 672
Sikorsky, I. I. : Awarded the Silver Medal of the Royal Aeronautical Society, 593
Simon, Prof. F. E. : Insulating Materials and Methods for Use at Low Temperatures, 324
Simon, Colonel Leslie E. : German Research in World War II, *review*, 219
Simpson, Charles : Foundations of Chemical Theory, *review*, 503
Simpson, J. C. E., and others : Cinnoline Derivatives as Chemotherapeutic Agents for *Trypanosoma congolense* Infections, 603, 758
Simpson, O., and others : Lead Telluride Cells for Infra-Red Spectroscopy, 281
Simpson, S. A., and Williams, P. C. : Improved Method of Getting Rats' Eggs from the Fallopian Tubes, 237
Sina, Aly (Schönberg, Prof. Alexander, and) : Xanthotoxin from the Fruits of *Ammi majus* L., 481
Sinclair, D. C., and others : Intravenous Methylene Blue, a New Method for Studying the Nervous System, 318
Sinclair, Dr. Hugh M. : Awarded the Medal of Freedom with Silver Palm by the Government of the United States, 215
Sinclair, J. : Appointed curator of the Herbarium, Singapore, 471
Singapore Herbarium : Appointment of J. Sinclair as curator, 471
Singh, Dr. B. N. : Degree of D.Sc. of the University of London conferred on, 233
Singh, Dr. B. N. (Anscombe, Dr. F. J., and) : Limitation of Bacteria by Micro-Predators in Soil, 140
Singh, H. B., and others : Inheritance of Sex Forms of *Luffa acutangula* Roxb., 775
Skinner, Dr. H. A., and others : Bond-Strength of C—Cd in Cadmium Methyl and of C—I in Methyl Iodide, 725
Slater, E. C. : A Factor in Heart Muscle required for the Reduction of Cytochrome *c* by Cytochrome *b*, 405
Slater, Prof. John C., and Frank, Prof. Nathaniel H. : Mechanics, *review* by J. H. Pearce, 376
Sloman, H. A. : Promoted to the grade of Senior Principal Scientific Officer, 195
Smart, Dr. G. A. : Awarded a Commonwealth Fund Fellowship, 1006
Smart, Dr. John : Lice, second edition, 389
Smart, R. Cecil : Awarded the Nursey Premium of the Society of Engineers, 346
Smart, Prof. W. M. : *Obituary* of Prof. Ludwig Becker, 161
Smith, Dr. A. E. Wilder (Hausmann, W., and) : Isomerization of Dienœstrol, 892
Smith, Eng.-Capt. Edgar C. : Scientific Centenaries in 1948, 11
Smith, Dr. F. (Nicholas, S. D., and) : Acetylation of Sugars, 349
Smith, H. C. : Appointed livestock officer, Tanganyika, 637
Smith, H. Williams : Calcium-Deficient Media—their Effect on Phage Action, 397
Smith, Dr. Kenneth M. : Plant Virus Research at Cambridge, 776
Smith, Dr. Kenneth M., and others : Molecular Arrangement in Tobacco Necrosis Virus Crystals, 760
Smith, Dr. M. S. : Persistence of *D.D.T.* and Benzene Hexachloride in Soil, 246
Smith, Dr. R. A. : Radio Aids to Navigation, *review* by Dr. R. L. Smith-Rose, 334
  Radio Physics, 796
Smith, Stuart : Bird Watching, 554
Smith, Webster : The Flow of Glaciers, 820
Smith, Dr. W. Campbell : *Obituary* of Prof. F. A. A. Lacroix, 962
Smith-Rose, Dr. R. L. : Appointed director of research at the Radio Research Establishment of the Department of Scientific and Industrial Research, 125, 387
  Meteorology and the Propagation of Radio Waves, 145
  Modern Radio Technique, *review*, 334
  Wireless Direction Finding, *review*, 375
  Scientific Radio, 793
Smithsonian Institution, Commonwealth of Australia, and the National Geographic Society : Scientific Expedition to Arnhem Land, 195
Smout, Sir Arthur : Elected president of the Institute of Metals, 468
  Past and Future of the Institute of Metals, 468
  The Flow of Glaciers, 819
Smuts, General : Elected chancellor of the University of Cambridge, 233
  Installed as chancellor of the University of Cambridge, 965
Smyth, Dr. J. D. : Development of Cestodes *in vitro*—Production of Fertile Eggs ; Cultivation of Plerocercoid Fragments, 138
Sneddon, Dr. I. N., and Touschek, B. F. : Nuclear Models, 61
Snellman, Olle, and Erdös, Thomas : Effect of Calcium Ions on the Charge of Myosin, 526
Snellman, Olle, and others : A New Extraction Procedure for the Preparation of Heparin, 639
Snoek, Dr. J. L. : New Developments in Ferromagnetic Materials, *review* by F. C. T., 666
Snoek, Dr. J. L., and Fast, J. F. : Metastable States of Nickel Characterized by a High Initial Permeability, 887
Snoek, Dr. J. L. (Dijkstra, Dr. L. J., and) : Effect of Lattice Distortions on the Mean Rate of Propagation of Large Barkhausen Discontinuities, 886
Snow, G. R. S. : Elected a Fellow of the Royal Society, 467
Snyder, L. H., and others : Nomenclature of the anti-*Rh* Typing Sera, 492
Social Hygiene Council, British : Ethics and Science Conference on Society and the Individual, 197
  Summer School on the Schools and the Land, 470
  Summer School on the International and Cultural Relations of Social Biology, 842
  Ethics and Science Conference on Where does Freedom End, 843
Social Hygiene Council, British, and the Town and Country Planning Association : Conference on the Family, 125
Social Science Research Council, Colonial : Third Annual Report, 142
Soddy, Dr. Kenneth : Sociology of Mental Disease, 408
Sols, Dr. A., and others : Effect of Insulin on Intestinal Glucose Absorption in Alloxan Diabetic Rats, 932
Sondheimer, E. H. (Reuter, G. E. H., and) : Theory of the Anomalous Skin Effect in Metals, 394
Sopwith, D. G. : Appointed superintendent of the Engineering Division of the National Physical Laboratory, 552 ; work of, 552
South African Council for Scientific and Industrial Research : Second Annual Report, 903
South African Institute for Medical Research : Annual Report for 1946, 162
South African Museums Association : Annual General Meeting (J. R. Harding), 984
South-Eastern Union of Scientific Societies : Fifty-second Annual Congress, 882
Southern, H. K. (Ingram, G. B., and) : Polarographic Determination of the Gamma-Isomer of Benzene Hexachloride, 437
Southgate, Dr. B. A. : Biological Aspects of Water Pollution, 874
Spaul, Prof. E. A. : The Field Study and Conservation of the British Fauna, 409
Spayne, A. J., and others : Pinhole Radiography of Magnetrons, 244
Speakman, Prof. J. B. : Bibliography of the Technical Literature on Silk (Dr. F. O. Howitt), *review*, 790
Speakman, Prof. J. B. (Farnworth, A. J., and) : Action of Sulphuryl Chloride on Wool, 850
  Chemical Mechanism of Permanent Set, 890
Speakman, Prof. J. B. (Peters, L., and) : The Viscous-Elastic Properties of Wool Fibres, 737
Special Libraries and Information Bureaux, Association of : Study Group on Special Librarianship, 430
  Meeting to discuss the formation of a proposed Institute of Recorded Sound, 493
Special Libraries and Information Bureaux, Association of, (Northern Branch) : Conference, 430
Speech Therapists, College of : Conference on Speech Therapy, 125
Speirs, Dr. L. : Surface Resistance of Metal Films at a Frequency of 24,000 Mc./s., 601
Spenceley, G. W. and R. M. : Smithsonian Elliptic Functions Tables, *review*, 747
Spencer, Steven M. : Awarded an American Association for the Advancement of Science—George Westinghouse Science Writing Award for 1947, 125
Sperber, I. : Specific and Non-Specific Competition in Tubular Excretion, 236
Spiers, J. A. : Angular Distribution of Radioactive Disintegration Products, 807
Sprague, Dr. T. A. : Forms of *Valeriana officinalis*, 734
Sprigg, Reg. C. : Newly Discovered Submarine Canyons of New Guinea and South Australia, 246
  Jellyfish from the Basal Cambrian in South Australia, 568
Spring, Prof. F. S., and others : *p*-Aminosalicylic Acid in the Treatment of Tuberculosis, 435
Srisukh, S. (Goodwin, T. W., and) : The Carotenoids of the Locust Integument, 525
St. Bartholomew's Hospital Medical College : Retirement of Prof. H. Hartridge from the University of London chair of physiology, 49
  Appointment of Prof. J. W. S. Blacklock to the University of London chair of pathology, 924
St. Mary's Hospital Medical School : Title of reader in morbid anatomy in the University of London conferred on Dr. D. M. Pryce, 924
St. Thomas's Hospital Medical School : Appointment of Dr. Leslie Young to the University of London chair of biochemistry, 233
  Appointment of Mary Barber to the University of London readership in bacteriology, 637
Stacey, Prof. M., and others : Conversion of *D*-Arabinose into 2-Deoxy *D*-Ribose and 3-Deoxy *D*-Xylose, 21
Stamp, Lord : Title of professor of bacteriology in the University of London conferred on, 51
Stamp, Prof. L. Dudley : Physical Planning in the South-West of England, *review*, 786
  Landscape Architecture, *review*, 868
  The Land of Britain, its Use and Misuse, *review* by Sir John Russell, 906
Stanley, G. J. (Bolton, J. G., and) : Variable Source of Radio Frequency Radiation in the Constellation of Cygnus, 312
Stanley, Dr. Robert Crooks : Awarded the Institute of Metals (Platinum) Medal for 1948, 344
Stanley, Dr. Wendell M. : Appointed professor of biochemistry in the University of California and director of a new Virus Laboratory, 49 ; work of, 49
Stanworth, J. E. : Transmission of Bactericidal Radiation through Glass, 856, *erratum*, 882
Statens Skogsforskningsinstitut : *Meddelandan* fran, Vol. 35 (1946), 781
Statistical Society, Royal : Offer of the Frances Wood Memorial Prize for 1948, 390
Stazione Zoologica di Napoli, 738
Steacie, Dr. E. W. R. : Elected a Fellow of the Royal Society, 467
Stebbing, Prof. E. P. : Practical British Forestry, *review*, 295
  World Forestry and Forest Products, 710
Steel, Robert W. : Awarded the Murchison Grant for 1948 of the Royal Geographical Society, 553
Steele, J. : Awarded a research grant by the Animal Health Trust, 924
Steenbjerg, Prof. F. : Trace Elements in Plant Physiology, 365
Steenland, M. J., and others : Magnetic Observations and Thermometry in the Region of Millidegrees Absolute, 678
Stein, Gabriel, and Weiss, Dr. Joseph : Chemical Effects of Ionizing Radiations, 650
Stenton, Sir Frank : Honorary degree of doctor of laws of the University of Sheffield conferred on, 555
Stephenson, Alfred : Title of reader in surveying in the University of London conferred on, 51
Stephenson, Rev. Dr. Thomas : *Death* of, 634 ; *obituary* by V. S. Summerhayes, 799
Stephenson, Prof. T. A. : Problems of Tidal Biology, 796

Sterland, E. G. : Gas Turbines, *review*, 910
Stern, E. S. (Braude, Dr. Ernest A., and) : Solvation of Hydrogen Ion in Oxygen-containing Solvents, 169
Stetson, Dr. Harlan True : Sunspots in Action, *review* by Dr. M. A. Ellison, 951
Steven, G. A. : The Fisheries School at Cronulla, New South Wales, 986
Steven, G. A. (Cooper, Dr. L. H. N., and) : An Experiment in Marine Fish Cultivation, 631
Stevens, G. W. W. : Resolution Testing in Autoradiography, 432
Stevens, Jun., Herbert H. : Roofs Supported by Air Pressure, 613
Stewart, Dr. Donald : Sociology of Mental Disease, 407
Stewart, Dr. G. T., and others : *Streptococcus fæcalis* in *E. histolytica* Infections, 936
Stewart, H. G. : Appointed senior veterinary officer, Uganda, 802
Stewart, I. G. : Awarded a Commonwealth Fund Fellowship, 1006
Stibbs, T. C. : Appointed mining inspector, Lands and Mines Department, British Guiana, 802
Stickland, Dr. A. C. : Meteorological Factors in Radio-Wave Propagation, 146
Stigant, S. Austen : Modern Electrical Engineering Mathematics, *review* by V. J. Francis, 541
Stockdale, Sir Frank : Factors of Agricultural Production in the British Colonial Empire, 337
Stocks, Dr. Percy : Regional and Local Differences in Cancer Death Rates, 17
Stoker, M. G. P. (Miles, J. A. R., and) : Puffinosis, a Virus Epizootic of the Manx Shearwater (*Puffinus p. puffinus*), 1016
Stokes, Dr. Alexander R. : Phase-Angle Determination in X-Ray Crystallography, 679
Stokes, P. E. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
Stonyhurst College Observatory (Rev. P. J. Treanor), 285
Störmer, Prof. Carl : Auroral Activity in Southern Norway from the Middle of August to the Middle of October 1947, 208
Storti, Prof. Edoardo : Awarded a grant from the Lady Tata Memorial Fund, 966
Stott, F. D., and Engel, Dr. A. von : Optical Transmission of a Colloidal Solution in a Magnetic Field, 728
Stott, R. W. : Electronic Theory and Chemical Reactions, second edition, *review* by Prof. E. D. Hughes, 503
Straiton, Prof. A. W., and Tolbert, C. W. : Dielectric Properties of Soils and Water at a Wave-length of 3·2 cm., 73
Stratton, Andrew : Awarded the Medal of Freedom with Bronze Palm by the Government of the United States, 215
Stratton, Prof. F. J. M. : Appointed deputy scientific adviser to the Army Council, 388
  Sons of Cambridge, *review*, 661
Streat, Sir Raymond : Elected chairman of the Manchester Joint Research Council, 272
  Presented by the Netherlands Ambassador with the Insignia of Commander in the Order of Orange-Nassau (Civilian Division), 307
Street, Dr. H. E. (Dormer, Dr. K. J., and) : Secondary Thickening in Excised Tomato Roots, 483
Stubbs, Dr. A. L., and others : Chemistry of Visual Processes, 424
Sturtevant, Prof. A. H. : Elected an honorary member of the Genetical Society of Great Britain, 595
Süe, P., and Kayas, G. : The Behaviour of some perfect Cobalt Complexes in Szilard-Chalmers Reactions, 901
Sugar Research Foundation : Third Annual Prize awarded to Dr. Leslie F. Wiggins, 756
Sugden, Prof. S. (Evans, C. C., and) : Exchange Reactions and Electrolytic Dissociation, 901
Sulman, Dr. Felix : Preparation of Œstrogens from Urine by Application of High Temperatures, 605
Summerhayes, V. S. : *Obituary* of Dr. Thomas Stephenson, 799
Summerhayes, V. S., and Turrill, Dr. W. B. : Vegetation after Draining, 421
Summerson, Dr. William H., and others : Practical Physiological Chemistry, twelfth edition, *review*, 830
Sumner, W. L. : Grammar School Science, *review*, 114
Supply, Ministry of : Appointment of Dr. F. J. Wilkins as principal director of scientific research (defence), 715
Surányi, Dr. Paul : The Fall Webworm of North America in Europe, 512
Sutherland, Dr. G. B. B. M., and others : Lead Telluride Cells for Infra-Red Spectroscopy, 281
Sutherland, Dr. Robert : The Health of the School Child, 960
Svensson, Harry : A Short-Focus Modification of the Lamm Scale Method for Measuring Refractive Index Gradients, 234
Swain, T. (Schofield, K., and) : Nitration of Simple Heterocycles, 690
Swainger, Dr. K. H. : A Coefficient of Viscous Extension, 650
Swainson, O. S. : Appointed director of agriculture, Zanzibar, 802
Swan, A. D. : Appointed assistant meteorologist, West Africa, 966
Swan, J. B. (Darby, J. F., and) : Scattering of D—D Neutrons by Deuterium, 22
Swarbrick, Dr. T. : Growth-promoting Substances in Horticulture, 656
Swietoslawski, Prof W. : Microcalorimetry, *review* by Dr. Ezer Griffiths, 460
Swiss Zootechnical Society : Meeting to discuss the formation of an International Society of Zootechny, 322
Sylvén, Dr. Bengt, and others : A New Extraction Procedure for the Preparation of Heparin, 639
Szwarc, Dr. M. : Energy of the Central C—C Bond in Diphenyl, 890

TANNENBAUM, Dr. Albert, and others : Nutrition in relation to Cancer, 106
Tanner, Prof. Väinö : *Death* of, 799
Tansley, A. G. : Introduction to Plant Ecology, 158
Tansley, A. G., and Evans, E. Price : Plant Ecology and the School, 158
Tar Confederation, British : Formation of a Coal Tar Research Association, 757
Tarrant, A. G. : Promoted to the grade of Senior Principal Scientific Officer, 195
Tarrant, Dr. G. T. P. : Electricity, Magnetism and Modern Physics, *review* by Prof. L. F. Bates, 829
Tata Memorial Fund : Grants and Scholarships, 233
  Awards for research in Blood Diseases, 966
Tate, G. H. H. : Mammals of Eastern Asia, *review* by T. C. S. M.-S., 188
Tate, Dr. P. : White-eyed Mutants of Diptera, 641
Tatum, Dr. E. L., and others : Nutrition in relation to Cancer, 106
Taylor, E. L., and Mozley, Alan : A Culture Method for *Lymnæa truncatula*, 894
Taylor, Dr. F. Sherwood : The Place of the History of Science in Education, 572
Taylor, G. : *Obituary* of Dr. Bernard S. Dyer, 386
Taylor, Sir Geoffrey : Elected an Honorary Member of the Institute o Metals, 16
Taylor, Dr. George : Plant Collecting in the Far East, 635
Taylor, George E., and others : The Artificial Insemination of Farm Animals, edited by Enos J. Perry, *review* by Dr. Arthur Walton, 831
Taylor, Prof. Griffith : Canada, *review*, 912
Taylor, H. Dennis : The Adjustment and Testing of Telescope Objectives, fourth edition, *review*, 419
Taylor, Dr. H. G. : Appointed director of the British Welding Research Association, 49 ; work of, 49
Taylor, M. K. : Awarded a Page Prize for 1947 of the Institution of Electrical Engineers, 90
Taylor, R. J., and others : Units and Useful Range in Photo-electric Colorimetry, 247
Taylor, T. W. J. : Awarded the Medal of Freedom with Bronze Palm by the Government of the United States, 215
Taylor, Dr. W. H. : Structure and Physical Properties of Metals, 263
Technical Publications in Sheffield, Organisation for the Interchange of : Report for 1947, 305
Telecommunications Research Establishment, Malvern : Exhibition of the work carried out at the, 918
Templeman, Dr. W. G. (Sexton, Dr. W. A., and) : Differential Effect of 2-Benzoylbenzoic Acid and its Derivatives upon Plant Species, 974
Tennyson, Sir Charles : Industrial Co-operation, 571
Terrill, Clair E., and others : The Artificial Insemination of Farm Animals, edited by Enos J. Perry, *review* by Dr. Arthur Walton, 831
Textile Institute : Annual Report of the, 635
  Conference on the Organisation of the Textile Industry, 842
Textile Institute, and others : Conference on the Rheological Properties of Textile Materials, 307, 737
Thesiger, Wilfred : Awarded the Founder's Medal for 1948 of the Royal Geographical Society, 553
Thijsse, Prof. J. Th. : Model Research in Hydraulics, *review*, 219
Thimann, Kenneth V., and Behnke, Jane : The Use of Auxins in the Rooting of Woody Cuttings, *review* by Prof. M. Thomas, 993
Thomas, D. G. : Appointed botanist, Uganda, 51
Thomas, D. R. O. : Conscription and Industry, 304
Thomas, F. W. : Appointed senior agricultural officer, Tanganyika, 471
Thomas, Dr. H. A. : Radio Noise, 795
Thomas, Dr. H. A., and Burgess, R. E. : Survey of Existing Information and Data on Radio Noise over the Frequency Range 1-30 Mc./s., 107
Thomas, J. F. (Harris, Dr. R. J. C., and) : Isolation and Separation of the Pyrimidine Nucleosides of Yeast Ribosenucleic Acid, 931
Thomas, Prof. M. : *Obituary* of Prof. M. C. Potter, 590
  Chemical Promotion of Rooting in Plants, *review*, 993
Thomas, Richard N. : Awarded a Frank B. Jewett Fellowship for 1948–49 by the American Telephone and Telegraph Co., 429
Thomas, Prof. W. Norman : Awarded the Medal of Freedom by the Government of the United States, 716
Thompson, Allyn J. : Making your own Telescope, *review*, 502
Thompson, Sir D'Arcy Wentworth : A Glossary of Greek Fishes, *review* by Sir John Myres, 185, 272
  Death of, 1003
Thompson, Dr. J. F. : Elected an Honorary Member of the Institute of Metals, 16
Thompson, K. F. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
Thompson, Dr. R. H. S. : Development of British Anti-Lewisite (*B.A.L.*), 226
Thomsen, Dr. Ellen : Effect of Removal of Neurosecretory Cells in the Brain of Adult *Calliphora erythrocephala Meig.*, 439
Thomsen, I. L. : Solar Radio Emissions and Sunspots, 134
Thomson, A. (Charlwood, P. A., and) : Electrophoretic Patterns of Lamb Serum Before and After Transfer of Colostrum, 59
Thomson, Amherst F. H. : Awarded the Medal of Freedom by the Government of the United States, 215
Thomson, Dr. A. Landsborough : Orientation of Birds on Migratory and Homing Flights, 998
Thomson, Dr. Donald F. : Awarded the Cuthbert Peek Grant for 1948 of the Royal Geographical Society, 553
Thomson, Sir George : Honorary degree of doctor of laws of the University of Aberdeen conferred on, 555
  The Growth of Crystals, 800
  Obituary of Prof. A. S. Eve, 838
  The Atom, third edition, *review* by P. B. M., 871
Thomson, Sir George, and Baker, Dr. John R. : Proposed Central Publication of Scientific Papers, 771
Thomson, Sir George, and others : Atomic Challenge, a Symposium, *review*, 995
Thomson, Prof. Godfrey : The Trend of National Intelligence (with a Symposium by Sir Alexander Carr-Saunders, Sir Cyril Burt, Prof. Lionel Penrose and Prof. Godfrey Thomson), *review* by Dr. Julian Blackburn, 37
Thomson, Dr. J. : Total Emission Damping, 847
Thomson, Prof. R. B. : *Death* of, 270
Thorne, A. L. C. : Appointed veterinary education officer, Nigeria, 637
Thorpe, Dr. W. H. : Interaction of Water and Porous Materials, 630
  Orientation of Birds on Migratory and Homing Flights, 996
Threlfall, H. R. : Appointed surveyor, Tanganyika, 51
Tilak, B. D., and others : Ammonium Salts of Sulphanilamides and Sulphonic Acids, 55
Tilley, Michael F. : Housing the Country Worker, *review* by R. B., 665

Tillotson, Ernest : Earthquakes and Volcanoes, *review*, 296
    Pure and Applied Seismology, *review*, 459
    Obituary of J. J. Shaw, 920
Tin, U. (Rhind, D., and) : Results of the Continuous Use of an Ammonium Phosphate Fertilizer on Rice in Lower Burma, 105
Tipper, Dr. C. F. : A 150-ton Universal Structure Testing Machine, 656
Tippett, —. : Operational Research in the Research Associations, 585
Tizard, Sir Henry : Honorary degree of doctor of laws of the University of Sheffield conferred on, 555
    Human Factors in Industry, 791
Todd, Prof. A. R., and others : Synthesis of Adenosine Triphosphate, 761
Todd, D. C. : Appointed agricultural officer, Uganda, 471
Todd, Dr. J. A. : Elected a Fellow of the Royal Society, 467
Tolansky, Prof. S., and Bardsley, W. : Application of Multiple-Beam Interferometry to the Study of Oscillating Quartz Crystals, 925
Tolbert, C. W. (Straiton, Prof. A. W., and) : Dielectric Properties of Soils and Water at a Wave-length of 3·2 cm., 73
Tomlinson, T. G. : Biological Aspects of Water Pollution, 875
Toovey, F. W. : Appointed officer-in-charge, Oil Palm Research Station, Nigeria, 637
Torkington, P. : Variation of the Force Constant with the Ionization Potential and the Polarizability for some Halogen Compounds, 724
Torriani, Annamaria : Behaviour of Gorini's Acid-Proteolytic Lactic Cocci with Penicillin, 275
Torrie, Brigadier A. : Sociology of Mental Disease, 408
Tötterman, Dr. Guido H. R. : Awarded a Scholarship from the Lady Tata Memorial Fund, 966
Touschek, B. F. (Sneddon, Dr. I. N., and) : Nuclear Models, 61
Towl, Asst. Prof. Andrew R. (Copeland, Melvin T., and) : The Board of Directors and Business Management, *review* by E. F. L. Brech, 869
Town and Country Planning Association (British Social Hygiene Council and the) : Conference on the Family, 125
Townend, Dr. D. T. A. : Britain's Fuel Problems, 669
Toy, Dr. F. C. : Operational Research in the Research Associations, 584
Toynbee, Arnold : Honorary degree of the University of Cambridge conferred on, 965
Toyne, S. M. : The Place of the History of Science in Education, 572
Tracy, Prof. Paul Hubert, and others : The Ice Cream Industry, second edition, *review* by Dr. L. H. Lampitt, 500
Trade, Board of : Reports on German War-time Industry and Science, 388
    Working Party Report on the Cutlery Industry, 448
    Working Party Report on Rubber-proofed Clothing, 448
    Working Party Report on Hand-blown Domestic Glassware, 449
Treanor, Rev. P. J. : Stonyhurst College Observatory, 285
Tredgold, Dr. R. F. : Human Factors in Industry, 791
Trent, P. T. (George, Dr. E. P., and) : High-Altitude Measurements on Cosmic Rays—Penetrating Bursts, 248
Trotman, Cyril G. : Awarded the Medal of Freedom with Silver Palm by the Government of the United States, 215
Trowell, Dr. O. A. : Brain and Mind, *review*, 498
    Advances in Physiology, *review*, 542
Trueta, Dr. Josep, and others : Studies of the Renal Circulation, *review*, 663
Truscott, Prof. S. J. : Honorary membership of the Institution of Mining and Metallurgy conferred on, 923
Tschopik, Jr., Harry : Highland Communities of Central Peru, 697
Tsetse Research Control Department, Tanganyika : Appointment of J. I. Moggridge as director, 637
Tuck, J. L., and others : A 16-MeV. Betatron, 472
Tucker, B. W. : Orientation of Birds on Migratory and Homing Flights, 998
Tulasne, Prof. R., and Vendrely, Dr. R. : Cytology of Staphylococci before and after Treatment with Penicillin, 316
Turnbow, Grover Dean, and others : The Ice Cream Industry, second edition, *review* by Dr. L. H. Lampitt, 500
Turner, E. E. : Elected president of the Society of Engineers, 346
Turner, Prof. John P. : Guide to the Study of the Anatomy of the Shark, *Necturus*, and the Cat, second edition, *review* by Dr. P. D. F. Murray, 955
Turrill, Dr. W. B. : Experimental Studies on British Species of Plants, 734
Turrill, Dr. W. B. (Summerhayes, V. S., and) : Vegetation after Draining, 421
Turtle, E. E. (Freeman, J. A., and) : Insect Pests of Flour, 554
Tutin, Prof. T. G. : The Study of Critical British Groups, 735
Twigg, Dr. G. H. : The Assaying of Penicillin, 286
Tyndall, Prof. A. M. : Retirement from the Henry Overton Wills chair of physics at the University of Bristol, 272, 755 ; work of, 755
Tyrrell, Dr. G. W. : The New Eruption from Hekla, 41
Tyrwhitt, Jaqueline (Colvin, Brenda, and) : Trees for Town and Country, *review* by Sir Edward Salisbury, 497

UBISCH, H. von : A New Hot-Wire Vacuum Gauge, 927
Ukil, Dr. A. C. : Scientific Research in India, 513
Unasylva, a Forestry and Forest Products Review, No. 1, 89
UNESCO : Second General Conference of, 159
    Science and, 159
    Appointment of Dr. Clarence E. Beeby as assistant director-general, 304
    Appointment of Prof. Emile Auger as head of the Natural Sciences Section, 304
    Appointment of Prof. Pedro Bosch Gimpera as director of the Philosophy and Humanistic Studies Section, 304
    Appointment of Gordon Menzies as director of administrative services, 304
    Appointment of Dr. Joseph Needham as honorary scientific adviser, 758
    Contribution of 3,000 dollars to the travelling expenses of the official members of the Union Radio Scientifique Internationale, and another 3,000 dollars to the publication of the Report of the General Assembly, 843
Union Radio Scientifique Internationale : Contribution from UNESCO of 3,000 dollars to the travelling expenses of the official members, and another 3,000 dollars to the publication of the Report of the General Assembly, 843
United Nations : Conference on the Conservation and Utilization of Resources, 617
United Nations (Food and Agriculture Organisation of the) : Publication of No. 1 of *Unasylva*, 89
    Energy-Yielding Components of Food and Computation of Calorie Values, 306
    Appointment of Norris E. Dodd as director-general, 637
    Appointment of Sir Herbert Broadley as deputy director-general, 637
    Forestry and Forest Products ; World Situation 1937–1946, 710
United States, Government of the : Awards to British Men of Science, 215, 390, 716, 800
United States National Academy of Sciences : Medal Awards, 49, 861
    Election of Officers and Members, 860
United States National Museum : Appointment of Dr. A. Remington Kellogg as director, 965
United States National Research Council : New programme of Atomic Energy Commission Fellowships, 593
United Steel Companies, Ltd. : Visit to branches by mechanical and production engineering professors from British Universities, 881
Universities of the British Empire : Congress of, 430
Universities Bureau of the British Empire : The Yearbook of the Universities of the Empire 1947, *review*, 583
University of Aberdeen : Honorary degree of doctor of laws conferred on Sir George Thomson and on Major-General D. N. Wimberley, 555
University of Birmingham : Appointment of Dr. Harold Scarborough as lecturer with title of reader in the Department of Medicine, 233
    Eighteenth Annual Report of the Joint Standing Committee for Research, 594
    Retirement of Sir Norman Haworth from the Mason chair of chemistry, 1007
    Appointment of Dr. K. Mather to the chair of genetics, 1007
    Appointment of Prof. H. W. Melville to the Mason chair of chemistry, 1007
University of Bristol : Retirement of Prof. A. M. Tyndall from the Henry Overton Wills chair of physics, 272, 755
    Appointment of Prof. N. F. Mott as Henry Overton Wills professor of physics and director of the Wills Laboratory, 272
    Appointment of Dr. C. F. Powell as Melville Wills professor of physics, 272
    Appointment of Dr. S. H. Piper as assistant director of the Wills Laboratory, 272
    Annual Report for 1946 of the Agricultural and Horticultural Research Station, Long Ashton, 862
University of Bristol in co-operation with the Institute of Physics : Summer School in Theoretical Physics, 233
    Summer School in the Physics of Solids, 233, 636
University of California : Appointment of Dr. Wendell M. Stanley as professor of biochemistry and director of a new Virus Laboratory, 49
University of Cambridge : Research Fellowships founded by Imperial Chemical Industries, Ltd., 90
    Election of General Smuts as chancellor, 233
    Gravity Survey in the English Channel to be made by the Department of Geodesy and Geophysics, 272
    Dr. Joseph Needham to return to his post, 304
    Installation of General Smuts as chancellor, 965
    Conferment of honorary degrees, 965
University of Cambridge, in co-operation with the Department of Scientific and Industrial Research : Summer Course in Food Science, 1007
University of Durham : Post-graduate course in chemical engineering at King's College, Newcastle-upon-Tyne, 965
    Fuel Technology course at King's College, Newcastle-upon-Tyne, 965
University of Edinburgh : James Tait Black Memorial Prize for 1947 awarded to Dr. C. E. Raven, 390
University of Glasgow : Appointment of Prof. Thomas Alty as deputy principal, 16
    Appointment of Dr. Basil C. King as lecturer in geology, 16
    Appointment of Daniel Martin and Walter Brown as lecturers in mathematics, 16
    Appointment of John B. Birks and G. M. Lewis as lecturers in natural philosophy, 16
    Appointment of Dr. William C. Hutchinson and George Leaf as lecturers in physiological chemistry, 16
    Coats Research Fellowship in Chemistry or Physics, 164
University of Hamburg : Amalgamation of the University Meteorological Institute, the Centre for Earthquake Research, and the University Institute for Oceanography to form the Geophysical Institute of the, 1006
University of Leeds : Appointment of Dr. W. Bradley as professor of colour chemistry and dyeing, 16
    Appointment of A. H. Hanson as lecturer in the Departments of Social Studies and Extra-Mural Studies, 16
    Appointment of H. D. Ursell as lecturer in mathematics, 16
    Gift of £10,000 from the International Wool Secretariat for equipment for the New Textile Laboratories, 305
    Appointment of Prof. H. S. Ruse as head of the Department of Mathematics, 307, 468
    Appointment of Prof. T. G. Cowling as professor of applied mathematics, 307, 468
    Appointment of Dr. N. H. Hartshorne as lecturer in chemical microscopy, 307
    Retirement of Prof. S. Brodetsky from the chair of applied mathematics and as head of the Department of Mathematics, 307, 467
    Appointment of Dr. J. W. Baker to the readership in the mechanism of organic reactions, 471
    Appointment of Dr. C. S. Whewell as honorary reader in textile finishing and lecturer in textile chemistry, 471
    Eleventh and Twelfth Reports of the Brotherton Collection Committee, 882
    Further grant of £10,000 from the Worshipful Company of Clothworkers to the Textile Industries Department, 1006
    Grant of £1,000 from the British Hat and Allied Feltmakers' Research Association for research in the Textile Industries Department, 1006
    Appointment of Dr. F. Henriques as lecturer in social anthropology, 1006

  Appointment of A. N. Greenwood as lecturer in electrical engineering, 1006
  Appointment of C. Kisby as lecturer in textile design, 1006
University of Liverpool : Appointment of Dr. C. E. H. Bawn to the Grant-Brunner chair of physical and inorganic chemistry, 715
  Appointment of Dr. H. Fröhlich to the chair of theoretical physics, 715
  Retirement of Prof. W. C. McC. Lewis from the Grant-Brunner chair of inorganic and physical chemistry, 756
  Pre-election of Sir James Chadwick as Master of Gonville and Caius College, Cambridge, 882, 964
University of London : Retirement of Prof. H. Hartridge from the University chair of physiology at St. Bartholomew's Hospital Medical College, 49
  Appointment of G. E. H. Foxon to the University readership in biology at Guy's Hospital Medical School, 51
  Title of University professor of bacteriology conferred on Lord Stamp, 51
  Title of University professor of biology conferred on Dr. J. H. Woodger, 51
  Title of University reader in surveying conferred on Alfred Stephenson, 51
  Degree of D.Sc. conferred on F. W. Andrews, 51
  Appointment of Dr. Leslie Young to the University chair of biochemistry at St. Thomas's Hospital Medical School, 233
  Degree of D.Sc. conferred on W. S. Rogers, Dr. B. N. Singh and F. L. Warren, 233
  Appointment of Dr. L. J. Audus to the Hildred Carlile chair of botany at Bedford College, 347, 427
  Appointment of Dr. Eric Boyland to the University chair of biochemistry at the Royal Cancer Hospital (Free), 347
  Degree of D.Sc. conferred on Sir Alfred Egerton, 347
  Appointment of K. de B. Codrington to the University chair of Indian archæology at the Institute of Archæology and the School of Oriental and African Studies, 430
  Appointment of Prof. E. D. Hughes to the University chair of chemistry at University College, 430, 511
  Appointment of Gordon Manley to the University chair of geography at Bedford College, 430, 511
  Appointment of Prof. A. C. Offord to the University chair of mathematics at Birkbeck College, 637, 757
  Appointment of Dr. R. E. Mortimer Wheeler to the University chair of the archæology of the Roman Provinces at the Institute of Archæology, 637, 674
  Appointment of Mary Barker to the University readership in bacteriology at St. Thomas's Hospital Medical School, 637
  Appointment of Dr. H. E. Rose to the University readership in mechanical engineering at King's College, 637
  Title of University professor of geology conferred on Dr. Leonard Hawkes, 637
  Title of University reader in organic chemistry conferred on Dr. A. H. Cook, 637
  Title of University reader in chemistry conferred on Dr. H. G. Poole, 637
  Title of University reader in agricultural chemistry conferred on Dr. R. L. Wain, 637
  Degree of D.Sc. conferred on Franz Bergel, 637
  Retirement of Prof. P. Dienes from the University chair of mathematics at Birkbeck College, 756
  Appointment of Prof. J. W. S. Blacklock to the University chair of pathology at St. Bartholomew's Hospital Medical College, 924
  Appointment of James Whillis to the chair of anatomy at Guy's Hospital Medical School, 924
  Appointment of Dr. Hugh Ford to the University readership in applied mechanics at the Imperial College of Science and Technology, 924
  Title of University professor of social studies conferred on Mrs. Barbara Wootton, 924
  Title of University reader in biochemistry conferred on Dr. H. W. Buston, 924
  Title of University reader in biochemistry conferred on Wilfrid Lawson, 924
  Title of University reader in morbid anatomy conferred on Dr. D. M. Pryce, 924
  Degree of D.Sc. conferred on B. H. Crawford, 924
University of London Institute of Archæology : Appointment of K. de B. Codrington to the chair of Indian archæology and at the School of Oriental and African Studies, 430
  Appointment of Dr. R. E. Mortimer Wheeler to the University chair of the archæology of the Roman Provinces, 637, 674
University of Madrid : Honorary degree conferred on Sir Alexander Fleming, 966
University of Manchester : Appointment of Prof. M. Polanyi as professor of social studies, 15
University of North Carolina : The Graduate School Research and Publications (edited by Prof. Edgar W. Knight and Agatha Boyd Adams), *review*, 705
University of Oxford : Appointment of D. G. Champernowne as professor of statistics, 966
  Appointment of Prof. J. Jewkes as professor of economic organisation, 966
University of Oxford Department of Education : Conference on the Education of the Young Worker, 801
University of Prague : Sexcentenary of the, 511
  Sexcentenary Celebrations (Dr. Gerald Druce), 670
University of St. Andrews : Retirement of Prof. P. T. Herring from the Chandos chair of physiology, 922
  Appointment of Dr. A. E. Ritchie to the Chandos chair of physiology, 922
University of Sheffield : Appointment of Dr. S. R. Elsden as senior lecturer in microbiology, 16
  Appointment of R. O'Rahilly as lecturer in anatomy, 16
  Appointment of T. F. Bamber as assistant lecturer in the Department of Mining, 16
  Appointment of Dr. J. L. Emery as honorary lecturer in pathology, 16
  Appointment of Dr. A. J. Gould as senior lecturer in the Department of Glass Technology, 307
  Appointment of Dr. J. S. D. Bacon as lecturer in biochemistry, 307
  Appointment of R. E. Davies as honorary lecturer in biochemistry, 307
  Appointment of A. Jordan as honorary lecturer in clinical biochemistry, 307
  Appointment of O. I. Butler as senior lecturer in charge of the Department of Electrical Engineering, 471
  Appointment of H. J. Cowan as lecturer in civil engineering, 471
  Appointment of G. Wiseman as assistant lecturer in physiology, 471
  Appointment of A. G. Macgregor as research assistant in the Department of Pharmacology and Therapeutics, 471
  Retirement of Prof. Douglas Knoop from the chair of economics, 471
  Gift of money from Prof. Douglas Knoop to endow an economics prize, 471
  Appointment of Dr. G. P. Jones as professor of economics, 553
  Honorary degrees of doctor of laws conferred on the Hon. Lewis W. Douglas, Anthony Eden, Lord Addison, Admiral of the Fleet Lord Cunningham, Sir Frank Stenton, Sir Henry Tizard and Ernest S. Graham, 555
  Appointment of J. C. Gilbert as senior lecturer in economics, 1007
  Appointment of A. Gilbert as lecturer in psychology, 1007
  Appointment of J. H. Davies and S. J. Langley as assistant lecturers in economics, 1007
  Appointment of Brian E. Heard as assistant lecturer in pathology, 1007
  Appointment of Peter Freeman as research assistant to the professor of engineering, 1007
University of Sydney : Appointment of Dr. J. Cymerman as lecturer in organic chemistry, 471
University of Western Ontario : Appointment of Prof. Frederick R. Miller as research professor of neuro-physiology, 125
University of Wisconsin : Symposium on Combustion and Flame and Explosion Phenomena, 307
University College, Dublin : Summer School in Chemistry arranged by the Irish Chemical Association, 390
  Sessional Inaugural Lecture (Prof. J. W. Cook), 554
University College, Dundee : Appointment of Dr. D. H. Everett to the chair of chemistry, 715
University College of the South-West, Exeter : Transfer of the Norman Lockyer Observatory to the, 15, 861
University College of the South-West, Exeter (Survey Committee of the) : Devon and Cornwall, a Preliminary Survey, *review* by Prof. L. Dudley Stamp, 786
University College, Leicester : Appointment of Dr. R. L. Goodstein to the chair of mathematics, 344
  Appointment of Dr. A. G. Pool to the chair of economics, 514
  Appointment of Dr. Z. P. Dienes to a lectureship in mathematics, 514
University College, London : Research in Surveying at, 50
  Appointment of Prof. E. D. Hughes to the University of London chair of chemistry, 430, 511
University College, Swansea : Retirement of Prof. J. E. Coates from the chair of chemistry, 1004
  Appointment of Dr. C. W. Shoppee to the chair of chemistry, 1004
  Appointment of L. J. Kastner to the chair of mechanical engineering, 1004
University Grants Committee : Appointment of a Sub-Committee on Higher Technological Education in Britain, 841
Urquhart, G. M. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
Ursell, H. D. : Appointed lecturer in mathematics in the University of Leeds, 16

VALENTINE, Dr. D. H. : Vegetative and Cytological Variation in *Viola Riviviana*, 734
Vallarta, Dr. M. S. : Cosmic Rays and the Magnetic Field of the Moon, 646
Van de Graaff, Dr. R. J. : Awarded the Duddell Medal for 1947 of the Physical Society, 511
Vand, Dr. V. : Method of Steepest Descents—Improved Formula for X-Ray Analysis, 600
Vanderplank, F. L. : Appointed entomologist, West African Institute for Trypanosomiasis, 471
Varjadebian, B. (Cottin, M., and) : Isotope Exchange and Molecular Structure, 901
Vassiliou, B., and White, Dr. J. : Relationships of Vapour Pressure, Capillarity and Temperature in Clays, 487
Vassy, Dr. A., and Vassy, E. : Ozone and Auroral Spectra, 566
Vegetable Research Station : Appointment of Dr. James Philip as director, 715
Veld, Leonora G. Huis in 't, and others : Isolation of a New Androstenol-3 (α)-on-17 from the Urine of a Patient with Adrenal Cancer, 848
Vendrely, Dr. R. (Tulasne, Prof. R., and) : Cytology of Staphylococci before and after Treatment with Penicillin, 316
Venkataraman, Prof. K., and others : Ammonium Salts of Sulphanilamides and Sulphonic Acids, 55
Venn, Dr. J. A. (compiled by) : Alumni Cantabrigienses, Part 2, From 1752 to 1900, Vol. 3, Gabb—Justamond, *review* by Prof. F. J. M. Stratton, 661
Verkade, Prof. P. E. : Physiology and Biochemistry of Fats and Lipoids, 534
Verzar, Prof. F. : Physiology and Biochemistry of Fats and Lipoids, 534
Vestine, E. H., and others : The Earth's Main Magnetic Field and its Secular Change 1905–1945, 161
  Final Values of Elements of the Geomagnetic Field at 5-Degree Intervals of Latitude and Longitude, Epoch 1945, 161
Veterinary Educational Trust : Plans to develop Research Stations, 254
Victoria, Government of : Presentation of a Transit Circle to the Royal Observatory, Greenwich, 271
Vidal, S., and others : Effect of Insulin on Intestinal Glucose Absorption in Alloxan Diabetic Rats, 932
Vincent, J. M. (Phillips, J. N., and) : Dosage/Response Relationships in Mould Inhibition, 210
Virtanen, Prof. Artturi I., and Csáky, Tihamer Z. : Formation of Oxime-Nitrogen in *Torula*-Yeast Fed with Potassium Nitrate, 814
Virtanen, Prof. Artturi I., and Kerkkonen, Heikki K. : Structure of Plasteins, 888

Visual Aids, Educational Foundation for : Appointment of John A. Harrison as director, 802
Viswanathan, R. (Panikkar, N. Kesava, and) : Active Regulation of Chloride in *Metapenæus monoceros* Fabricius, 137
Voelcker, O. J. : The West African Cacao Research Institute, 117
Vogel, Dr. Arthur I. : A Text-Book of Practical Organic Chemistry, *review* by Prof. J. W. Cook, 995
Volcani, Z., and Dowson, Dr. W. J. : A Plant Disease caused by a Spore-forming Bacterium under Natural Conditions, 980
Vologdin, Dr. Alexander G. : Awarded the Charles Doolittle Walcott Bronze Medal and Award for 1947 of the U.S. National Academy of Sciences, 861
Vries, Dr. Hl. de : Minimum Perceptible Energy and Brownian Motion in Sensory Processes, 63

WADDINGTON, Prof. C. H. : Operational Research, 404
  The Argument from Mouse to Man, *review*, 543
Wadia, Ardaser Sorabjee N. : The Romance of Rhodesia, *review*, 871
Wadia, D. N. : Scientific Research in India, 513
Wadman, H., and others : Separation and Identification of Methylated Sugars on the Paper Chromatogram, 720
Wain, Dr. R. L. : Title of University of London reader in agricultural chemistry conferred on, 637
Wald, Prof. Abraham : Sequential Analysis, *review* by M. G. Kendall, 790
Waldman, Dr. Jerome, and others : Failure of Sulphanilamide to Inhibit Calcification of Bone, 273
Waley, S. G., and others : Synthetic Polyglutamic Acid, 132
Walker, F. T. : Sublittoral Seaweed Survey—Relationship of Algal Growth and Depth, 977
Walker, G. R. (Herzberg, Prof. G., and) : Initiation of High Explosives, 647
Walker, Dr. James (Forrest, Dr. H. S., and) : Condensation of 2 : 4 : 5-Triamono-6-hydroxy-pyrimidine with Glucose and Fructose, 308
  Reductone and the Synthesis of Pteridines, 721
Walkley, Allan (Cowley, J. M., and) : Reaction between Manganous Ion and Manganese Dioxide, 173
Wallace, Henry, and others : Atomic Challenge, a Symposium, *review*, 995
Wallace, Prof. T. : Trace Elements in Plant Physiology, 364
Wallace, Prof. T., and Hewitt, E. J. : Effects of Calcium Deficiency on Potato Sets in Acid Soils, 28
Waller, E. G. : Appointed temporary agricultural survey officer (cocoa), Gold Coast, 966
Wallis, C. J. : Practical Biology for Medical and Intermediate Students, second edition, *review* by Dr. P. D. F. Murray, 912
Walsh, Dr. E. O'F., and Walsh, Mrs. G. : Inhibition of Hexosediphosphatase by Sulphhydryl Reagents and by Ascorbic Acid, 976
Walshe, Veryan (Sherlock, Sheila, and) : Effect of Under-Nutrition in Man on Hepatic Structure and Function, 604
Walter, W. H. : The Society for Psychical Research, an Outline of its History, 880
Walters, S. M. : The Study of Critical British Groups, 735
Walton, Dr. Arthur : The Artificial Insemination of Farm Animals (John W. Bartlett, George E. Taylor, Joseph Edwards, Clair E. Terrill, Victor Berliner and Fred P. Jeffrey), edited by Enos J. Perry, *review*, 831
Walton, Prof. John : Palæobotany, *review*, 623
  Obituary of Prof. F. O. Bower, 753
Wang, C. Y., and others : Pharmacology of Ch'ang Shan (*Dichroa febrifuga*), a Chinese Antimalarial Herb, 400
Wapstra, A. H. : Mass-Defects of the Heavy Isotopes, 529
War Office : Exhibition of Teaching Aids at the Imperial Institute, 164
  Memoranda on Medical Diseases in Tropical and Sub-Tropical Areas, eighth edition, *review* by Dr. N. Hamilton Fairley, 499
Warburg, Dr. E. F. : Cytology in relation to Critical Groups, 733
Warburton, F. S. : The Mechanical Properties of Horn, 737
Warburton, M. F., and others : Adsorption of Bacterial Polysaccharides to Erythrocytes, 687
Ward, A. G. : War-time Rheological Investigations for the British Armed Services, 252
Ward, F. Kingdon : War-time Explorations in Manipur, 636
Ward, J. F. : Appointed senior agricultural officer, Nigeria, 51
Ward, W. H. : The Flow of Glaciers, 821
Wardlaw, Prof. C. W. : The Natural Vegetation of Trinidad, 31
Wardrop, A. B., and Preston, Dr. R. D. : Organisation of the Cell Walls of Tracheids and Wood Fibres, *erratum*, 90
Ware, W. D. : Awarded a moiety of the Lyell Fund of the Geological Society, 122
Warne, Dr. L. G. G. : Bulb Formation in the Shallot, 935
Warren, Dr. F. L. : Degree of D.Sc. of the University of London conferred on, 233
Warren, Dr. F. L. (Robinson, Dr. Alice M., and) : Presence of Substances Inhibitory to Acid Phosphatase in Normal Human Urine, 397
Warren, I. H. : Appointed agricultural chemist, Tanganyika, 51
Warren, S. Hazzledine : Flint Flaking, 569
Wassermann, Dr. A. : Adsorption of Calcium Ions by an Acid-extracted Brown Alga under Continuous Flow Conditions, 562
Wataghin, Prof. G. : Showers of Penetrating Particles, 91
Waters, Brian : Severn Tide, *review* by A. T. D., 790
Waterton, F. W. : Effect of the Electron Beam on the Voltage Distribution of a High-Voltage Multi-Stage Electron Accelerator, 563
Watling, J. F. B. : Appointed principal produce inspector, Nigeria, 637
Watson, Dr. E. A. : Fuel Systems for the Aero-Gas Turbine, 196
Watson, Fletcher G. : Between the Planets, *review* by H. S. J., 460
Watson, H. : Mosses as Soil Indicators, 823
Watson, Prof. H. E. : Chemical Engineering, *review*, 911
Watson, H. S. H. : Appointed assistant conservator of forests, Northern Rhodesia, 802
Watson, J., and others : Synthetic Polyglutamic Acid, 132
Watson, T. Y. : Appointed deputy director of agriculture, Uganda, 966
Watson, W., and others : Cambridge Archæological Expedition to Cyrenaica, 327
Watson, W. C. R. : An Introduction to *Rubus*, 734
Watson-Watt, Sir Robert : Radio Noise, 794
  Development of Radar, *review*, 867
Watt, A. W. M. : Appointed assistant conservator of forests, Uganda, 51
Watt, C. H. (Bellamy, Dr. L. J., and) : Factors Involved in the Deactivation of Penicillin Solutions by Rubber Tubing, 940
Watts and Son, Ltd., E. R. : Amalgamation with Adam Hilger, Ltd., 345
Weatherhead, A. V. : Petrographic Micro-technique, *review* by F. I. G. Rawlins, 626
Webb, Dr. E. C. : Alkyl Fluorophosphonates, 226
Webb, Dr. J. S. : To receive an Award from the Daniel-Pidgeon Fund of the Geological Society of London, 1007
Weber, Alfred : Farewell to European History, or the Conquest of Nihilism, translated from the German by R. F. C. Hull, *review* by Maurice Bruce, 151
Weber, F., and others : Reaction of Boric Acid with Polysaccharides, 96
Weber, Max : Essays in Sociology (translated, edited and with an Introduction by H. H. Gerth and C. Wright Mills), *review* by Prof. D. W. Brogan, 950
Weber, Robert L., and others : College Technical Physics, *review* by S. Weintroub, 954
Webley, D. M. : Aerobic Mesophilic Bacteria in Composts, 174
Webley, D. P. : Awarded an Agricultural Research Council Postgraduate Scholarship, 16
Webster, Robert : The Gemmologists' Compendium, second edition, *review*, 297
Weddell, Dr. G., and others : Intravenous Methylene Blue, a New Method for Studying the Nervous System, 318
Wedel, W. R. : Prehistory and the Missouri Development Program, 636
Weeks, Sir Ronald : Industrial Co-operation, 572
  Appointed chairman of the National Advisory Council for Education in Industry and Commerce, 801
Weil, Prof. André : Foundations of Algebraic Geometry, *review* by Prof. H. T. H. Piaggio, 787
Weil, Dr. E. : Catalogue 10, From Alchemy to Chemistry and Pharmacology, 306
Weintroub, S. : Temperature Measurement, *review*, 624
  Optics in Holland, *review*, 704
  Britain's Scientific War Effort, *review*, 907
  College Physics, *review*, 954
  Les mesures physiques (Albert Perard), *review*, 955
Weiss, Dr. Joseph (Stein, Gabriel, and) : Chemical Effects of Ionizing Radiations, 650
Weissenberg, K. (Freeman, S. M., and) : Some New Anisotropic Time Effects in Rheology, 324
Weissmann, D., and others : Active Penetration of Fat into Adipose Tissue, 482
Weissman, Dr. S. I. : Mechanism of Conductance by Hydrogen and Hydroxyl Ions in Aqueous Solutions, 241
Welding Research Association, British : Offer from British Oxygen Co., Ltd., to provide a prize fund, 17
  Appointment of Dr. H. G. Taylor as director, 49
Wells, A. A. : A Large Field Compensator for Measurement of Birefringence, 602
Wells, Frederic L., and others : What People Are, a Study of Normal Young Men, *review*, 502
Wells (Horace) and Anæsthesia, 123
Wertheimer, E., and others : Active Penetration of Fat into Adipose Tissue, 482
West, Dr. T. F. (Acheson, G. G., and) : Reaction of β-Naphthol with *l*-α- and *l*-β-Phellandrene, 976
West, Dr. W. D. : Elected president for 1948 of the Royal Asiatic Society of Bengal, 553
West African Cacao Research Institute (O. J. Voelcker), 117
West African Institute for Trypanosomiasis : Appointment of F. L. Vanderplank as entomologist, 471
Westcott, J. H. : Awarded a Senior Scholarship by the Commissioners of the Exhibition of 1851, 966
Westlake, Aubrey T. (Maynard, G., and) : Mr. E. Westlake and the Geology of the Cantal Region, Central France, 485
Westoll, Dr. T. S. : Appointed to the chair of geology at King's College, Newcastle-upon-Tyne, 1003 ; work of, 1003
Weston, H. C. : Human Factors in Industry, 791
Whatley, F. R. (Comline, R. S., and) : Inactivation of Flavine Adenine Dinucleotide by Tissue Extracts, 350
Wheatley, P. J. (Linnett, Dr. J. W., and) : A Correlation between Molecular Vibrations and Bond-forming Orbitals, 971
Wheeler, Dr. R. E. Mortimer : Appointed to the University chair of the archæology of the Roman Provinces at the University of London Institute of Archæology, 637, 674 ; work of, 674
Whelan, W. J., and others : Photochemical Degradation of Starch, 762
Whewell, Dr. C. S. : Appointed honorary reader in textile finishing and lecturer in textile chemistry in the University of Leeds, 471
  Textile Fibres, *review*, 581
Whiddington, R. (Crowther, J. G., and) : Science at War, *review* by S. Weintroub, 907
Whillis, James : Appointed to the University of London chair of anatomy at Guy's Hospital Medical School, 924
Whitchurch Hospital, Cardiff : Gift of £9,000 from the Rockefeller Foundation for research at the Neuropsychiatric Research Centre, 346
White, Dr. Florence R., and others : Nutrition in relation to Cancer, 106
White, Dr. Julius, and others : Nutrition in relation to Cancer, 106
White, Dr. J. (Vassiliou, B., and) : Relationships of Vapour Pressure, Capillarity and Temperature in Clays, 487
White, Marsh W., and others : College Technical Physics, *review* by S. Weintroub, 954
White, Dr. Philip R., and others : Nutrition in relation to Cancer 106

Whitehead, Prof. A. N.: *Death* of, 15; *obituary* by Sir Edmund Whittaker, 267
Whitehead, Dr. S.: Operational Research in the Research Associations, 584
Whitmore, Dr. F. E.: Determination of Radioactive and Stable Tracer Isotopes, 694
Whittaker, Sir Edmund: *Obituary* of Prof. A. N. Whitehead, 267
Wicklund, Elsa: Distribution of Alkaline Phosphatase in the Eggs of a Sea-urchin, 556
Widder, Prof. David V.: Advanced Calculus, *review* by J. H. Pearce, 188
Widdowson, E. M., and others: Effect of Under-nutrition and Alterations in Diet on the Choline Esterase Activity of Serum, 56
Widgery, W. M.: Awarded the R.38 Memorial Prize of the Royal Aeronautical Society, 593
Wigan Mining College: Ninetieth Anniversary of the, 1027
Wiggins, Dr. L. F.: Awarded the third Annual Prize of the Sugar Research Foundation, 756; work of, 756
Wiggins, Dr. L. F., and others: Conversion of *D*-Arabinose into 2-Deoxy *D*-Ribose and 3-Deoxy *D*-Xylose, 21
Wigglesworth, Dr. V. B.: Simple Experiments with Insects (Dr. H. Kalmus), *review*, 955
Wight, Martin: The Gold Coast Legislative Council, 371
Wilkes, Dr. M. V.: Calculating Machines, 712
Wilkins, Dr.: Mycological Education, 508
Wilkins, Dr. F. J.: Appointed principal director of scientific research (defence), Ministry of Supply, 715; work of, 715
Wilkins, Marjorie (Robertson, Dr. R. N., and): Quantitative Relation between Salt Accumulation and Salt Respiration in Plant Cells, 101
Wilkins, Dr. M. H. F., and Garlick, Dr. G. F. J.: Relation between Photoconduction and Luminescence in Zinc Sulphide, 565
Wilkinson, Dr. D. H.: Orientation of Birds on Migratory and Homing Flights, 997
Wilkinson, Dr. G. (Grummitt, Dr. W. E., and): Fission Products of U^{233}, 520
Wilkinson, Prof. J. F., and others: Choleglobin Formation in the Erythrocyte, 607
Wilkinson, J. H.: Calculating Machines, 713
Wilkinson, K. J. R., and others: A 16-MeV. Betatron, 472
Williams, Dr. Alwyn: Awarded a Commonwealth Fund Fellowship, 1006
Williams, Dr. C. B.: Butterfly Migration, 636
Williams, Prof. F. C.: Calculating Machines, 713
Williams, J. R.: Appointed entomologist, Mauritius, 51
Williams, P. C. (Simpson, S. A., and): Improved Method of Getting Rats' Eggs from the Fallopian Tubes, 237
Williams, Dr. R. Tecwyn (Dodgson, K. S., and): Isolation of Stilbœstrol Monoglucuronide from Human Urine, 604
Williams, Dr. R. Tecwyn (Guerrero, A. H., and): The Tollens Naphthoresorcinol Reaction for Uronic Acids, 930
Williams, Dr. Trevor I.: A Modified Microbiological Assay Procedure, 19
Williams, Dr. W. T. (Heath, Dr. O. V. S., and): Studies in Stomatal Action—Adequacy of the Porometer in the Investigation of Stomatal Aperture, 178
Williams, William W.: Awarded the Gill Memorial for 1948 of the Royal Geographical Society, 553
Williamson, Dr. G. Scott, and Pearse, Dr. I. H. (edited by): Biologists in Search of Material, second edition, *review* by Dr. G. Lapage, 336
Williamson, J., and Lourie, Dr. E. M.: 'Melarsen' and 'Melarsen Oxide', 103
Williamson, J., and others: Cinnoline Derivatives as Chemotherapeutic Agents for *Trypanosoma congolense* Infections, 603, 758
Willimott, S. G.: Appointed chemist (soils), Federation of Malaya, 802
Willis, A. G.: Mauthner's Cells in the Larvæ of Anuran Amphibia, 65
Willis, A. J.: Appointed assistant meteorologist, Nigeria, 637
Willis, Dr. Hector F.: Awarded the Medal of Freedom with Silver Palm by the Government of the United States, 215
  Audio-Frequency Magnetic Fluctuations, 887
Willshaw, W. E. (Newbery, G. R., and): A Method of Feeding Micro-wave Power into a Resonator having a Fine Mode Structure, 519
Wilmott, A. J.: Intraspecific Categories of Variation, 734
Wilsdon, B. H.: Operational Research in the Research Associations, 584, 585
Wilson, Dr. A. J. C.: Theory of the Structure of Clay Minerals—Tailed X-Ray Reflexions from Random Layer Lattices, 773
Wilson, Dr. A. T. M.: Human Factors in Industry, 792
Wilson, Dr. C. W.: Fluorescence of Highly Insulating Dielectrics produced by X- and γ-Radiations, 520
Wilson, Douglas P.: They Live in the Sea, *review* by Dr. L. Harrison Matthews, 40
Wilson, F. B.: Appointed agricultural officer, Kenya, 966
Wilson, Dr. Greenwood: Sociology of Mental Disease, 408
Wilson, G. Fox: The Detection and Control of Garden Pests, *review* by A. D. I., 419
Wilson, J. Steuart: The Borderline of Psychology, Physics and Music, 590
Wilson, Prof. Levi Thomas (Clements, Prof. Gut Roger, and): Manual of Mathematics and Mechanics, second edition, *review*, 789
Wimberley, Major-General D. N.: Honorary degree of doctor of laws of the University of Aberdeen conferred on, 555
Winfield, J. N.: Awarded an Agricultural Research Council Post-graduate Scholarship, 16
Winnington, J. (Reaveley, C., and): Democracy and Industry, 109
Winter, D. W.: Appointed agricultural officer, Zanzibar, 51
Winter, Dr. E. R. S.: Determination of Radioactive and Stable Tracer Isotopes, 694
Wintrobe, M. W., and others: Nomenclature of the anti-*Rh* Typing Sera, 492
Wiseman, G.: Appointed assistant lecturer in physiology in the University of Sheffield, 471
Woiwod, A. J.: Micro Estimation of Amino-Nitrogen and its Application to Paper Partition Chromatography, 169
Wojtusiak, Prof. R. J.: Orientation of Birds on Migratory and Homing Flights, 997
Wolverhampton Industrial Centenary Exhibition (Opened by Hugh Gaitskell), 634
Women Science Teachers, Association of, and others: Discussion on the Place of the History of Science in Education, 347, 572
Wood, Dr.: Mycological Education, 508
Wood, Dr. A. B.: British Scientific Instruments, 732
Wood, D. A. J.: Appointed assistant conservator of forests, Gold Coast, 51
Wood, T. R., and others: Anti-Pernicious Anæmia Factor, 676
Wood, Dr. W. A., and Dewsnap, N.: Internal Stresses in Metals, 682
Wood, Dr. W. A., and Rachinger, W. A.: X-Ray Diffraction Rings from Deformed Solid Metal and Metal Powders, 93
Woodcock, Alfred H.: The Swimming of Dolphins, 602
Woodger, Dr. J. H.: Title of professor of biology in the University of London conferred on, 51
Woods, H. J., and others: Some Tensile Properties of Jute, 737
Woods, H. J. (Sen, M. K., and): X-Ray Investigation of the Structure of Jute, 768
Woods, William L., and others: What People Are, a Study of Normal Young Men, *review*, 502
Wool Industries Research Association: Report of the Director of Research for 1947–48, 880
Wool Secretariat, International: Gift of £10,000 to the University of Leeds for equipment for the new Textile Laboratories, 305
Woolf, Dr. B.: Economy in Cell Counts, 361
Woolf, Dr. L. I., and others: Pharmacological Activities in different Rodent Species of *d*-Tubocurarine Chloride and the Dimethyl Ether of *d*-Tubocurarine Iodide, 817
Wootton, Mrs. Barbara: Title of professor of social studies in the University of London conferred on, 924
Wootton, Veryan (Haslewood, Dr. G. A. D., and): Bile Acids of the Whale, 356
Worden, Prof. Alastair N. (edited by): The UFAW Handbook on the Care and Management of Laboratory Animals, *review* by Frances Pitt, 664
Work, T. S.: Pharmacology of Ch'ang Shan (*Dichroa febrifuga*), a Chinese Antimalarial Herb, 401
Work, T. S. (Harris, J. I., and): Synthetic Pentapeptides related to Gramicidin-*S*, 804
World Health Organisation: First meeting of the Expert Committee on the Unification of Pharmacopœias, 33
World Power Conference: Reports on Fuel Economy since 1939—Swiss National Committee, 253
  Meeting of the International Executive Council at Stockholm, 1005
Wormell, Dr. T. W.: Radio Noise, 794
Wredden, J. H.: The Microscope, its Theory and Applications, *review* 626
Wright, D. A.: The Thermionic Cathode, *review*, 500
Wright, Orville: *Death* of, 194; *obituary* by M. J. B. Davy, 269
Wright, P. H., and others: Cinnoline Derivatives as Chemotherapeutic Agents for *Trypanosoma congolense* Infections, 603, 758
Wright, Prof. Sewall: Awarded the Daniel Giraud Elliot Medal for 1945 of the U.S. National Academy of Sciences, 49; work of, 49
Wuhrmann, Dr. F., und Wunderly, Dr. Ch.: Die Bluteiweisskörper des Menschen, *review*, 376
Wunderly, Dr. Ch. (Wuhrmann, Dr. F., und): Die Bluteiweisskörper des Menschen, *review*, 376
Wyckoff, Dr. Ralph W. G., and others: Molecular Arrangement in Tobacco Necrosis Virus Crystals, 760
Wylie, Dr. A. W.: Constitution of Monazite, 97
Wylie, Dr. A. W. (Hartley, F. R., and): Preparation of Rare-Earth Chlorides, 241
Wynne-Edwards, Prof. V. C.: Orientation of Birds on Migratory and Homing Flights, 998

YABSLEY, D. E. (Lehany, F. J., and): A Solar Noise Outburst at 600 Mc./s. and 1200 Mc./s., 645
Yang, L. M.: Coefficients of Viscosity and Thermal Conduction in Dense Gases and Liquids, 523
Yang, S. H. (Findlay, Dr. J. D., and): Capillary Distribution in Cow Skin, 1012
Yates, Dr. F.: Sampling Practice in the United States of America, *review*, 153
  Elected a Fellow of the Royal Society, 467
  Operational Research, 609
Yeo, D. (Kendall, J. T., and): Magnetic Susceptibility of Mica, 476
Yoffe, A.: Initiation of Explosives by Adiabatic Compression of their own Vapour, 349
Yoffe, A. (Robertson, Dr. A. J. B., and): Gases Liberated from Explosions Initiated by Impact, 806
Yonge, Prof. C. M.: Formation of Siphons in Lamellibranchia, 198
  Problems of Tidal Biology, 796
Yorkshire Museum: Presented with the late Dr. W. E. Collinge's collection of terrestrial Isopoda, 51
Young, Prof. J. Z.: Transmission in Nerves, *review*, 76
Young, Dr. Leslie: Appointed to the University of London chair of biochemistry at St. Thomas's Hospital Medical School, 233
Youngson, G. W. (Melville, Prof. H. W., and): Branched-Chain High Polymers, 803
Yuill, John L.: Production of Itaconic Acid and Kojic Acid by a Species of *Aspergillus*, 397

ZAIMIS, Dr. E. J. (Paton, Dr. W. D. M., and): Curare-like Action of Polymethylene *bis*-Quaternary Ammonium Salts, 718
Zimanyi, Dr. S.: Thyroid Gland as a Special Factor influencing the Conditional Disposition to Infectious Diseases, 57
Zondek, Prof. B., and others: Variations in Spermatogenesis of Oligospermic Men, 176
Zoological Society of Scotland: Now the Royal Zoological Society of Scotland, 592
Zoologists (British), Association of: Discussion on the Field Study and Conservation of the British Fauna, 408
Zootechny, International Society of (Meeting of the Swiss Zootechnical Society to discuss the formation of an), 322
Zuckerman, Prof. S.: Control of the Germinal Epithelium, *review*, 221
  The Laurentian Hormone Conference, *review*, 295
  Awarded the Medal of Freedom with Silver Palm by the Government of the United States, 716

TITLE INDEX

ABNORMALITIES in the *F*-Region of the Ionosphere at Calcutta (S. S. Baral, S. N. Ghosh and M. Debray), 24
Absorptiometry : Reversion—a New Procedure in (Dr. H. Irving, G. Andrew and E. J. Risdon), 805
Absorption of Protein and Bacteria from Normal and Infected Joints (Torbjörn Edlund), 102
Absorption Band Spectrum of S_2 in the Schumann Region (R. Maeder and Prof. E. Miescher), 393
Absorption Spectra of Crystals : Infra-Red (Sir C. V. Raman), 165
2-Acetaminofluorene on the Adreno-Gonadal System of Rats : Effect of Feeding (Cornelia Hoch-Ligeti), 58
Acetylation of Sugars (S. D. Nicholas and Dr. F. Smith), 349 ; (Dr. P. H. Plesch), 637
Acetylcholine and Body Temperature (Prof. J. H. Burn and N. K. Dutta), 19
Acid Phosphatase in Normal Human Urine : Presence of Substances Inhibitory to (Dr. Alice M. Robinson and Dr. F. L. Warren), 397
Acid Soils : Effects of Calcium Deficiency on Potato Sets in (Prof. T. Wallace and E. J. Hewitt), 28
Acid-extracted Brown Alga under Continuous Flow Conditions : Adsorption of Calcium Ions by an (Dr. A. Wassermann), 562
Acid-Proteolytic Lactic Cocci (Gorini's) : Behaviour of, with Penicillin (Annamaria Torriani), 275
Acoustics : Studio (H. L. Kirke), 732
Acridine Antibacterials : Mode of Action of (Dr. Adrien Albert and Reginald Goldacre), 95
Acridines and Antimalarial Action : Absence of Correlation between Respiratory Inhibition of Plasmodia by (Dr. Adrien Albert and P. B. Marshall), 1008
Actinomycetes : Molds, Yeasts and (the late Dr. A. T. Henrici), second edition by Dr. Charles E. Skinner, Dr. Chester W. Emmons and Dr. Henry M. Tsuchiya, *review*, 40
Action of Acridine Antibacterials : Mode of (Dr. Adrien Albert and Reginald Goldacre), 95
Action of Clover Juice on Isolated Muscle and 'Bloat' in Cattle : A Possible Relation between the (W. S. Ferguson), 816
Activation of Heterolytic Reactions : Effect of Ionic Charges on the Energy and Entropy of (J. Gripenberg, Prof. E. D. Hughes and Prof. C. K. Ingold), 480
Activator of Plasma Protease : Staphylokinase, an (Charles H. Lack), 559
Active Nitrogen : Mechanism of the Emission Spectrum of (L. Herman and R. Herman), 1018
Active Penetration of Fat into Adipose Tissue (B. Shapiro, D. Weissmann, V. Bentor and E. Wertheimer), 482
Adaptation Mechanism of the Organism to Damage—the Role of 'Resistine' (Dr. S. Karády and Dr. A. Kovács), 688
Adenosine Triphosphate : Synthesis of (J. Baddiley, A. M. Michelson and Prof. A. R. Todd), 761
Adenosine Triphosphate in Glutamine Synthesis (W. H. Elliott), 128
Adiabatic Compression of their own Vapour : Initiation of Explosives by (A. Yoffe), 349
Adipose Tissue : Active Penetration of Fat into (B. Shapiro, D. Weissmann, V. Bentor and E. Wertheimer), 482
Administration (Public) : Study of (Dr. W. A. Robson), 879
Administrations fédérales aus États-Unis : Méthodes statistiques modernes des (Pierre Thionet), *review* by Dr. F. Yates, 153
Adrenal Cancer : Isolation of a New Androstenol-3(α)-on-17 from the Urine of a Patient with (Dr. Elizabeth Dingemanse, Leonora G. Huis in 't Veld and S. Lore Hartogh-Katz), 848
Adrenal Cortical Extracts to cause Lysis of Living Lymphocytes *in vitro* : Failure of (J. S. Robertson), 814
Adrenaline and Methyladrenaline : Demonstration and Separation of Noradrenaline, (Dr. W. O. James), 851
Adreno-Gonadal System of Rats : Effect of Feeding 2-Acetaminofluorene on the (Cornelia Hoch-Ligeti), 58
Adrenolytic Substance in Aglomerular Fish Kidney : A Vasodilator, (Dr. Benjamin Jablons), 100
Adrostenol-3(α)-on-17 from the Urine of a Patient with Adrenal Cancer : Isolation of a New (Dr. Elizabeth Dingemanse, Leonora G. Huis in 't Veld and S. Lore Hartogh-Katz), 848
Adsorption of Bacterial Polysaccharides to Erythrocytes (Dr. E. V. Keogh, Dr. E. A. North and M. F. Warburton), 687
Adsorption of Calcium Ions by an Acid-extracted Brown Alga under Continuous Flow Conditions (Dr. A. Wassermann), 562
Adsorption on to Ionogenic Surfaces (Dr. P. H. Plesch and R. H. S. Robertson), 1020
Adsorption and Heterogeneous Catalysis (Prof. Eric K. Rideal), 461
Aëdes *aegypti* in Khartoum : Extermination of (R. Kirk), 139
Aero-Gas Turbine : Fuel Systems for the (Dr. E. A. Watson), 196
Aerobic Mesophilic Bacteria in Composts (D. M. Webley), 174
Aerobiology on Commercial Air Routes (Dr. I. V. Newman), 275
Aerodynamics : Elementary Applied (Prof. Paul E. Hemke), *review*, 544
Aerodynamics : Theoretical (Prof. L. M. Milne-Thomson), *review* by Prof. W. J. Duncan, 703
Aerofoils : Potential Theory of, *review* by Prof. W. J. Duncan, 703
Aeronautics : Busk Studentship in, 595
Afforestation as a World Problem (Prof. F. G. Champion), 902
Africa : Education for Citizenship in (Colonial Office Advisory Committee on Education in the Colonies), 948
Tsetse Flies and the Development of (Prof. P. A. Buxton), 802
Africa (Central) : Research in, 230
Africa (East) : Industrial Research in, 122
Africa (South) : Archæology in, 881
Medical Research in, 162
African Fossil Primates discovered during 1947 (Prof. W. E. Le Gros Clark), 667
Agassiz Gold Medal and Honorarium for 1947 of the U.S. National Academy of Sciences awarded to Prof. Felix Andries Vening Meinesz, 861
Ageing in the Population of France : Scientific Research on (French National Union for Prevention of Depopulation and the French National Demographic Institute conference on), 163
Agglomeratic Slates of Kashmir : Occurrence of Volcanic Bomb in the (Dr. R. C. Misra), 895
Agglutinin Predicted by Fisher and Race : Two Examples of Sera containing the Anti-*d* (Dr. Joseph M. Hill and Dr. Sol Haberman), 688
Aggression, a Component of Post-Epileptic Automatism in *Peromyscus* (M. R. A. Chance), 101
Aglomerular Fish Kidney : A Vasodilator, Adrenolytic Substance in (Dr. Benjamin Jablons), 100
Agricultural Economics, Statistics and Agricultural and Dairy Engineering : Postgraduate Scholarships in Husbandry, (Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland), 637
Agricultural Physiology : Co-operation between Medical and, *review*, 113
Agricultural Produce : Marketing (Thomas Shaw), 470
Agricultural Production in the British Colonial Empire : Factors of (Sir Frank Stockdale), 337
Agricultural and related Products of the British Colonies, 779
Agricultural and Dairy Engineering : Postgraduate Scholarships in Husbandry, Agricultural Economics, Statistics and (Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland), 637
Agriculture : Films in (Scientific Film Association conference on), 17
Reclamation Disease in, *review*, 624
'Agrocide' Generator, 575
'Agrocide' Range of Insecticides (Plant Protection, Ltd.), 595
Agro-Climatic Analogues (G. Melvyn Howe), 983
Air : Studies in Stomatal Action—Control of Stomatal Movement by a Reduction in the Normal Carbon Dioxide Content of the (Dr. O. V. S. Heath), 179
Air at Ultra High-Frequencies : Electrical Breakdown Strength of (J. A. Pim), 683
Air Pressure : Roofs Supported by (Herbert H. Stevens, Jun.), 613
Air Routes : Aerobiology on Commercial (Dr. I. V. Newman), 275
Air-depolarized Primary Cells (British Standard 1335 : 1946), 51
Aircraft Attack on Locusts (Dr. D. L. Gunn), 342
Aircraft Strength of Materials (Dr. H. D. Conway), *review*, 503
Alaska : Earthquake south-west of Fairbanks on October 16, 306
Alchemist in Life, Literature and Art (Prof. John Read), *review* by T. I. W., 787
Alchemists : Private Lives of the, *review* by T. I. W., 787
Alga (Acid-extracted Brown) : Adsorption of Calcium Ions by an, under Continuous Flow Conditions (Dr. A. Wassermann), 562
Alga (Green) : Influence of Low Bicarbonate Concentrations on the Growth of a (Sven Österlind), 319
Algæ : The Iron Alum Acetocarmine Method for (Dr. M. B. E. Godward), 203
Algal Growth and Depth : Sublittoral Seaweed Survey—Relationship of (F. T. Walker), 977
Algal Life-Histories : Genetics and (Dr. Kathleen M. Drew), 223
Algebra (Dr. A. Page), *review*, 626
Algebraic Geometry : Foundations of (Prof. André Weil), *review* by Prof. H. T. H. Piaggio, 787
Alkali Metal Salts, Gold and Platinum : Magnetic Susceptibility of Borax Glasses containing Crystallites of (Prof. Subodh Kumar Majumdar), 684
Alkali Metals below 20° K. : Electrical Resistivity of (Dr. D. K. C. MacDonald and Dr. K. Mendelssohn), 972
Alkaline Phosphatase in various Cell Types of the Anterior Pituitary of the Guinea Pig (Prof. Leo Abolins), 556
Alkaline Phosphatase in the Eggs of a Sea-urchin : Distribution of (Elsa Wicklund), 556
Alkaline Phosphatase in Fish Gut (A. H. Al-Hussaini), 274
Alkaline Phosphatase in Taste Buds and Nasal Mucosa (Dr. Geoffrey H. Bourne), 445
Alkaloidal Content of *Datura metel* : Effect of Colchicine Treatment on the (A. E. Beesley and Dr. G. E. Foster), 561
Alkyl Fluorophosphonates (Dr. E. C. Webb), 226
Allelomorphic to *C* : *Rh* Genes (Dr. R. R. Race, Dr. Ruth Sanger and Mrs. Sylvia D. Lawler), 316
Alloxan Diabetic Rats : Effect of Insulin on Intestinal Glucose Absorption in (Dr. A. Sols, S. Vidal and J. Larralde), 932
Alloy : 'Supermalloy', a New Magnetic (O. L. Boothby and R. M. Bozorth), 554
Alloys : Internal Stresses in Metals and (Institute of Metals, in association with the Faraday Society, the Institute of Physics, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Physical Society and the Royal Aeronautical Society symposium on), 70
Alloys of Gold, Silver and Copper : Amalgamation of some (Dr. Douglas Rennie Hudson), 288
α-Particles from Polonium : Excitation Curves for the γ-Radiation from Light Elements Bombarded with (Prof. Hilding Slätis), 899
Alpha Rays : Surface Radiography with (C. Jech), 314
Alterations in Diet : Effect of Under-nutrition and, on the Choline Esterase Activity of Serum (Prof. R. A. McCance, E. M. Widdowson and A. O. Hutchinson), 56
Alternating Current Electrical Engineering (Philip Kemp), seventh edition, *review* by J. G., 297
Aluminium : Stressed (Prof. E. A. Owen, Y. H. Liu and D. P. Morris), 882
Aluminium Bromide : Band Spectrum of (Carl Gustav Jennergren), 315
Alumni Cantabrigienses (compiled by Dr. J. A. Venn), Part 2, From 1752 to 1900, Vol. 3, Gabb—Justamond, *review* by Prof. F. J. M. Stratton, 661

Amalgamation of some Alloys of Gold, Silver and Copper (Dr. Douglas Rennie Hudson), 288
America (Latin) : Forage Resources of (Hugo W. Alberts), 657
America (North) : The Fall Webworm of, in Europe (Dr. Paul Surányi), 512
American Academies : War-time Work of the, 304
American Awards to British Men of Science, 215, 390, 716, 800
American Awards for Work on Penicillin, 800
American Oil Operations Abroad (Leonard M. Fanning), *review* by H. B. Milner, 186
American Summer Scholarships for European Students (Massachusetts Institute of Technology), 593 ; *erratum*, 637
American (Central) Culture : Origins of, 594
American (Latin) Cultures (Dr. G. H. S. Bushnell), 697
American (North) Archæology, *review* by Dr. G. H. S. Bushnell, 501
American (South) Chemical Congress : The Fourth, 654
Ames des Dogons : Les (Mme. G. Dieterlen), *review* by G. I. Jones, 622
Amino-Acid Metabolism of Tissue Cells *in vitro* (Dr. Albert Fischer), 1008
Amino-Acids in Bacterial Hydrolysates : New (A. Polson), 351
α-Amino-Acids : Quantitative Chromatographic Estimation of (Dr. L. Naftalin), 763
p-Aminobenzoic Acid on the Leucocyte Count in Leukæmia : Effect of (Dr. J. Bichel), 353
Amino-Nitrogen and its Application to Paper Partition Chromatography : Micro-Estimation of (A. J. Wolwod), 169
p-Aminosalicylic Acid in the Treatment of Tuberculosis (D. D. Martin, Prof. F. S. Spring, Dr. T. G. Dempsey, C. L. Goodacre and D. E. Seymour), 435
Ammi majus L. : Xanthotoxin from the Fruits of (Prof. Alexander Schönberg and Aly Sina), 481
Ammonia Inversion Spectrum at High Pressures : Collision Broadening of the (Dr. B. Bleaney and J. H. N. Loubser), 522
Ammonium Phosphate Fertilizer on Rice in Lower Burma : Results of the Continuous Use of an (D. Rhind and U Tin), 105
Ammonium Salts : Curare-like Action of Polymethylene *bis*-Quaternary (Dr. R. B. Barlow and Dr. H. R. Ing), 718 ; (Dr. W. D. M. Paton and Dr. E. J. Zaimis), 718
Ammonium Salts of Sulphanilamides and Sulphonic Acids (S. K. Munshi, B. D. Tilak and Prof. K. Venkataraman), 55
Amœbic Infections in Laboratory Rodents : Natural (Dr. J. D. Fulton and L. P. Joyner), 66
Amontons' Law : Rate of Wear in the Region of the Validity of (Henry James Bezer and Dr. Robert Schnurmann), 728
Amphibia (Anuran) : Mauthner's Cells in the Larvæ of (A. G. Willis), 65
Amphibian Tissue Cultures for Biophysical Research (M. M'E. Preston), 203
Amphipod *Orchestia bottæ* A. Edwards in Britain : Second Occurrence and Persistence of the (A. J. Cain and D. H. Cushing), 483
Amphipod *Orchestia bottæ* and other Organisms in Britain : Occurrence of the (D. M. Reid), 609
Amplifying Conditions : Low-Frequency Noise from Thermionic Valves working under (Dr. E. J. Harris and P. O. Bishop), 971
Amylopectin : Enzymic Conversion of Amylose into (Dr. S. Peat, Dr. E. J. Bourne and S. A. Barker), 127
Amylopectin Fractions of Starch : Arsenolysis and Phosphorolysis of the Amylose and (Dr. Joseph Katz, Dr. W. Z. Hassid and Dr. Michael Doudoroff), 96
Amylose into Amylopectin : Enzymic Conversion of (Dr. S. Peat, Dr. E. J. Bourne and S. A. Barker), 127
Amylose and Amylopectin Fractions of Starch : Arsenolysis and Phosphorolysis of the (Dr. Joseph Katz, Dr. W. Z. Hassid and Dr. Michael Doudoroff), 96
Anæmia Factor : Anti-Pernicious (E. L. Rickes, N. G. Brink, F. R. Koniuszy, T. R. Wood and K. Folkers), 676 ; (Dr. E. Lester Smith), 676
Anæmia Factors from Liver : Purification of Anti-pernicious (Dr. E. Lester Smith), 638, 676
Anæsthesia : History of, *review* by Dr. G. Edwards, 458
  Horace Wells and, 123
Anæsthetic : A Radioactive Local (Frank Howarth), 857
Analysis : Sequential (Prof. Abraham Wald), *review* by M. G. Kendall, 790
Analysis of Political Behaviour (Harold D. Lasswell), *review* by Prof. D. W. Brogan, 950
Anatomy of the Renal Circulation, *review*, 663
Anatomy of the Shark, *Necturus*, and the Cat : Guide to the Study of the (Prof. Samuel Eddy, Prof. Clarence P. Oliver and Prof. John P. Turner), second edition, *review* by Dr. P. D. F. Murray, 955
Ancient China : Science and Society in (Dr. Joseph Needham), 305
Ancient Cliff near Plymouth : A Submerged (Dr. J. H. N. Cooper), 280
Ancient Indian Mathematics and Vedha (Prof. L. V. Gurjar), *review* by Prof. E. H. Neville, 580
Anderson-Berry (David) Prizes of the Royal Society of Edinburgh awarded to Dr. Ralston Paterson and Dr. P. C. Koller, 716
Androstenol-3 (α)-on-17 from the Urine of a Patient with Adrenal Cancer : Isolation of a New (Dr. Elizabeth Dingemanse, Leonora G. Huis in 't Veld and S. Lore Hartogh-Katz), 848
Anethole : Addition of Maleic Anhydride to (Prof. V. Bruckner and Dr. J. Kovács), 651
Angular Distribution of Radioactive Disintegration Products (J.A. Spiers), 807
Animal (Conscious) : Electrical Stimulation of the Neurohypophysis in the (G. W. Harris), 739
Animal Cells : Photo-electric Counting of Individual Microscopic Plant and (Carl Lagercrantz), 25
  Shrinkage of, due to Fixatives (Dr. Daya Krishna), 202
Animal Genetics and Medicine (Dr. Hans Grüneberg), *review* by Prof. C. H. Waddington, 543
Animal Health in British Guiana (Prof. W. C. Miller), 345
Animal Kingdom : Parade of the (Prof. Robert Hegner, assisted by Jane Z. Hegner), *review* by Dr. Edward Hindle, 501
Animal Migration : Salmon and (Dr. A. G. Huntsman), 300
Animal Parade, *review* by Dr. Edward Hindle, 501
Animal Production : International Meeting on (I. L. Mason), 322
Animal Production and on Artificial Insemination : First International Congress on the Physiology and Pathology of, 197
Animal System : Relation of Intermediary Metabolites to the Lowering of the Potency of Pancreatic Insulin in the (Prof. M. C. Nath and H. D. Brahmachari), 18
Animal Tissue Cells in Protein-Free Media (Aage Bohus Jensen), 273
Animal Tissue Culture with a Synthetic Medium (Dr. F. Jacoby and S. J. Darke), 768
Animal Virus : Structure of an (Dr. I. M. Dawson and Dr. A. S. McFarlane), 464
Animal and Human Sex Behaviour, 124
Animals and the Laboratory, *review* by Frances Pitt, 664
Animals (Farm) : The Artificial Insemination of (John W. Bartlett, George E. Taylor, Joseph Edwards, Clair E. Terrill, Victor Berliner and Fred P. Jeffrey), edited by Enos J. Perry, *review* by Dr. Arthur Walton, 831
Animals (Laboratory) : The UFAW Handbook on the Care and Management of (edited by Prof. Alastair N. Worden), *review* by Frances Pitt, 664
Anisotropic Time Effects in Rheology : Some New (S. M. Freeman and K. Weissenberg), 324
Annealing of Glass (S. M. Cox), 401, 813 ; (Dr. G. O. Jones), 813
Annual Review of Biochemistry (edited by J. Murray Luck, Hubert S. Loring and Gordon Mackinney), Vol. 16, *review*, 870
Annual Review of Microbiology (edited by Charles E. Clifton, Sidney Raffel and H. Albert Baker), Vol. 1, *review* by Sir Paul Fildes, 995
Annual Review of Physiology (edited by Victor E. Hall, Jefferson M. Crismon and Arthur C. Giese), Vol. 9, *review* by Dr. O. A. Trowell, 542
Annular Eclipse of the Sun on May 8–9, 196, 389, 879
Anomaloscope Matching on Viewing-Distance or Field-Size : Dependence of (R. G. Horner and E. T. Purslow), 484
Anomalous Distribution of Nuclear Disintegration in Photographic Emulsions Exposed to Cosmic Rays—Double Stars (L. Leprince-Ringuet and J. Heidmann), 844 ; (T. T. Li and D. H. Perkins), 844
Anomalous Effect of Ionospheric Absorption (Sir Edward Appleton, W. J. G. Beynon and W. R. Piggott), 967
Anomalous Skin Effect in Metals : Theory of the (G. E. H. Reuter and E. H. Sondheimer), 394
Anomaly in Electromagnetic Theory : An (Prof. E. G. Cullwick), 969
Antagonism between Molybdenum and certain Heavy Metals in Plant Nutrition (C. R. Millikan), 528
Antarctic : Synoptic Weather Maps for the, 709
Anterior Pituitary of the Guinea Pig : Alkaline Phosphatase in various Cell Types of the (Prof. Leo Abolins), 556
Anthocyanins and related Substances in Petal Extracts : Paper Chromatography of (E. C. Bate-Smith), 835
Anthracene : Oxidation of, by Osmium Tetroxide (Prof. J. W. Cook and Dr. R. Schoental), 237
Anthropological and Ethnological Sciences : International Congress of, 88
Anthropologist : Political Testament of an, *review* by Dr. E. R. Leach, 457
Anti-*d* Agglutinin Predicted by Fisher and Race : Two Examples of Sera containing the (Dr. Joseph M. Hill and Dr. Sol Haberman), 688
Anti-Anæmia Factors : B_T, a New Vitamin of the B-Group and its relation to the Folic Acid Group and other (Dr. G. Fraenkel, with the assistance of M. Blewett and M. Coles), 981
Antibacterial Analogues of Vitamin K on *M. tuberculosis* : Effect of (C. N. Iland), 1010
Antibacterials (Acridine) : Mode of Action of (Dr. Adrien Albert and Reginald Goldacre), 95
Antibiotic Concentrate from *Bacillus subtilis* : Subtilin *C*, an (C. H. Hassall), 317
Antibiotic Substance on Wheat Straw and other Organic Materials and in the Soil : Production of an (Erna Grossbard), 614
Antibiotic Substances from the Heart Wood of *Thuja plicata* Don. (Prof. Holger Erdtman and Dr. Jarl Gripenberg), 719
Antibody-Antigen Reactions : Plant Virus Proteins and (R. E. F. Matthews), 611
Antihistamines on *Daphnia* : Effect of (Dr. Otakar Poupa), 235
Antimalarial Action : Absence of Correlation between Respiratory Inhibition of Plasmodia by Acridines and (Dr. Adrien Albert and P. B. Marshall), 1008
Antimalarial Herb : Pharmacology of Ch'ang Shan (*Dichroa febrifuga*), a Chinese (Dr. C. S. Jang, F. Y. Fu, K. C. Huang and C. Y. Wang), 400 ; (T. S. Work), 401
Anti-Pernicious Anæmia Factor (E. L. Rickes, N. G. Brink, F. R. Koniuszy, T. R. Wood and K. Folkers), 676 ; (Dr. E. Lester Smith), 676
Anti-Pernicious Anæmia Factors from Liver : Purification of (Dr. E. Lester Smith), 638, 676
Anti-*Rh* Typing Sera : Nomenclature of the (W. B. Castle, M. W. Wintrobe and L. H. Snyder), 492
Anuran Amphibia : Mauthner's Cells in the Larvæ of (A. G. Willis), 65
Ape-Man, *Plesianthropus* : Size of the Brain in the (Dr. R. Broom and J. T. Robinson), 438
Apodan Sertoli Cell : The Nucleolus of the (B. R. Seshachar), 558
Apparent Emission of Positive Electrons from β-Emitters (C. B. A. McCusker), 564
Apple Canker Lesions with Plant-growth Substances : Treatment of (S. H. Crowdy), 320
Apple Juice : Effect of Ion-Exchange Treatment on the Stability of (Dr. S. W. Challinor, Margaret E. Kieser and Dr. A. Pollard), 1023
Applied Energy : Elements of (Prof. Frederick T. Morse), *review* by R. W. Haywood, 829
Applied Mechanics : Seventh International Congress of, 232
Approaches to Sociology, *review* by Prof. D. W. Brogan, 950
Aqueous Solution : The Reactions of Mustard Gas in (Dr. A. G. Ogston), 225
Aqueous Solutions : Mechanism of Conductance by Hydrogen and Hydroxyl Ions in (Dr. S. I. Weissman), 241
Aqueous Solutions of Soap : Bactericidal Activity of Phenols in (Prof. H. Berry and H. S. Bean), 396
Arabian Sea (south of Baluchistan) : Earthquake on August 5, 657
D-Arabinose into 2-Deoxy *D*-Ribose and 3-Deoxy *D*-Xylose : Conversion of (Dr. P. W. Kent, Prof. M. Stacey and Dr. L. F. Wiggins), 21
Arc Discharge : Transition from Glow to (Dr. Chas. E. R. Bruce), 521
Archæological Expedition to Cyrenaica : Cambridge (C. B. M. McBurney, R. W. Hey and W. Watson), 327
Archæology : North American, *review* by Dr. G. H. S. Bushnell, 501
Archæology of the Missouri Valley, 636
Archæology at Oxford, *review* by Miles Burkitt, 459
Archæology in South Africa, 881

Archæology in the University of London, 674
Archæology and the History of Europe (Prof. C. F. C. Hawkes), *review* by Miles Burkitt, 459
Archæology and Society (Grahame Clark), second edition, *review* by Prof. C. F. C. Hawkes, 583
Archéologie du Pacifique-nord (Dr. André Leroi-Gourhan), *review* by Prof. J. H. Hutton, 545
Architecture : Landscape, *review* by Prof. L. Dudley Stamp, 868
Argentine (northern) : Earthquake on July 25, 657
Argument from Mouse to Man, *review* by Prof. C. H. Waddington, 543
Armed Services (British) : 'War-time Rheological Investigations for the (British Rheologists' Club meeting on), 252
Armeria (Late-Glacial) : Significance of Pollen Dimorphism in (Dr. H. G. Baker), 770
Army Education : Citizenship and Current Affairs in (Lieut.-Colonel Eric Lowe), 444
  The Present Outlook in (Major-General Cyril Lloyd), 262
  Progress in, 257
Arnhem Land : Scientific Expedition to (National Geographic Society, Smithsonian Institution and the Commonwealth of Australia), 195
Aromatic Double Bonds : Relative Reactivity of (Dr. G. M. Badger and Dr. R. I. Reed), 238
Aromatic Hydrocarbon Pentalene : The Non-Benzenoid (D. P. Craig and Allan Maccoll), 481
Arrow-heads : Tanged and Winged (Dr. van Riet Lowe), 881
Arsenicals : An Improved Method for the Assay of Toxicity of (W. L. M. Perry), 975
Arsenolysis and Phosphorolysis of the Amylose and Amylopectin Fractions of Starch (Dr. Joseph Katz, Dr. W. Z. Hassid and Dr. Michael Doudoroff), 96
Art : The Alchemist in Life, Literature and (Prof. John Read), *review* by T. I. W., 787
Artery Pressure (Pulmonary) : Effect of Renin on (E. G. Brewin, R. A. Kenney and D. H. Miller), 893
Artificial Illumination : Progress in, 821
Artificial Insemination : First International Congress on the Physiology and Pathology of Animal Production and on, 197
Artificial Insemination of Farm Animals (John W. Bartlett, George E. Taylor, Joseph Edwards, Clair E. Terrill, Victor Berliner and Fred P. Jeffrey), edited by Enos J. Perry, *review* by Dr. John Walton, 831
Artificial Production of Mesons (Dr. G. P. S. Occhialini and Dr. C. F. Powell), 551
Ascidians : Interspecific Fertilization in (Dr. Antonio Minganti), 643
Ascorbic Acid : Inhibition of Hexosediphosphatase by Sulphhydryl Reagents and by (Dr. E. O'F. Walsh and Mrs. G. Walsh), 976
Ascorbic Acid in the Organs of the Guinea Pig : Influence of Vitamin P (Vitamin C.) upon the Amount of (H. Cotereau, M. Gabe, E. Géro and Prof. J.-L. Parrot), 557
Asia (Eastern) : Mammals of (G. H. H. Tate), *review* by T. C. S. M.-S., 188
Aspergillus : Production of Itaconic Acid and Kojic Acid by a Species of (John L. Yuill), 397
Aspergillus nidulans : Mustard-gas Mutation in (Donald Hockenhull), 100
Assay (Biological) : Primary and Secondary Responses in (R. E. Blackith), 20
Assay Procedure (Microbiological) : A Modified (Dr. Trevor I. Williams), 19 ; (Stanley A. Price), 20
Assay of Toxicity of Arsenicals : An Improved Method for the (W. L. M. Perry), 975
Assaying of Penicillin (Biological Methods and Physical Methods Groups of the Society of Public Analysts and other Analytical Chemists discussion on), 285
Assembly Processes : Modern (J. L. Miller), second edition, *review* by H. W. G. H., 503
Astronomia : I fondamenti scientifici della (Prof. G. Armellini), *review* by H. S. J., 419
Asymptotic Solution of the Fundamental Equation of the Statistical Atom Theory : An (Dr. J. I. Hórvath), 26
Atlantic (mid-) : Earthquake on August 9, 657
Atmosphere (Upper) : Production of Nitrogen Atoms in the (Prof. G. Herzberg and L. Herzberg), 283
Atmosphere of Mars (Dr. G. P. Kuiper), 594
Atmosphere in the 1–5 Micron Region : Transmission of the (A. Elliott and G. G. MacNeice), 516
Atmosphere over the Oceans : Sublimation in the (Dr. B. Cwilong), 62
Atmosphere (Solar) : Spontaneous Waves in Discharge Tubes and in the (Prof. V. A. Bailey), 599
Atmospheric Pressure : 'Low-Temperature' Oxidation of Higher Hydrocarbons at (Dr. G. Friedlander and L. Grunberg), 360
Atom : The (Sir George Thomson), third edition, *review* by P. B. M., 871
  The Church and the, a Study of the Moral and Theological Aspects of Peace and War (Church Assembly), 990
Atom and its Energy (Prof. E. N. da C. Andrade), *review* by Prof. P. B. Moon, 582
Atom Theory (Statistical) : An Asymptotic Solution of the Fundamental Equation of the (Dr. J. I. Hórvath), 26
Atomic Challenge (A Symposium by Prof. J. D. Cockcroft, Prof. M. L. Oliphant, Group-Capt. G. L. Cheshire, Dr. J. Bronowski, Sir George Thomson, Capt. Cyril Falls, Prof. P. M. S. Blackett, Sir Henry Dale, Bertrand Russell, Sir John Anderson and Henry Wallace), *review*, 995
Atomic Energy (Atomic Scientists' Association, London Branch, lectures on), 164 ; (Society of Calvinist Lawyers and the Christian Society of Scientists and Physicians in the Netherlands discussion on), 123
Atomic Energy : Control of, 123
  International Control of, 291
  Release of Information on, 146
Atomic Energy, its International Implications (Chatham House Study Group discussion on), 741
Atomic Energy in Cosmic and Human Life (Prof. George Gamow), *review* by Prof. J. A. Crowther, 4
Atomic Energy Control : Ethical Basis of, 989
Atomic Oxygen and Dissociation in Flame Gases (Prof. W. T. David, C. Rounthwaite and N. Carpenter), 726
Atomic Power : Peace and, 741
Atomic and Planetary Properties : Parallelism between, 780
Atoms : Meet the (O. R. Frisch), *review* by Prof. P. B. Moon, 582
Atoms for the Layman, *review* by Prof. P. B. Moon, 582
Atoms (Helium-like) : Energy of the Ground-State of (H. A. S. Eriksson), 393
Atypical Scale of *Sciæna coitor* (Hamilton) : An (Dr. Sivatosh Mookerjee), 64
Audio-Frequency Magnetic Fluctuations (H. F. Willis), 887
Audio-Frequency Radio Waves from the Sun (Dr. Donald H. Menzel and Winfield W. Salisbury), 91
Audiovisual Aids to Instruction (William Exton, Jr.), *review* by Lieut.-Colonel Eric Lowe, 745
Auroral Activity in Southern Norway from the Middle of August to the Middle of October 1947 (Prof. Carl Störmer), 208
Auroral Spectra : Ozone and (Dr. A. Vassy and E. Vassy), 566
Auroras : Emission Spectra of the Night Sky and (Physical Society to arrange for separate publication of papers read before the International Conference on the), 514
Austenite (Retained) : Comparison of Metallographic and X-Ray Measurements of (William J. Harris, jun.), 315
Austenitic Stainless Steels : Ferromagnetic Structure of Cold-Worked (P. T. Hobson and W. P. Osmond), 562
Australia : Echinoderm Fauna of (Dr. D. Dilwyn John), 32 ; (Dr. Hubert Lyman Clark), 32
Australia (South) : Jellyfish from the Basal Cambrian in (Reg. C. Sprigg), 568
  Newly Discovered Submarine Canyons of New Guinea and (Reg. C. Sprigg), 246
Australian Plague Grasshopper : Measurement of 'Environmental Resistance' in the (Dr. H. G. Andrewartha and L. C. Burch), 447
Automatism in *Peromyscus* : Aggression, a Component of Post-Epileptic (M. R. A. Chance), 101
Autoradiography : Resolution Testing in (G. W. W. Stevens), 432
Auxiliary Language : A Planned (H. Jacob), *review*, 665
Auxins in the Rooting of Woody Cuttings : The Use of (Kenneth V. Thimann and Jane Behnke), *review* by Prof. M. Thomas, 993
Avocets in Britain : Breeding of (P. E. Brown and E. Lynn-Allen), 271
Azo-Compounds and other Substances : Toxicity of, to the Fruit Tree Red Spider Mite (Dr. J. K. Eaton and R. G. Davies), 644

BACILLUS SUBTILIS : Subtilin C, an Antibiotic Concentrate from (C. H. Hassall), 317
Back Grant for 1948 of the Royal Geographical Society awarded to Alan J. Marshall, 553
Bacteria : The Chemical Activities of (Dr. Ernest F. Gale), *review* by Dr. H. K. King, 78
  Enzymes in, *review* by Dr. H. K. King, 78
  Limitation of, by Micro-Predators in Soil (Dr. F. J. Anscombe and Dr. B. N. Singh), 140
Bacteria in Composts : Aerobic Mesophilic (D. M. Webley), 174
Bacteria from Normal and Infected Joints : Absorption of Protein and (Torbjörn Edlund), 102
Bacterial Cell, as shown by the Electron Microscope : Submicroscopic Structure of the (Dr. Stuart Mudd), 302
Bacterial Flagella and Motility (Prof. Adrianus Pijper), 200
Bacterial Hydrolysates : New Amino-Acids in (A. Polson), 351
Bacterial Hydrolysis and Utilization of Polysaccharide-like Substances ('Mucin') in Saliva (Dr. H. J. Rogers), 815
Bacterial Polysaccharides to Erythrocytes : Adsorption of (Dr. E. V. Keogh, Dr. E. A. North and M. F. Warburton), 687
Bacterial Products on Human Red Cells : Enzymic Action of Viruses and (C. M. Chu), 606
Bactericidal Activity of Phenols in Aqueous Solutions of Soap (Prof. H. Berry and H. S. Bean), 396
Bactericidal Radiation through Glass : Transmission of (J. E. Stanworth), 856 ; *erratum*, 882
Bacterium (Spore-forming) : A Plant Disease caused by a, under Natural Conditions (Z. Volcani and Dr. W. J. Dowson), 980
Baffin Bay : Earthquake on July 10, 657
B.A.L. : Development of British Anti-Lewisite (Dr. R. H. S. Thompson), 226
Ballistics of Rockets : Exterior, *review* by Dr. R. A. Rankin, 3
Band Spectrum of Aluminium Bromide (Carl Gustav Jennergren), 315
Band Spectrum of ClO in Flames (Dr. G. Pannetier and Dr. A. G. Gaydon), 242
Bands in the Schumann-Runge System of the Oxygen Molecule : New (Lalji Lal), 477
Barclay Memorial Medal of the Royal Asiatic Society of Bengal awarded to Rai Bahadur K. C. Mehta, 553
Barium Sulphate : Electrokinetic Potential and Surface Structure of (A. S. Buchanan and Dr. E. Heymann), 649
Barium Titanate Crystals : Dielectric Constant and Piezo-Electric Resonance of (Bernd T. Matthias), 325
Barkhausen Discontinuities : Effect of Lattice Distortions on the Mean Rate of Propagation of Large (Dr. L. J. Dijkstra and Dr. J. L. Snoek), 886
Barley, Fifty Years of Observation and Experiment (Dr. E. S. Beaven), *review* by Sir John Russell, 828
Basal Cambrian in South Australia : Jellyfish from the (Reg. C. Sprigg), 568
Basidiomycetes with reference to some British Species : Distribution Patterns in European (R. W. G. Dennis), 1015
Bee Plants : British (edited by A. F. Harwood), 470
Behaviour (Human) : The Framework of (Dr. Julian Blackburn), *review*, 502
Behaviour of Crystal Boundaries in Metals : Mechanical (R. King, R. W. Cahn and Dr. B. Chalmers), 682
Beilby Memorial Awards, 231
Belgium : Grants for Scientific Research in, 634
Benzene Hexachloride : Polarographic Determination of the Gamma-Isomer of (G. B. Ingram and H. K. Southern), 437
Benzene Hexachloride in Soil : Persistence of D.D.T. and (Dr. M. S. Smith), 246
2-Benzoylbenzoic Acid and its Derivatives upon Plant Species : Differential Effect of (Dr. W. A. Sexton and Dr. W. G. Templeman), 974
3 : 4 Benzpyrene : Inhibition of the Photodynamic Action of (G. Calcutt and J. P. Newhouse), 53
Berek Type : A Large Field Compensator of the (W. A. P. Fisher), 848
Bernays Premium of the Society of Engineers awarded to Bernard Payne, 346

essemer Gold Medal for 1948 of the Iron and Steel Institute awarded to W. J. Dawson, 512
essemer Premium of the Society of Engineers awarded to C. D. Mitchell, 346
etatron : A 16-MeV. (K. J. R. Wilkinson, J. L. Tuck and R. S. Rettie), 472
  X-Radiation from a 20-MeV. (W. Bosley, Dr. J. D. Craggs, W. F. Nash and R. M. Payne), 1022
iaxial Crystals : A Simple Universal Model for Representing the Optic Orientation of (Dr. N. H. Hartshorne), 94
ibliographic Classification : A (Henry Evelyn Bliss), Vol. 2, Classes H–K, the Human Sciences, *review* by R. B., 705
ibliography of the Technical Literature on Silk (Dr. F. O. Howitt), *review* by Prof. J. B. Speakman, 790
icarbonate Concentrations : Influence of Low, on the Growth of a Green Alga (Sven Österlind), 319
ikini Bomb and the Seismology of the Pacific Region (Prof. K. E. Bullen), 62
ile Acids of the Whale (Dr. G. A. D. Haslewood and Veryan Wootton), 356
ilirubin-Serum Protein Complexes and the van den Bergh Reaction (C. H. Gray and Dr. R. A. Kekwick), 274
inley Lake : The Draining of, and its Ecological Consequences (Wing-Comdr. T. R. Cave-Browne-Cave), 420
inuclear Metallic Carbonyls and Nitrosyls : Constitution of certain (Dr. R. V. G. Ewens), 530
iochemical Reactions of Chemical Warfare Agents (Biochemical Society symposium on), 225
iochemistry : Annual Review of (edited by J. Murray Luck, Hubert S. Loring and Gordon Mackinney), Vol. 16, *review*, 870
iochemistry of Brain Tissue : Research on the, 346
iochemistry of Fats and Lipoids : Physiology and (Le Centre National de la Recherche scientifique symposium on), 534
iochemistry in Progress, *review*, 870
iochemistry in the University of California, 49
iological Applications of Ultra-violet and Infra-red Radiation, *review* by H. G. Jenkins, 542
iological Aspects of Water Pollution (Association of Applied Biologists symposium on), 874
iological Assay : Primary and Secondary Responses in (R. E. Blackith), 20
iological Interest : Nature of Forces between Large Molecules of (Prof. Linus Pauling), 707
iological Tissues as revealed by X-Ray Diffraction Analysis and Electron Microscopy : The Structure of (Prof. W. T. Astbury), 514
iologists in Search of Material (edited by Dr. G. Scott Williamson and Dr. I. H. Pearse), second edition, *review* by Dr. G. Lapage, 336
iology : Radioactive Tracers in (Prof. Martin D. Kamen), *review* by Prof. F. A. Paneth, 456
iology (Marine) : Recent Research in (Dr. N. B. Eales), 737
iology (Social) : The International and Cultural Relations of (British Social Hygiene Council Summer School on), 842
iology (Tidal) : Problems of (Prof. C. M. Yonge), 796
iology in Colonial Universities (Dr. E. B. Edney), 506
iology of Lice, 389
iology of the Louse, *review* by Dr. A. D. Imms, 418
iology for Medical and Intermediate Students : Practical (C. J. Wallis), second edition, *review* by Dr. P. D. F. Murray, 912
iophysical Research : Amphibian Tissue Cultures for (M. M'E. Preston), 203
.I.O.S. Overall Reports, 388
ird Recognition, I, Sea-Birds and Waders (James Fisher), *review* by Frances Pitt, 831
ird Watching (Stuart Smith), 554
irds : Edibility of the Eggs of (Dr. Hugh B. Cott), 8
irds, (British) : Feeding Times of (Rev. John Lees), 802
irds on Migratory and Homing Flights : Orientation of (Linnean Society discussion on), 996
irds of the Southwest Pacific (Ernst Mayr), *review* by Frances Pitt, 545
irefringence : A Large Field Compensator for Measurement of (P. E. Jellyman and A. J. Milne), 477 ; (A. A. Wells), 602
irth : Nicotinic Acid in Human Blood Cells at (R. F. A. Dean and W. I. M. Holman), 439
irth and Growth of the Explosion in Solids Initiated by Impact (Dr. F. P. Bowden and O. A. Gurton), 348
lack (James Tait) Memorial Prize for 1947 of the University of Edinburgh awarded to Dr. C. E. Raven, 390
lackett's Hypothesis of the Magnetic Field of Rotating Bodies (Dr. Niels Arley), 598 ; (Dr. J. Fuchs), 599
linking, its Role in Physical Measurements (Dr. Robert W. Lawson), 154
loat' in Cattle : A Possible Relation between the Action of Clover Juice on Isolated Muscle and (W. S. Ferguson), 816
lood of Malaria-infected Monkeys : Hæmolytic System in the (Dr. H. Laser), 560
lood Cells at Birth : Nicotinic Acid in Human (R. F. A. Dean and W. I. M. Holman), 439
lood Parasite of the Hagfish : *Trypanosoma heptatretæ* sp. n., a (Marshall Laird), 440
luteiweisskörper des Menschen : Die (Dr. F. Wuhrmann und Dr. Ch. Wunderly), *review*, 376
oard of Directors and Business Management (Melvin T. Copeland and Asst. Prof. Andrew R. Towl), *review* by E. F. L. Brech, 869
ody Temperature : Acetylcholine and (Prof. J. H. Burn and N. K. Dutta), 18
ond-forming Orbitals : A Correlation between Molecular Vibrations and (Dr. J. W. Linnett and P. J. Wheatley), 971
ond-Strength of C—Cd in Cadmium Methyl and of C—I in Methyl Iodide (A. S. Carson, K. Hartley and Dr. H. A. Skinner), 725
one : Failure of Sulphanilamide to Inhibit Calcification of (Dr. Zelma Baker Miller, Dr. Jerome Waldman and Prof. Franklin C. McLean), 274
  The Theory of Primary Calcification in (Dr. Marcel J. Dallemagne), 115
one Metabolism : Influence of Folliculin on, Studied by Means of Radio-phosphorus, $^{32}_{15}$P (Dr. J. Govaerts and Prof. M. J. Dallemagne), 977
ooks : Imports of Scientific and Technical, 75
  Importation of, into Britain : (Lord Balfour of Inchrye), 304 ; (Lord Chorley), 304
  Old Scientific and Natural History, 305
  Recent Scientific and Technical, Supp. ii, January 31 ; Supp. ii, February 28 ; Supp. ii, March 27 ; Supp. ii, April 24 ; Supp. ii, May 29 ; Supp. ii, June 26
Books, Periodicals and Newspapers : German (European Periodicals Publicity and Advertising Co., Ltd., First Post-War Exhibition of), 595
Borax Glasses containing Crystallites of Alkali Metal Salts, Gold and Platinum : Magnetic Susceptibility of (Prof. Subodh Kumar Majumdar), 684
Borderline of Psychology, Physics and Music (Acoustics Group of the Physical Society symposium on), 589
Boric Acid with Polysaccharides : Reaction of (Dr. H. Deuel, H. Neukom and F. Weber), 96
Botanical Nomenclature of the Shaddock or Pomelo (Dr. D. Chatterjee), 770
Botany : The Ecological Approach to (Dr. H. Godwin), 157
Botany at Bedford College, London, 427
Botany of the Living Plant (Prof. F. O. Bower), fourth edition, *review* by Prof. F. T. Brooks, 153
Bottom Deposits of Lake Windermere in relation to the Quaternary History of the British Isles (Dr. H. G. Baker), 987
Botulinum Toxin : Peripheral Action of (Dr. N. Ambache), 482
Boulder Clays : Long-Distance Correlation of (D. F. W. Baden-Powell), 287
Brain of Adult *Calliphora erythrocephala* Meig. : Effect of Removal of Neurosecretory Cells in the (Dr. Ellen Thomsen), 439
Brain in the Ape-Man, *Plesianthropus* : Size of the (Dr. R. Broom and J. T. Robinson), 438
Brain Lactate in Emotion (Dr. D. Richter and R. M. C. Dawson), 205
Brain Tissue : Research on the Biochemistry of, 346
Brain and Mind, *review* by Dr. O. A. Trowell, 498
Branched-Chain High Polymers (Prof. H. W. Melville and G. W. Youngson), 803
β-Brass by Cold Work : The Disordering of (R. W. K. Honeycombe and Dr. W. Boas), 612
Breakdown of Serpulid Tubes : Formation and (Jean Hanson), 610
Breeding of Avocets in Britain (P. E. Brown and E. Lynn-Allen), 271
Bridge Networks discriminating between Positive and Negative Sequences in Polyphase Supply (N. F. Barber), 685
Brightness of the New Moon (Dr. J. A. M. van Liempt), 27
Britain : Breeding of Avocets in (P. E. Brown and E. Lynn-Allen), 271
  The Deployment of Scientific Effort in, 1
  The Gas Industry in (Dr. E. V. Evans), 832
  Government Research in, 214
  Higher Technological Education in, 217 ; (University Grants Committee Sub-Committee on), 841
  Importation of Books into (Lord Balfour of Inchrye), 304 ; (Lord Chorley), 304
  The Land of—its Use and Misuse (Prof. L. Dudley Stamp), *review* by Sir John Russell, 906
  Land Use and Service Requirements in, 149
  Local Government in, 825
  Lyon Playfair and Technical Education in (W. H. G. Armytage), 752
  Mobility of Man-Power in, 453
  National Parks in, 783
  Radio Research in (Prof. J. Greig), 943
  Occurrence of the Amphipod *Orchestia bottæ* and other Organisms in (D. M. Reid), 609
  Second Occurrence and Persistence of the Amphipod *Orchestia bottæ* M. Edwards in (A. J. Cain and D. H. Cushing), 483
  Potato Blight and the Weather in (A. Beaumont), 429
  Regional Development Organisations in, 183
  See *also under* Great Britain
Britain's Fuel Problems (Dr. D. T. A. Townend), 669
Britain's Scientific War Effort, *review* by S. Weintroub, 907
British Anti-Lewisite (*B.A.L.*): Development of (Dr. R. H. S. Thompson), 226
British Armed Services : War-time Rheological Investigations for the (British Rheologists' Club meeting on), 252
British Bee Plants (edited by A. F. Harwood), 470
British Birds : Feeding Times of (Rev. John Lees), 802
British Civilization : Some Aspects of (Prof. H. J. Fleure), *review* by D. B. Harden, 746
British Colonial Development, 331
British Colonial Empire : Factors of Agricultural Production in the (Sir Frank Stockdale), 337
British Colonial Territories : Research and Development in, 141
British Colonies : Agricultural and related Products of the, 779
British Commonwealth Entomological Conference, 429
British Empire Forestry Conference : Fifth (Summary Report and Results and Reports of Committees), 449
British Fauna : The Field Study and Conservation of the (Association of British Zoologists discussion on), 408
  Synopses of the (Linnean Society), 594
British Fishes : The Trematoda of (Dr. Ben Dawes), *review* by Dr. G. Lapage, 222
British Forces : The Rocket as a Weapon of War in the (Sir Alwyn Crow), 329
British Forestry : Practical (C. P. Ackers), second edition, *review* by Prof. E. P. Stebbing, 295
British Fuel and Power Industries (Political and Economic Planning Report on), 669
British Grid System : Load Dispatching and the (A. R. Cooper), 822
British Groups : The Study of Critical (Botanical Society of the British Isles conference on), 514, 733
British Guiana : Animal Health in (Prof. W. C. Miller), 345
British International Plastics Annual 1947, *review* by Dr. S. R. Carter, 581
British Isles : Bottom Deposits of Lake Windermere in relation to the Quaternary History of the (Dr. H. G. Baker), 987
  Geographical Approach to the History of the, *review* by D. B. Harden, 746
British Laminariales : Seasonal Variation in Chemical Constitution of some Common (Dr. W. A. P. Black), 174
British Men of Science : American Awards to, 215, 390, 716, 800
British Research in the Radio Field (Research Committee of the Institution of Electrical Engineers), 943
British Rocket Weapons Research (R. H. Macmillan), 329
British Scientific Instruments (Dr. A. B. Wood), 732
  Export Organisation for, 345

British Scientific Workers : American Awards to, 215, 390, 716, 800
British Seismological Observatories, 923
British Somali Place Names : A Gazetteer of, 195
British Somaliland : Report on the General Survey of (1945), 195
British Sources of Reference and Information (edited by Theodore Besterman), *review* by R. Brightman, 789
British Standard 1313 : 1947, Quality Control, 50
British Standard 1335 : 1946, Air-depolarized Primary Cells, 51
British Waters : Occurrence of *Elminius modestus* (Darwin) in (D. J. Crisp and P. N. J. Chipperfield), 64
British Zone of Germany : Scientific Research in the (Prof. F. A. Paneth), 191
Bromate Effect : Studies on the Nature of the (Dr. Holger Jørgensen), 294
Bronze Medal of the Royal Aeronautical Society awarded to Miss F. B. Bradfield, 593
Bronze Star awarded to Peggy Furse by the Government of the United States, 716
Brown Alga under Continuous Flow Conditions : Adsorption of Calcium Ions by an Acid-extracted (Dr. A. Wassermann), 562
Brownian Motion in Sensory Processes : Minimum Perceptible Energy and (Dr. Hl. de Vries), 63
Brucine : Relation of Vomicine to Strychnine and (Dr. A. S. Bailey and Sir Robert Robinson), 433
Bruhl (Paul Johannes) Memorial Medal of the Royal Asiatic Society of Bengal awarded to Prof. S. R. Bose, 553
Bulb Formation in the Shallot (Dr. L. G. G. Warne), 935
Bunsen Flame as a Column of Luminous Gas (Dr. A. S. Leah and Prof. W. T. David), 524
Burma (Lower) : Results of the Continuous Use of an Ammonium Phosphate Fertilizer on Rice in (D. Rhind and U Tin), 105
Burma and Netherlands India : Colonial Policy and Practice, a Comparative Study of (J. S. Furnivall), *review* by Maurice Bruce, 908
Business Management : The Board of Directors and (Melvin T. Copeland and Asst. Prof. Andrew R. Towl), *review* by E. F. L. Brech, 869
Busk (Edward) Memorial Prize of the Royal Aeronautical Society awarded to Air Marshal the Hon. Sir Ralph Cochrane, 593
Busk Studentship in Aeronautics, 595
Butterflies : Natural History of, 636
Butterfly Migration (Dr. C. B. Williams), 636

CADMIUM Methyl : Bond-Strength of C—Cd in, and of C—I in Methyl Iodide (A. S. Carson, K. Hartley and Dr. H. A. Skinner), 725
Calcification of Bone : Failure of Sulphanilamide to Inhibit (Dr. Zelma Baker Miller, Dr. Jerome Waldman and Prof. Franklin C. McLean), 274
Calcification in Bone (Primary) : The Theory of (Dr. Marcel J. Dallemagne), 115
Calcium Deficiency on Potato Sets in Acid Soils : Effects of (Prof. T. Wallace and E. J. Hewitt), 28
Calcium Ions : Adsorption of, by an Acid-extracted Brown Alga under Continuous Flow Conditions, (Dr. A. Wassermann), 562
Calcium Ions on the Charge of Myosin : Effect of (Olle Snellman and Thomas Erdös), 526
Calcium Fluoride Films Evaporated on Polished Glass Surfaces : Structure of (J. Bannon and C. E. Curnow), 136
Calcium-Deficient Media—their Effect on Phage Action (H. Williams Smith), 397
Calculating Machines (Royal Society discussion on), 712
Calculus : Advanced (Prof. David V. Widder), *review* by J. H. Pearce, 188
    Differential and Integral, Functions of One Variable (Prof. Francis D. Murnaghan), *review* by F. G. W. Brown, 261
Calculus based on the Fundamental Concept of Number, *review* by F. G. W. Brown, 261
Calcutta : Abnormalities in the *F*-Region of the Ionosphere at (S. S. Baral, S. N. Ghosh and M. Debray), 24
Calliphora erythrocephala Meig. : Effect of Removal of Neurosecretory Cells in the Brain of Adult (Dr. Ellen Thomsen), 439
Calorie Values : Energy-Yielding Components of Food and Computation of (Food and Agriculture Organisation of the United Nations), 306
Calories : Food, 306
'Calyx' Burner to Determine Combustion Conditions : Use of (H. Rostron Hindley), 395
Cambrian (Basal): Jellyfish from the, in South Australia (Reg. C. Sprigg), 568
Cambridge : Plant Virus Research at (Dr. Kenneth M. Smith), 776
    Sons of, *review* by Prof. F. J. M. Stratton, 661
Cambridge Archæological Expedition to Cyrenaica (C. B. M. McBurney, R. W. Hey and W. Watson), 327
Canada (Prof. Griffith Taylor), *review*, 912
Canada : Corrosion Research in, 553
    Radio and Electrical Research in, 513
Canada East of the Rocky Mountains : Handbook of the Trees of the Northern States and (Romeyn Beck Hough), *review* by Sir Edward Salisbury, 497
Canadian Mathematical Congress, Montreal 1945 : Proceedings of the First, *review* by H. T. H. P., 666
Canadian Rockies (Northern) : Exploration of the Lloyd George Mountains in the (Dr. N. E. Odell), 327
Cancer : The Genetics of (Genetical Society of Great Britain and the British Empire Cancer Campaign symposium on), 843
    Nutrition in relation to (New York Academy of Sciences symposium on), 106
Cancer (Adrenal) : Isolation of a New Androstenol-3(α)-on-17 from the Urine of a Patient with (Dr. Elizabeth Dingemanse, Leonora G. Huis in 't Veld and S. Lore Hartogh-Katz), 848
Cancer Death Rates: Regional and Local Differences in (Dr. Percy Stocks), 17
Cancer et hormones : Radiophysiologie expérimentale, 6, Étude de la cancérisation par les substances chimiques exogènes (Antoine Lacassagne), *review* by Prof. E. Boyland, 621
Cancer Research : Progress of (Dr. I. Hieger), 385
Cancérisation par les substances chimiques exogènes : Radiophysiologie expérimentale, cancer et hormones, 6, Étude de la (Antoine Lacassagne), *review* by Prof. E. Boyland ,621

Cantabrigienses : Alumni (compiled by Dr. J. A. Venn), Part 2, From 1752 to 1900, Vol. 3, Gabb—Justamond, *review* by Prof. F. J. M. Stratton, 661
Cantal Region, Central France : Mr. E. Westlake and the Geology of the (G. Maynard and Aubrey T. Westlake), 485
Capillarity and Temperature in Clays : Relationships of Vapour Pressure, (B. Vassiliou and Dr. J. White), 487
Capillary Distribution in Cow Skin (Dr. J. D. Findlay and S. H. Yang), 1012
Capture of Negative Mesons by Nuclei (A. S. Lodge), 809
Capture of 220 and 900 keV. Neutrons : Comparison of Cross-sections for the (R. Allen, G. R. Bishop, P. Demers and Dr. H. Halban), 727
C^{14}-Labelled Ethyl Iodide : Microsynthesis of (Dr. W. J. Arrol and Raymond Glascock), 932
C—C Bond in Diphenyl : Energy of the Central (Dr. M. Szwarc), 890
C—Cd in Cadmium Methyl and of C—I in Methyl Iodide : Bond-Strength of (A. S. Carson, K. Hartley and Dr. H. A. Skinner), 725
Carbon–Carbon Double Bonds : Mechanisms of Reactions at (Prof. Charles C. Price), *review* by Dr. J. Sheridan, 626
Carbon Dioxide : Regeneration of Prothrombin Activity by (I. M. Chak and Dr. K. V. Giri), 354
Carbon Dioxide Concentration in Photosynthesis of Foliage Leaves : Threshold Value of (Dr. E. K. Gabrielsen), 138
Carbon Dioxide Content of the Air : Studies in Stomatal Action—Control of Stomatal Movement by a Reduction in the Normal (Dr. O. V. S. Heath), 179
C—I in Methyl Iodide : Bond-Strength of C—Cd in Cadmium Methyl and of (A. S. Carson, K. Hartley and Dr. H. A. Skinner), 725
Carbonyls and Nitrosyls (Binuclear Metallic) : Constitution of certain (Dr. R. V. G. Ewens), 530
Cardamine pratensis : Chromosome Number of (Dr. H. W. Howard), 277 ; (F. Hussein), 1015
Care and Management of Laboratory Animals : The UFAW Handbook on the (edited by Prof. Alastair N. Worden), *review* by Frances Pitt, 664
Caribbean : Democracy and Empire in the (Paul Blanshard), 948
Carotenoids of the Locust Integument (T. W. Goodwin and S. Srisukh), 525
Casein (Iodinated) : Stimulation of Growth in Pigs by, and Stilbœstrol (Dr. R. Braude), 856
Cat Guide to the Study of the Anatomy of the Shark, *Necturus*, and the (Prof. Samuel Eddy, Prof. Clarence P. Oliver and Prof. John P. Turner), second edition, *review* by Dr. P. D. F. Murray, 955
Catalase and Hydrogen Peroxide : Reaction between (R. Lemberg and E. C. Foulkes), 131
Catalase and Peroxides : The Enzyme-Substrate Compounds of (Britton Chance), 914
Catalysis (Heterogeneous) : Adsorption and (Prof. Eric K. Rideal), 461
Catalytic Poisons and Magnetic Susceptibility (M. H. Dilke, Dr. D. D. Eley and Dr. E. B. Maxted), 804
Cathode : The Thermionic, *review* by D. A. Wright, 500
Cathode Surface Area : Electron Multiplier Tube of Large Effective (P. S. Faragó), 60
Cathodes chaudes : Les (Charles Biguenet), *review* by D. A. Wright, 500
Cathodes under Electron Bombardment : Electron Emission from Oxide-coated (T. J. Jones), 846
Cattle : Isolation in Chick Embryos of a Filtrable Agent possibly related etiologically to Lumpy Skin Disease of (Prof. M. van den Ende, P. Don, A. Kipps and R. Alexander), 526
    A Possible Relation between the Action of Clover Juice on Isolated Muscle and 'Bloat' in (W. S. Ferguson), 816
Cattle Health and Milk Production, 1005
Cattle Trypanosomiasis : Control of (R. N. T.-W.-Fiennes), 602
Caves : My (Norbert Casteret), translated by R. L. G. Irving, *review*, 830
Cell Counts : Economy in (Dr. B. Woolf), 361
Cell Walls of Tracheids and Wood Fibres : Organisation of the (A. B. Wardrop and Dr. R. D. Preston), *erratum*, 90
Cells (Plant and Animal) : Photo-electric Counting of Individual Microscopic (Carl Lagercrantz), 25
Cellulose Acetate Moulds : Recording Crevices in Plane Surfaces by Pigment-fillings held in (Dr. A. T. J. Dollar), 358
Cementiferous Paints and their Uses (Prof. G. Wesley Austin), 569
Centenaries in 1948 : Scientific (Eng.-Capt. Edgar C. Smith), 11
Centimetre Wave-lengths : Electrical Properties of Soil and Water at, 73
    Gas discharges at (W. A. Prowse and R. Cooper), 310
    Measurement of High Permittivity Values at (J. G. Powles), 25
Central Africa : Research in, 230
Central American Culture : Origins of, 594
Central Government : The Efficiency of the (D. N. Chester), 496
Centrifuge (Counter-streaming) : Principle of a, for the Separation of Particles of Different Sizes (Per Eric Lindahl), 648
Ceramic Complex of La Venta : Some Implications of the (Dr. Philip Drucker), 594
Cereal Chemistry : Modern (Dr. D. W. Kent-Jones and Dr. A. J. Amos), fourth edition, *review* by A. L. Bacharach, 293
Cereal Rusts as Exemplified in the Leaf Rust of Wheat : The Nature and Prevention of (Dr. K. Starr Chester), *review* by P. H. Gregory, 220
Cerebro-Spinal Fluid : Cholinesterase Activity in (Dr. M. Reiss and R. E. Hemphill), 18
Cestodes *in vitro* : Development of—Production of Fertile Eggs ; Cultivation of Plerocercoid Fragments (Dr. J. D. Smyth), 138
Cetacea : Hearing in (Robert Clarke), 979
Chaetomium-like Thermophile Fungus (C. J. La Touche), 320
Chalk : Wild Flowers of the (John Gilmour), *review*, 188
Champs macroscopiques : Théorie des (Prof. Jean Mariani), 450
Ch'ang Shan (*Dichroa febrifuga*), a Chinese Antimalarial Herb (Dr. C. S. Jang, F. Y. Fu, K. C. Huang and C. Y. Wang), 400 ; (T. S. Work), 401
Charge of Myosin : Effect of Calcium Ions on the (Olle Snellman and Thomas Erdös), 526
Chemical Activities of Bacteria (Dr. Ernest F. Gale), *review* by Dr. H. K. King, 78
Chemical Bonds between Them : Beta-quinol, an Example of the Firm Union of Molecules without the Formation of (H. M. Powell and P. Riesz), 52
Chemical Breakage of Chromosomes (C. B. Allsopp and Dr. D. G. Catcheside), 1011
Chemical Composition of Plants as an Index of their Nutritional Status (Dr. D. W. Gooda and Dr. F. G. Gregory), 406

Chemical Compounds : Induction of Tumours by, *review* by Prof. E. Boyland, 621
  The Theory of Valency and the Structure of (Prof. P. Ray), *review*, 460
Chemical Congress : The Fourth South American, 654
Chemical Constitution of some Common British Laminariales : Seasonal Variation in (Dr. W. A. P. Black), 174
Chemical Effects of Ionizing Radiations (Gabriel Stein and Dr. Joseph Weiss), 650
Chemical Engineering Fundamentals (Chalmer G. Kirkbride), *review* by Prof. H. E. Watson, 911
Chemical Engineering and Fuel Technology at the University of Durham, 965
Chemical Mechanism of Permanent Set (A. J. Farnworth and Prof. J. B. Speakman), 890
Chemical Promotion of Rooting in Plants, *review* by Prof. M. Thomas, 993
Chemical Reactions : Electronic Theory and (R. W. Scott), second edition, *review* by Prof. E. D. Hughes, 503
Chemical Research : Ramsay Memorial Fellowships for, 272
Chemical Theory : Foundations of (Charles Simpson), *review*, 503
Chemical Warfare Agents : Biochemical Reactions of (Biochemical Society symposium on), 225
Chemicals, Humus and the Soil (Donald P. Hopkins), *review*, 39
Chemistry : Education in—the Teaching of Chemistry in Schools and the Training of Chemists and Chemical Technicians for Industry (British Association of Chemists), 31
  Fundamental (Prof. Horace G. Deming), second edition, *review* by Dr. S. H. Harper, 992
  General (Prof. Linus Pauling), *review* by Dr. S. H. Harper, 992
  Humour and Humanism in (Prof. John Read), *review* by Denis I. Duveen, 869
  Modern Cereal (Dr. D. W. Kent-Jones and Dr. A. J. Amos), fourth edition, *review* by A. L. Bacharach, 293
  Practical (John Lambert and T. A. Muir), *review* by Dr. S. H. Harper, 992
  Practical Physiological (Dr. Philip B. Hawk, Dr. Bernard L. Oser and Dr. William H. Summerson), twelfth edition, *review*, 830
  Summer School in, 390
  Synthetic Resin (Dr. S. R. W. Martin), *review* by Dr. P. D. Ritchie, 502
Chemistry (Inorganic) : Modern Advances in (E. B. Maxted), *review* by G. R. Martin, 335
Chemistry (Organic) : Elsevier's Encyclopædia of (edited by E. Josephy and F. Radt), Series 3, Carboisocyclic Condensed Compounds, Vol. 13, Tricyclic Compounds, *review* by Prof. J. W. Cook, 415
  Scope of (Sir Robert Robinson), 508
Chemistry (Physical) : A Text Book of (Dr. N. C. Sen Gupta and K. C. Sen), new edition, *review*, 460
Chemistry (Practical Organic) : A Text-Book of (Dr. Arthur I. Vogel), *review* by Prof. J. W. Cook, 995
Chemistry for Matriculation (Dr. G. H. Bailey and H. W. Bausor), fourth edition, *review* by Dr. S. H. Harper, 992
Chemistry from the School to the University, *review* by Dr. S. H. Harper, 992
Chemistry for Schools (C. Jenkins and E. H. Foinette), Part 3, *review* by Dr. S. H. Harper, 992
Chemistry in combating Tropical Diseases : The Role of (Sir Ian Heilbron), 956
Chemistry at Dublin : Summer School in, 390
Chemistry at the University of Liverpool, 715
Chemistry at University College, Dundee, 715
Chemistry at University College, London, 511
Chemistry at University College, Swansea, 1004
Chemistry of Visual Processes (S. Ball, F. D. Collins, Prof. R. A. Morton and Dr. A. L. Stubbs), 424 ; (Dr. M. H. Pirenne), 724
Chemists : Training for (Dr. E. J. Holmyard), 31
Chemotherapeutic Agents for *Trypanosoma congolense* Infections : Cinnoline Derivatives as (J. R. Keneford, Dr. E. M. Lourie, J. S. Morley, J. C. E. Simpson, J. Williamson and P. H. Wright), 603, 758
Cherán, a Sierra Tarascan Village (Ralph L. Beals), 697
Chick Embryos : Isolation in, of a Filtrable Agent possibly related etiologically to Lumpy Skin Disease of Cattle (Prof. M. van den Ende, P. Don, A. Kipps and R. Alexander), 526
Child (School) : The Health of the (Dr. Robert Sutherland), 960
Chimie organique (Prof. A. Kirrmann), 1, Chimie organique générale, 2, Fonctions simples, *review* by Dr. S. H. Harper, 992
China : Discovery of a Living *Metasequoia* in (Prof. E. D. Merrill), 594
China (Ancient) : Science and Society in (Dr. Joseph Needham), 305
Chinese Antimalarial Herb : Pharmacology of Ch'ang Shan (*Dichroa febrifuga*), a (Dr. C. S. Jang, F. Y. Fu, K. C. Huang and C. Y. Wang), 400 ; (T. S. Work), 401
Chloride in *Metapenæus monoceros* Fabricius : Active Regulation of (N. Kesava Panikkar and R. Viswanathan), 137
Chlorides (Rare-Earth) : Preparation of (F. R. Hartley and A. W. Wylie), 241
Chlorine in Fasting Rats : Premortal Increase in the Output of Sodium and (Dr. Peter Bálint and Dr. Helene Kabdebó), 57
ClO in Flames : Band Spectrum of (Dr. G. Pannetier and Dr. A. G. Gaydon), 242
α-Chloroacids : Raman Spectra of some Synthetic Mixtures of (Dr. Marcel Renard), 354
Choleglobin Formation in the Erythrocyte (C. Gardikas, Dr. J. E. Kench and Prof. J. F. Wilkinson), 607
Cholera Infection (Human) : A New Sulpha Compound ('6257') and its Use in (Dr. S. S. Bhatnagar, F. Fernandes, J. de Sa and P. V. Divekar), 395
Cholinesterase Activity in Cerebro-Spinal Fluid (Dr. M. Reiss and R. E. Hemphill), 18
Choline Esterase Activity of Serum : Effect of Under-nutrition and Alterations in Diet on the (Prof. R. A. McCance, E. M. Widdowson and A. O. Hutchinson), 56
Chromatic Aberration of Electrostatic Lenses (W. A. Le Rütte), 392
Chromatogram (Paper) : Separation and Identification of Methylated Sugars on the (F. Brown, Prof. E. L. Hirst, L. Hough, Dr. J. K. N. Jones and H. Wadman), 720
Chromatographic Estimation of α-Amino-Acids : Quantitative (Dr. L. Naftalin), 763
Chromatographical Study of Meristematic Plant Tissues (Dr. A. Allsopp), 833
Chromatography : A Modified Technique in Filter-Paper (L. Rutter), 435
  Micro-Estimation of Amino-Nitrogen and its Application to Paper Partition (A. J. Woiwod), 169
  Quantitative Paper (R. B. Fisher, D. S. Parsons and G. A. Morrison), 764
  Use of Ultra-Violet Fluorescence in Paper (D. M. P. Phillips), 53
Chromatography of Anthocyanins and related Substances in Petal Extracts : Paper (E. C. Bate-Smith), 835
Chromatography of Flavine Nucleotides : Paper (Dr. J. L. Crammer), 349
Chromatography of Sugars : Colour Reagents for the Paper (Dr. W. G. C. Forsyth), 239
Chromosomal Evolution in the European Mole-Cricket (Tuviah Kushnir), 531
Chromosome Multiplication and Reduction in Somatic Tissues (Prof. C. Leonard Huskins), 80
Chromosome Number of *Cardamine pratensis* (Dr. H. W. Howard), 277 ; (F. Hussein), 1015
Chromosome Number of *Sesamum laciniatum* Klein (Dr. S. Ramanujam and A. B. Joshi), 99
Chromosomes : Chemical Breakage of (C. B. Allsopp and Dr. D. G. Catcheside), 1011
Chronicle and Commentary, *review* by Maurice Bruce, 151
Chronometric Observations of the Song of *Fringilla coelebs* Linn. (D. R. Barber), 277
Chrysanthemum and the Sword (Ruth Benedict), *review* by Peter Lawrence, 77
Church and the Atom, a Study of the Moral and Theological Aspects of Peace and War (Church Assembly), 990
Ciliate Protozoan Fauna of Soil and Inland Waters (Ernest Gray), 854
Cinnoline Derivatives as Chemotherapeutic Agents for *Trypanosoma congolense* Infections (J. R. Keneford, Dr. E. M. Lourie, J. S. Morley, J. C. E. Simpson, J. Williamson and P. H. Wright), 603, 758
Circulation (Renal) : Studies of the (Dr. Josep Trueta, Dr. Alfred E. Barclay, Dr. Kenneth J. Franklin, Peter M. Daniel, Marjorie M. L. Prichard), *review*, 663
Citizen : Local Government and the, *review* by Lieut.-Colonel Eric Lowe, 870
Citizenship in Africa : Education for (Colonial Office Advisory Committee on Education in the Colonies), 948
Citizenship and Current Affairs in Army Education (Lieut.-Colonel Eric Lowe), 444
Citric Acid in Semen (G. F. Humphrey and Dr. T. Mann), 352
City ! : X-Ray the (Dr. Ernest Fooks), *review* by R. Brightman, 297
Civil Service in the Changing State (H. R. G. Greaves), 496
Civilization : Freedom and (Bronislaw Malinowski), *review* by Dr. E. R. Leach, 457
Civilization (British) : Some Aspects of (Prof. H. J. Fleure), *review* by D. B. Harden, 746
Clanship among the Tallensi : The Dynamics of (Dr. Meyer Fortes), *review* by Dr. A. I. Richards, 111
Classification : A Bibliographic (Henry Evelyn Bliss), Vol. 2, Classes H—K, the Human Sciences, *review* by R. B., 705
Clay Minerals : Theory of the Structure of—Tailed X-Ray Reflexions from Random Layer Lattices (Dr. A. J. C. Wilson), 773 ; Banded X-Ray Reflexions from Clay Minerals (Dr. G. W. Brindley and J. Méring), 774
Clays : Relationships of Vapour Pressure, Capillarity and Temperature in (B. Vassiliou and Dr. J. White), 487
Clayton Fellowships for 1948 (Institution of Mechanical Engineers), 470
Clayton Prize for 1947 of the Institution of Mechanical Engineers awarded in two equal moieties to J. E. Sears and T. E. Beacham, 470
Cleaning and Sterilizing of Plant in the Food Industry (Royal Sanitary Institute and the Food Group of the Society of Chemical Industry discussion on), 1025
Cliff near Plymouth : A Submerged Ancient (Dr. L. H. N. Cooper), 280
Climates (Hot) : Medical Diseases in, *review* by Dr. N. Hamilton Fairley, 499
Climatic Fluctuations : Recent (L. Lysgaard), 442
Climatic Fluctuations and Vegetation Growth in Northern Finland : Northern Hemisphere Surface Pressure and (G. W. Brier), 730
Climatic and Ecological Changes in Northern Waters, 428
Cloches : Crop Production in Frames and (Ministry of Agriculture Bulletin 65), 196
Cloud Chamber Investigation of Straggling of Short-Range Particles produced by Slow Neutron Reactions (Dr. J. K. Bøggild), 810
Clover Juice on Isolated Muscle and 'Bloat' in Cattle : A Possible Relation between the Action of (W. S. Ferguson), 816
Coats Fellowships at Glasgow, 164
Coefficient of Viscous Extension (Dr. K. H. Swainger), 650
Coefficients of Viscosity and Thermal Conduction in Dense Gases and Liquids (L. M. Yang), 523
Coelom-Dwelling Trematode : A Rare (Dr. Ben Dawes), 642
Coffea arabica L. : Latent Infection in (R. W. Rayner), 245
Coincidence Device of 10^{-8}–10^{-9} Sec. Resolving Power (Z. Bay and G. Papp), 59
Colchicine, its Chemical and Biological Properties (Prof. J. W. Cook), 554
Colchicine Treatment on the Alkaloidal Content of *Datura metel* : Effect of (A. E. Beesley and Dr. G. E. Foster), 561
Cold : The Common (Dr. G. Lapage), 328 ; (Dr. C. H. Andrews), 328
Cold Work : The Disordering of β-Brass by (R. W. K. Honeycombe and Dr. W. Boas), 612
Cold-Worked Austenitic Stainless Steels : Ferromagnetic Structure of (P. T. Hobson and W. P. Osmond), 562
Collector's Trail : A, *review* by Frances Pitt, 222
Collision Broadening of the Ammonia Inversion Spectrum at High Pressures (Dr. B. Bleaney and J. H. N. Loubser), 522
Colloidal Solution in a Magnetic Field : Optical Transmission of a (F. D. Stott and Dr. A. von Engel), 728
Colombia : Earthquake at Pasto on July 15, 657
Colonial Administration by European Powers (José de Almada, Robert Godding, Lord Hailey, A. M. Joekes and H. Laurentie), 372
Colonial Development : British, 331
  Education and, 947
Colonial Development and International Co-operation, 371
Colonial Empire, 1939–1947 (Colonial Office), 332
Colonial Empire (British) : Factors of Agricultural Production in the (Sir Frank Stockdale), 337

Colonial Geological Survey Service, 50
Colonial Policy and Practice, a Comparative Study of Burma and Netherlands India (J. S. Furnivall), *review* by Maurice Bruce, 908
Colonial Research 1946–47, 14
Colonial Territories (British) : Research and Development in, 141
Colonial Universities : Biology in (Dr. E. B. Edney), 506
Colonies (British) : Agricultural and related Products of the, 779
Colorimetry (Photo-electric) : Units and Useful Range in (Dr. Walter Koch and Dr. Deborah Kaplan), 247 ; (Dr. J. R. Edisbury, R. J. Taylor and N. T. Gridgeman), 247
Colostrum : Electrophoretic Patterns of Lamb Serum Before and After Transfer of (P. A. Charlwood and A. Thomson), 59
Colour Reagents for the Paper Chromatography of Sugars (Dr. W. G. C. Forsyth), 239
Colour Vision : Race, Pigmentation and (Dr. R. W. Pickford), 687
Columbus : Indians before (Paul S. Martin, George I. Quimby and Donald Collier), *review* by Dr. G. H. S. Bushnell, 501
Combustion Conditions : Use of 'Calyx' Burner to determine (H. Rostron Hindley), 395
Combustion and Flame and Explosion Phenomena (University of Wisconsin symposium on), 307
Combustion and Ignition Reactions in the Gas Phase : The Kinetics and Mechanism of (International symposium on), 347
Comet 1947*n* : Orbit and Ephemeris for, 17
Commentary : Chronicle and, *review* by Maurice Bruce, 151
Commerce : Education in Industry and, 801
Commercial Air Routes : Aerobiology on (Dr. I. V. Newman), 275
Common Sense : Time Study and (Abraham Cohen), *review* by J. Leigh, 910
Commonwealth Entomological Conference : Fifth British, 429
Community : Engineers and the (Dr. Harold Hartley), 1005
Compensator of the Berek Type : A Large Field (W. A. P. Fisher), 848
Compensator for Measurement of Birefringence : A Large Field (P. E. Jellyman and A. J. Milne), 477 ; (A. A. Wells), 602
Competition in Tubular Excretion : Specific and Non-specific (I. Sperber), 236
Complexities of Human Structure : Some (Dr. W. L. H. Duckworth), 628
Complexity of Fresh *Hevea* Latex (L. N. S. Homans, J. W. van Dalfsen and G. E. van Gils), 177
Composts : Aerobic Mesophilic Bacteria in (D. M. Webley), 174
Concentration of the Heavy Isotopes of Oxygen and Hydrogen : Fractional Distillation and its Application in the (Dr. I. Dostrovsky, Prof. E. D. Hughes and Dr. D. R. Llewellyn), 858
Condensation of 2 : 4 : 5-Triamono-6-hydroxypyrimidine with Glucose and Fructose (H. S. Forrest and Dr. James Walker), 308
Conditional Disposition to Infectious Diseases : Thyroid Gland as a Special Factor Influencing the (Dr. S. Zimanyi), 57
Conductance by Hydrogen and Hydroxyl Ions in Aqueous Solutions : Mechanism of (Dr. S. I. Weissman), 241
Configuration of Synthetic Œstrogens (H. P. Koch), 309
Conflicts : Our Inner (Dr. Karen Horney), *review* by Dr. Clifford Allen, 830
Conjugation of Linoleic Acid in Oxidation with Lipoxidase : Total (Prof. Sune Bergström and Ralph T. Holman), 55
Conscious Animal : Electrical Stimulation of the Neurohypophysis in the (G. W. Harris), 739
Conscription and Industry (D. R. O. Thomas), 304
Conservation of the British Fauna : The Field Study and (Association of British Zoologists discussion on), 408
Conservation and Utilization of Resources (United Nations conference on the), 617
Consolidated Gold Fields of South Africa, Ltd. Gold Medal awarded jointly to Dr. Anthony Caplan and J. K. Lindsay, 924
Constitution of certain Binuclear Metallic Carbonyls and Nitrosyls (Dr. R. V. G. Ewens), 530
Constitution of Monazite (Dr. A. W. Wylie), 97
Contact Laminated Plastics, *review* by J. M. J. Estevez, 788
Continents and Ocean Bottoms : Ground Blocks of the (Prof. H. Cloos), 71
Continuous Flow Conditions : Adsorption of Calcium Ions by an Acid-extracted Brown Alga under (Dr. A. Wassermann), 562
Continuous Spectra : Smoothing Periodograms from Time-Series with (Prof. M. S. Bartlett), 686
Convalescence : Metabolic Aspects of (M. W. Grant), 535
Conversion of *D*-Arabinose into 2-Deoxy *D*-Ribose and 3-Deoxy *D*-Xylose (Dr. P. W. Kent, Prof. M. Stacey and Dr. L. F. Wiggins), 21
Conway Memorial Lecture (Dr. Joseph Needham), 305
Co-operation between Medical and Agricultural Physiology, *review*, 113
Co-operation in Science : World (Prof. J. D. Bernal), 840
Co-operation (Industrial) : The Short Road to (British Association for Commercial and Industrial Education), 571
Coopers Hill War Memorial Prize and Medal for 1946 of the Institution of Electrical Engineers awarded to E. C. Cherry, 90
Copepoda : The Free-Swimming Planktonic (Lieut.-Colonel R. B. Seymour Sewell), 822
Copepods : Sex Reversal in (J. G. Cattley), 937
Copper : Amalgamation of some Alloys of Gold, Silver and (Dr. Douglas Rennie Hudson), 288
Copper Protein in Serum : Histaminolytic Activity of a (Dr. C. G. Holmberg and C.-B. Laurell), 236
Corn (*Zea Mays* L.) Genetics in the United States (Gordon Haskell), 42
Cornwall : Devon and (Survey Committee of the University College of the South-West, Exeter), *review* by Prof. L. Dudley Stamp, 786
Correlation of Boulder Clays : Long-Distance (D. F. W. Baden-Powell), 287
Correlation between Molecular Vibrations and Bond-forming Orbitals (Dr. J. W. Linnett and P. J. Wheatley), 971
Correlation between Respiratory Inhibition of Plasmodia by Acridines and Antimalarial Action : Absence of (Dr. Adrien Albert and P. B. Marshall), 1008
Corrosion : Stress (J. C. Chaston), 891
Corrosion Research in Canada, 553
Cosmic and Human Life : Atomic Energy in (Prof. George Gamow), *review* by Prof. J. A. Crowther, 4
Cosmic Radio Noise : Frequency Variation of the Intensity of (Jack W. Herbstreit and Joseph R. Johler), 515
Cosmic Ray Particle : A Doubly Charged (A. B. Sahiar), 811
Cosmic Rays (Colston Research Society symposium on), 125
Cosmic Rays (Prof. L. Jánossy), *review* by Prof. T. G. Cowling, 785
  Electrons (+ and —), Protons, Photons, Neutrons, Mesotrons and (Robert Andrews Millikan), revised edition, *review* by Dr. L. G. H. Huxley, 789
  High-Altitude Measurements on—Penetrating Bursts (Dr. E. P. George and P. T. Trent), 248
  High-Altitude Measurements on—Penetrating Cosmic Ray Showers (Dr. E. P. George and A. C. Jason), 248
  Production of Helium by (H. E. Huntley), 356
Cosmic Rays—Double Stars : Anomalous Distribution of Nuclear Disintegration in Photographic Emulsions Exposed to (L. Leprince-Ringuet and J. Heidmann), 844 ; (T. T. Li and D. H. Perkins), 844
Cosmic Rays and the Magnetic Field of the Moon (Dr. M. S. Vallarta), 646
Cosmos : The Matter-Radiation Cycle in the (and the Second 'Law')—the Sun's Equilibrium (Alfred Lauck Parson), 802
Cote des Esclaves : La Géomancie à l'ancienne (Bernard Maupoil), *review* by G. I. Jones, 663
Cotton Wool Plugs : Unsaturated Fatty Acids in (Dr. M. R. Pollock), 853
Counter-streaming Centrifuge for the Separation of Particles of Different Sizes : Principle of a (Per Eric Lindahl), 648
Counting of Individual Microscopic Plant and Animal Cells : Photo-electric (Carl Lagercrantz), 25
Country : Trees for Town and (Brenda Colvin and Jaqueline Tyrwhitt), *review* by Sir Edward Salisbury, 497
Country Life : Early English, *review* by Sir John Russell, 701
Country Worker : Housing the (Michael F. Tilley), *review* by R. B., 665
Countryside : The Right Way to Understand the (Stanley A. Manning), *review* by T. H. Hawkins, 995
Courageous : The New (John Maude), 414
Cow Skin : Capillary Distribution in (Dr. J. D. Findlay and S. H. Yang), 1012
Creep in Metals : Theories of, 233
Crepis : The Genus (Ernest Brown Babcock), *review* by Prof. I. Manton, 455
Crevices in Plane Surfaces by Pigment-fillings held in Cellulose Acetate Moulds : Recording (Dr. A. T. J. Dollar), 358
Critical British Groups : The Study of (Botanical Society of the British Isles conference on), 514, 733
Critical Temperature and Molecular Weight of *n*-Paraffins (L. Grunberg and Dr. A. H. Nissan), 170
Cronulla, New South Wales : The Fisheries School at (G. A. Steven), 986
Crop Production in Frames and Cloches (Ministry of Agriculture Bulletin 65), 196
Cross-Linking in Polymeric Systems (Dr. G. F. Bloomfield), 298
Cross-Sections for the Capture of 220 and 900 keV. Neutrons : Comparison of (R. Allen, G. R. Bishop, P. Demers and Dr. H. Halban), 727
Crystal Boundaries in Metals : Mechanical Behaviour of (R. King, R. W. Cahn and Dr. B. Chalmers), 682
Crystal Structure of Polyvinyl Alcohol (C. W. Bunn), 929
Crystal Structure Analysis : The Fourier Method of (Dr. W. Cochran), 765
Crystallites of Alkali Metal Salts, Gold and Platinum : Magnetic Susceptibility of Borax Glasses containing (Prof. Subodh Kumar Majumdar), 684
Crystallization of Proteins : Use of Solubility Curves at Varying *p*H and Constant Ionic Strength for the Precipitation and (A. Distèche), 130
Crystallography : International Congress of, 124
Crystals : The Growth of (Sir George Thomson), 800
  Infra-Red Absorption Spectra of (Sir C. V. Raman), 165
Crystals (Biaxial) : A Simple Universal Model for Representing the Optic Orientation of (Dr. N. H. Hartshorne), 94
Crystals (Glacier) : Growth of (G. Seligman), 485
Cultural Background of Personality (Prof. Ralph Linton), *review* by Prof. T. H. Pear, 622
Cultural Relations of Social Biology : The International and (British Social Hygiene Council Summer School on), 842
Culture (Japanese) : A Study of, *review* by Peter Lawrence, 77
Culture Method for *Lymnæa truncatula* (E. L. Taylor and Alan Mozley), 894
Curare-like Action of Polymethylene *bis*-Quaternary Ammonium Salts (Dr. R. B. Barlow and Dr. H. R. Ing), 718 ; (Dr. W. D. M. Paton and Dr. E. J. Zaimis), 718
Current Affairs in Army Education : Citizenship and (Lieut.-Colonel Eric Lowe), 444
Currents : Lightning Arrester Discharge (Robert C. Cuffe), 885
Cutlery Industry : Working Party Report on the (Board of Trade), 448
Cuttings (Woody) : The Use of Auxins in the Rooting of (Kenneth V. Thimann and Jane Behnke), *review* by Prof. M. Thomas, 993
Cyclo-octatetraene : Structure of (H. S. Kaufman, Dr. I. Fankuchen and Prof. H. Mark), 165
Cyclopropane : Structure of (Sir Robert Robinson), 176
Cygnus : Variable Source of Radio Frequency Radiation in the Constellation of (J. G. Bolton and G. J. Stanley), 312
Cyrenaica : Cambridge Archæological Expedition to (C. B. M. McBurney, R. W. Hey and W. Watson), 327
Cytochemical Study of the Perinuclear Lipidic Layer in the Liver Cell (Dr. C. A. Baud), 559
Cytochrome *c* by Cytochrome *b* : A Factor in Heart Muscle required for the Reduction of (E. C. Slater), 405
Cytology of Staphylococci before and after Treatment with Penicillin (Prof. R. Tulasne and Dr. R. Vendrely), 316

D-LAYER (Ionospheric) : Electrical Conductivity of the (Prof. T. G. Cowling and R. Borger), 515
Dahomey : Divination in, *review* by G. I. Jones, 663
Daily Variation of the Horizontal Magnetic Force at the Magnetic Equator (J. Egedal), 443
Dairy Engineering : Postgraduate Scholarships in Husbandry, Agricultural Economics, Statistics and Agricultural and (Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland), 637
Dairy Farming (V. C. Fishwick), *review* by S. B., 544
Damage : An Adaptation Mechanism of the Organism to—the Role of 'Resistine' (Dr. S. Karády and Dr. A. Kovács), 688
Damping : Total Emission (Dr. J. Thomson), 847
Daniel-Pidgeon Fund of the Geological Society of London : Awards made to Dr. J. S. Webb and to W. S. McKerrow, 1007

Daphnia : Effect of Antihistamines on (Dr. Otakar Poupa), 235
Darkening of Red in Protanopes (Dr. R. W. Pickford), 27
Darkness into Daylight (Science Museum Exhibition), 674, 821
Data from Electrical Resistivity Geophysical Surveys : Interpretation of (J. M. Hough), 812
Data on Hilbert's Inequality : Empirical (E. H. Copsey, H. Frazer and W. W. Sawyer), 361
Datura metel : Effect of Colchicine Treatment on the Alkaloidal Content of (A. E. Beesley and Dr. G. E. Foster), 561
Davy and Faraday Exhibition at the Palais de la Découverte, Paris, 675
Day by Day on Skokholm Island, *review* by Frances Pitt, 5
Daylight : Darkness into (Science Museum Exhibition), 674, 821
D.D.T. with Selective Properties : New Formulation of (Dr. W. E. Ripper, R. M. Greenslade, J. Heath and K. Barker), 484
D.D.T. and Benzene Hexachloride in Soil : Persistence of (Dr. M. S. Smith), 246
Deactivation of Penicillin Solutions by Rubber Tubing : Facts involved in the (Dr. L. J. Bellamy and C. H. Watt), 940
Deaths from Cancer : Geographical Distribution of, 17
Deformed Solid Metal and Metal Powders : X-Ray Diffraction Rings from (Dr. W. A. Wood and W. A. Rachinger), 93
Degradation of Starch : Photochemical (Dr. S. Peat, Dr. E. J. Bourne and W. J. Whelan), 763
Dehydro-β-ionone : Synthesis of (Dr. H. B. Henbest), 481
Dehydrogenase of Mammalian Liver : Higher Fatty Acid (K. Burton), 606
Delayed Fracture of Glass under Tension, Torsion and Radial Pressure (C. Gurney), 729
Democracy and Empire in the Caribbean (Paul Blanshard), 948
Democracy and Industry (C. Reaveley and J. Winnington), 109
Democracy in Industry, 109
Demonstration of the Heart Beat (Dr. C. A. Beevers), 65, 321 ; (Dr. Alan J. Hird), 321 ; (Dr. Ian F. S. Mackay), 771
Denning Report on Procedure in Matrimonial Causes, 539
Density Distribution : Internal Waves in certain Types of (Dr. P. Groen), 92
Dental Caries : Relation of Enamel Protein to (Dr. Paul Pincus), 1014
Deployment of Scientific Effort in Britain, 1
Depth : Variation of Geomagnetic Intensity with (Prof. Sydney Chapman), 52 ; (S. K. Runcorn), 52
Derivatives of Diiodotyrosine : Formation of Derivatives of Thyroxine from (Rosalind Pitt Rivers), 308
Derivatives of Thyroxine from Derivatives of Diiodotyrosine : Formation of (Rosalind Pitt Rivers), 308
Dermatology : Modern Trends in (edited by Dr. R. M. B. MacKenna), *review* by Dr. James Marshall, 788
Descendant of Benjamin Franklin : A, *review* by Lieut.-Colonel H. D. Anthony, 909
Descents (Steepest) : Method of—Improved Formula for X-Ray Analysis (Dr. V. Vand), 600
Desert : Physiology of Man in the (E. F. Adolph and associates), *review* by Dr. B. McArdle, 744
Desert Conditions : Water Requirements under, *review* by Dr. B. McArdle, 744
Design for Europe (Design for Freedom Committee), 413
Design for Recovery (Design for Freedom Committee), 660
Determination of the Mass of Mesons : A New Method for the (Dr. C. F. Powell and Dr. S. Rosenblum), 473
Detonation in High Explosives : Spread of (Elwyn Jones and Dugald Mitchell), 98
Deuterium : Scattering of D—D Neutrons by (J. F. Darby and J. B. Swan), 22
Development in British Colonial Territories : Research and, 141
Development of Inventions Bill, 700
Development Organisations in Britain : Regional, 183
Development and Welfare in the West Indies (Sir John Macpherson), 181
Devises des Dogons : Les (Mme. Solange de Ganay), *review* by G. I. Jones, 622
Devon and Cornwall, a Preliminary Survey (Survey Committee of the University College of the South-West, Exeter), *review* by Prof. L. Dudley Stamp, 786
Dewar Research Fellowship, 802
Diabetic Rats (Alloxan) : Effect of Insulin on Intestinal Glucose Absorption in (Dr. A. Sols, S. Vidal and J. Larralde), 932
Dialysate ? : What is a (Eric G. Ball), 404
Diamond : Dielectric Constant of (Prof. S. Bhagavantam and D. A. A. S. Narayana Rao), 729
Dichroa febrifuga, a Chinese Antimalarial Herb : Pharmacology of Ch'ang Shan, (Dr. C. S. Jang, F. Y. Fu, K. C. Huang and C. Y. Wang), 400 ; (T. S. Work), 401
Dicumarol Poisoning and Vitamin K Deficiency in relation to Quick's Concept of the Composition of Prothrombin (Prof. Henrik Dam), 1010
Dielectric Constant of Diamond (Prof. S. Bhagavantam and D. A. A. S. Narayana Rao), 729
Dielectric Constant and Piezo-Electric Resonance of Barium Titanate Crystals (Bernd T. Matthias), 325
Dielectric Properties of Soils and Water at a Wave-length of 3·2 cm. (Prof. A. W. Straiton and C. W. Tolbert), 73
Dielectric Relaxation of Molecules containing Rotating Polar Groups (Prof. A. Budó), 133
Dielectrics (Highly Insulating) : Fluorescence of, produced by X- and γ-Radiations (Dr. C. W. Wilson), 520
Dienoestrol : Isomerization of (W. Hausmann and Dr. A. E. Wilder Smith), 892
Diet : Effect of Under-nutrition and Alterations in, on the Choline Esterase Activity of Serum (Prof. R. A. McCance, E. M. Widdowson and A. O. Hutchinson), 56
Dietetic Hepatic Lesions and Protein Deficiency (Dr. M. V. Radhakrishna Rao), 446
Differential Effect of 2-Benzoylbenzoic Acid and its Derivatives upon Plant Species (Dr. W. A. Sexton and Dr. W. G. Templeman), 974
Differentiation : Significance of Nuclear Change in (Dr. K. Mather), 872
Diffraction of Light by Very High Frequency Ultrasonic Waves (Prof. S. Bhagavantam and B. Ramachandra Rao), 927
Diffraction of Radio Waves from Trails during Formation : Velocity of Meteors Measured by (C. D. Ellyett and J. G. Davies), 596
5 : 6-Dihydroxyindole : The Melanin Problem—a Synthesis of (Dr. R. J. S. Beer, K. Clarke, H. G. Khorana and Prof. A. Robertson), 525
5 : 6-Dihydroxyindole and its Derivatives : The Melanin Problem—Synthesis of (Prof. H. Burton and J. A. Duffield), 725
Diiodotyrosine : Formation of Derivatives of Thyroxine from Derivatives of (Rosalind Pitt Rivers), 308
1 : 4-Diketones : Reduction of (Dr. Neil Campbell and Nandoomal Khanna), 54
Dimethyl Ether of *d*-Tubocurarine Iodide : Pharmacological Activities in Different Rodent Species of *d*-Tubocurarine Chloride and the (Dr. H. O. J. Collier, Sheila K. Paris and Dr. L. I. Woolf), 817
Diphenyl : Energy of the Central C—C Bond in (Dr. M. Szwarc), 890
Diphtheria Antitoxin : Sir Charles Sherrington and (Dr. A. N. Drury), 266
Diptera : White-eyed Mutants of (Dr. P. Tate), 641
Direction Finding : Wireless (R. Keen), fourth edition, *review* by Dr. R. L. Smith-Rose, 375
Directors and Business Management : The Board of (Melvin T. Copeland and Asst. Prof. Andrew R. Towl), *review* by E. F. L. Brech, 869
Discharge Currents : Lightning Arrester (Robert C. Cuffe), 885
Discharge Tube for Nuclear Reactions with Improved Yield (Jaroslav Pachner), 252
Discharge Tubes : Spontaneous Waves in, and in the Solar Atmosphere (Prof. V. A. Bailey), 599
Discovery of the Electron : Jubilee of the, 16
Discovery of Radioactivity (Prof. Jean Becquerel), 609 ; (Prof. J. A. Crowther), 609
Disease in Plants : Physiology of Resistance to (Royal Society symposium on), 422
Disease Resembling Virus Yellows through the 'Seed' of Sugar Beet : Transmission of a (Dr. Phyllis E. M. Clinch, J. B. Loughnane and R. McKay), 28
Diseases (Infectious) : Thyroid Gland as a Special Factor influencing the Conditional Disposition to (Dr. S. Zimanyi), 57
Diseases (Tropical) : The Role of Chemistry in combating (Sir Ian Heilbron), 956
Disintegration of Highly Excited Nuclei (D. H. Perkins), 486
Disintegration of Nuclei : Emission of Li^8 in the Explosive (C. Franzinetti and R. M. Payne), 735
Disintegration Products : Angular Distribution of Radioactive (J. A. Spiers), 807
Disordering of β-Brass by Cold Work (R. W. K. Honeycombe and Dr. W. Boas), 612
Dispersion in Organic Liquids : Ultrasonic (Dr. A. Schallamach), 476
Disposal of Effluents from Harwell, 163
Disposition to Infectious Diseases : Thyroid Gland as a Special Factor influencing the Conditional (Dr. S. Zimanyi), 57
Dissociation in Flame Gases : Atomic Oxygen and (Prof. W. T. David, C. Rounthwaite and N. Carpenter), 726
Dissociation Energies (Dr. A. G. Gaydon), 731
Distillation and its Application in the Concentration of the Heavy Isotopes of Oxygen and Hydrogen : Fractional (Dr. I. Dostrovsky, Prof. E. D. Hughes and Dr. D. R. Llewellyn), 858
Distribution of Nuclear Disintegration in Photographic Emulsions Exposed to Cosmic Rays—Double Stars ; Anomalous (L. Leprince-Ringuet and J. Heidmann), 844 ; (T. T. Li and D. H. Perkins), 844
Distribution of Radioactive Disintegration Products : Angular (J. A. Spiers), 807
Distribution Patterns in European Basidiomycetes with reference to some British Species (R. W. G. Dennis), 1015
Divination in Dahomey, *review* by G. I. Jones, 663
Documentation of Organic Chemistry, *review* by Prof. J. W. Cook, 415
Dogons : Les Ames des (Mme. G. Dieterlen), *review* by G. I. Jones, 622
Dogons : Les Devises des (Mme. Solange de Ganay), *review* by G. I. Jones, 622
Dolphins : The Swimming of (Alfred H. Woodcock), 602 ; (Dr. L. Harrison Matthews), 731
Domestic Fowl : Relationship of Glioma to Encephalitis in the, and an Associated Parasitic Agent (Prof. Cecil Jackson), 441
Dosage/Response Relationships in Mould Inhibition (J. N. Phillips and J. M. Vincent), 210
Double Bonds : Relative Reactivity of Aromatic (Dr. G. M. Badger and Dr. R. I. Reed), 238
Doubly Charged Cosmic Ray Particle (A. B. Sahiar), 811
Draining : Vegetation after (V. S. Summerhayes and Dr. W. B. Turrill), 421
Draining of Binley Lake and its Ecological Consequences (Wing-Comdr. T. R. Cave-Browne-Cave), 420
Draper (Henry) Medal for 1947 of the U.S. National Academy of Sciences awarded to Prof. Hans Albrecht Bethe, 861
Drosophila : Natural Selection of (Dr. F. W. Sansome), 409
Drosophila Egg : Ribose Nucleic Acid in the (H. G. Callan), 440
Drosophila melanogaster : Nutritional Requirements of (Dr. Michael Begg and Dr. Forbes W. Robertson), 769
Duddell Medal for 1947 of the Physical Society awarded to Dr. R. J. Van de Graaff, 511
Dwarfs (White) : Spectrum of (Dr. Evry Schatzman), 61
Dynamics of Clanship among the Tallensi (Dr. Meyer Fortes), *review* by Dr. A. I. Richards, 111
Dynamics of Power and Personality (Prof. H. D. Lasswell), 654

EAR : Phase Memory of the, a Proof of the Resonance Hypothesis (Dr. R. J. Pumphrey and T. Gold), 640
Ear (Vertebrate) : Oscillographic Analysis of the Non-Acoustic Functions of the (Dr. Otto Lowenstein), 652
Earliest Known Prehistoric Industry (T. T. Paterson), 278
Earth Currents : Water Movement and—Electrical and Magnetic Effects (N. Barber and M. S. Longuet-Higgins), 192
Earth Quakes : When the (Rev. James B. Macelwane), *review* by Ernest Tillotson, 459
Earth's Main Magnetic Field and its Secular Change, 1905–1945 (E. H. Vestine, Lucile Laporte, Caroline Cooper, Isabelle Lange and W. C. Hendrix), 161
Earth's Surface Magnetic Field and its Secular Change (Prof. Sydney Chapman), 160

Fat into Adipose Tissue : Active Penetration of (B. Shapiro, D. Weissmann, V. Bentor and E. Wertheimer), 482
Fat Supplies : Rebuilding Europe's (G. Heyworth), 123
Fats : World Supplies of Oils and, 123
Fats and Lipoids : Physiology and Biochemistry of (Le Centre National de le Recherche scientifique symposium on), 534
Fatty Acid Dehydrogenase of Mammalian Liver : Higher (K. Burton), 606
Fatty Acids in Cotton Wool Plugs : Unsaturated (Dr. M. R. Pollock), 853
Fauna (British) : The Field Study and Conservation of the (Association of British Zoologists discussion on), 408
  Synopses of the (Linnean Society), 594
Fauna of Soil and Inland Waters : Ciliate Protozoan (Ernest Gray), 854
Fauna and Flora of Palestine, 902
Feeding 2-Acetaminofluorene on the Adreno-Gonadal System of Rats : Effect of (Cornelia Hoch-Ligeti), 58
Feeding Micro-Wave Power into a Resonator having a Fine Mode Structure: A Method of (G. R. Newbery and W. E. Willshaw), 519
Feeding Times of British Birds (Rev. John Lees), 802
Fellowship : Dewar Research, 802
Fellowship Awards for 1948–49 : Frank B. Jewett (American Telephone and Telegraph Co.), 429
Fellowships : Atomic Energy Commission, 593
  Clayton, for 1948 (Institution of Mechanical Engineers), 470
  Commonwealth Fund, 1006
  Nuffield (Penicillin) Research, 16
  Postdoctorate, in Pure Chemistry (National Research Council of Canada), 555
  Ramsay Memorial, for Chemical Research, 272
  Research, in the University of Cambridge (Imperial Chemical Industries, Ltd.), 90
  Research, in Chemistry or Physics at the University of Glasgow and the Royal Technical College, Glasgow (J. and P. Coats, Ltd.), 164
Ferromagnetic Materials : New Developments in (J. L. Snoek), *review* by F. C. T., 666
Ferromagnetic Structure of Cold-Worked Austenitic Stainless Steels (P. T. Hobson and W. P. Osmond), 562
Fertility : The Problem of (Proceedings of the Conference on Fertility held under the auspices of the National Committee on Maternal Health, edited by Earl T. Engle), *review*, 113
  Soil, *review*, 39
Fertilization in Ascidians : Interspecific (Dr. Antonio Minganti), 643
Fertilized Rabbit Ova : Transplantation of—the Effect on Viability of Age, *in vitro* Storage Period, and Storage Temperature (Dr. Min-Chueh Chang), 978
Fertilizer Requirements : Plant Analysis and, 406
F.I.A.T. Review of German Science, 389
Fibers : Textile (Matthews), fifth edition, edited by Herbert R. Mauersberger, *review* by Dr. C. S. Whewell, 581
Fibres : Industrial (Commonwealth Economic Committee), 961
  Textile, *review* by Dr. C. S. Whewell, 581
Fibrinokinase and Fibrinolytic Enzymes (Dr. Tage Astrup and Per M. Permin), 689
Fibrinolytic Enzymes : Fibrinokinase and (Dr. Tage Astrup and Per M. Permin), 689
Field Distributions : An Electrolytic Tank for Exploring Potential (R. Makar, A. R. Boothroyd and E. C. Cherry), 845
Field Ecology : Practical (Dr. R. C. McLean and Dr. W. R. Ivimey Cook), 158
Field Study and Conservation of the British Fauna (Association of British Zoologists discussion on), 408
Field-Size : Dependence of Anomaloscope Matching on Viewing-Distance or (R. G. Horner and E. T. Purslow), 484
Fiji Islands (east of the) : Earthquake on July 13, 657
Films (Medical) : Catalogue of (Royal Society of Medicine and the Scientific Film Association), 594
Films in Agriculture (Scientific Film Association conference on), 17
Filmstrips : An Introduction to (H. R. and I. W. Dance), *review* by Lieut.-Colonel Eric Lowe, 830
Filter-Paper Chromatography : A Modified Technique in (L. Rutter), 435
Filtrable Agent possibly related etiologically to Lumpy Skin Disease of Cattle : Isolation in Chick Embryos of a (Prof. M. van den Ende, P. Don, A. Kipps and R. Alexander), 526
Finland (Northern) : Northern Hemisphere Surface Pressure and Climatic Fluctuations and Vegetation Growth in (G. W. Brier), 730
Fires (Petrol) : Extinction of, by Methyl Iodide (Dr. Oliver C. de C. Ellis), 402
Fish Cultivation : An Experiment in Marine (L. H. N. Cooper and G. A. Steven), 631
Fish Farming in the Middle and Far East (Dr. C. F. Hickling), 748
Fish Gut : Alkaline Phosphatase in (A. H. Al-Hussaini), 274
Fish Kidney (Aglomerular) : A Vasodilator, Adrenolytic Substance in (Dr. Benjamin Jablons), 100
Fisher and Race : Two Examples of Sera containing the Anti-*d* Agglutinin predicted by (Dr. Joseph M. Hill and Dr. Sol Haberman), 688
Fisheries : Report on Sea and Inland (Government of Northern Ireland), 451
Fisherman and Nature Lover, *review* by Seton Gordon, 951
Fishes (British) : The Trematoda of (Dr. Ben Dawes), *review* by Dr. G. Lapage, 222
Fishes (Greek) : A Glossary of (Sir D'Arcy Wentworth Thompson), *review* by Sir John Myres, 185, 272
Fishing Industry Developments during the War Years : Northern Ireland, 451
Fison Lectures of the Animal Health Trust (Prof. L. Seekles), 637, 1005
Fission Products of U^{238} (Dr. W. E. Grummitt and Dr. G. Wilkinson), 520
Fixatives : Shrinkage of Animal Cells due to (Dr. Daya Krishna), 202
Flagella and Motility : Bacterial (Prof. Adrianus Pijper), 200
Flame Gases : Atomic Oxygen and Dissociation in (Prof. W. T. David, C. Rounthwaite and N. Carpenter), 726
Flame and Explosion Phenomena : Combustion and (University of Wisconsin symposium on), 307
Flames : Band Spectrum of ClO in (Dr. G. Pannetier and Dr. A. G. Gaydon), 242
Flavine Adenine Dinucleotide : Inactivation of, by Tissue Extracts (R. S. Comline and F. R. Whatley), 350
Flavine Nucleotides : Paper Chromatography of (Dr. J. L. Crammer), 349
Fleas' and 'Lesser Fleas' : 'Little, *review* by Dr. G. Lapage, 662
Flights (Migratory and Homing) : Orientation of Birds on (Linnean Society discussion on), 996
Flint Flaking (S. Hazzledine Warren), 569
Floating Thread, a Surface Phenomenon on Flowing Water (I. Kuscer), *erratum*, 51
Flora of Palestine : Fauna and, 902
Floras : Origins of Species and Migrations of, *review* by Prof. I. Manton, 455
Flour : Insect Pests of (J. A. Freeman and E. E. Turtle), 554
Flow of Glaciers (British Glaciological Society, the British Rheologists' Club and the Institute of Metals discussion on), 819
Flowering Plants : Critical British Groups of (J. E. Lousley), 733
  The Geography of the (Prof. Ronald Good), *review* by Sir Edward Salisbury, 704, 857
Flowers of the Chalk : Wild (John Gilmour), *review*, 188
Flowing Water : The Floating Thread, a Surface Phenomenon on (I. Kuscer), *erratum*, 51
Fluoranthene Derivatives : A Synthesis of (Dr. E. Bergmann), 889
Fluorescence (Ultra-Violet) : Use of, in Paper Chromatography (D. M. P. Phillips), 53
Fluorescence of Highly Insulating Dielectrics produced by X- and γ-Radiations (Dr. C. W. Wilson), 520
Fœtal Hæmoglobin and Erythroblastosis (Dr. J. H. P. Jonxis), 850
Fœtus : Die Hormonversorgung des (Dr. Jules Samuels), *review*, 297
Foliage Leaves : Threshold Value of Carbon Dioxide Concentration in Photosynthesis of (Dr. E. K. Gabrielsen), 138
Folic Acid Group, and other Anti-Anæmia Factors : B_T, a New Vitamin of the B-Group and its relation to the (Dr. G. Fraenkel, with the assistance of M. Blewett and M. Coles), 981
Folliculin on Bone Metabolism, Studied by means of Radiophosphorus, $^{32}_{15}P$: Influence of (Dr. J. Govaerts and Prof. M. J. Dallemagne), 977
Food : Energy-Yielding Components of, and Computation of Calorie Values (Food and Agriculture Organisation of the United Nations), 306
Food Calories, 306
Food of Humming-Birds (Frank Bené), 881
Food Industry : Cleaning and Sterilizing of Plant in the (Royal Sanitary Institute and the Food Group of the Society of Chemical Industry discussion on), 1025
Food Poisoning (Elliot B. Dewberry), second edition, *review*, 540
Food Production from Hill Grazing Land (Dr. George Dunlop), 585
Food Production and Land Utilization, 905
Food Science : Summer Course in, 1007
Forage Resources of Latin America (Hugo W. Alberts), 657
Foraminifera in the Gullmar Fjord and the Skagerak (Hans Högland), 513
Force Constant with the Ionization Potential and the Polarizability for some Halogen Compounds : Variation of the (P. Torkington), 724
Force Field for Molecular Vibrations : A Suggested New (D. F. Heath and Dr. J. W. Linnett), 314
Forces between Large Molecules of Biological Interest : Nature of (Prof. Linus Pauling), 707
Foreign Universities : Scholarships for 1948–49 at (British Council), 347
Forest (New) : The Future of the (Prof. H. G. Champion), 547
Forest Products : Forestry and ; World Situation 1937–1946 (Food and Agriculture Organisation of the United Nations), 710
Forest Valuation (Prof. Herman H. Chapman and Prof. Walter H. Meyer), *review* by J. J. MacGregor, 831
Forestry : Practical British (C. P. Ackers), second edition, *review* by Prof. E. P. Stebbing, 295
Forestry in Trinidad and Tobago, 147
Forestry Conference : Fifth British Empire (Summary Report and Results and Reports of Committees), 449
Forestry and Forest Products ; World Situation 1937–1946 (Food and Agriculture Organisation of the United Nations), 710
Formation of Oxime-Nitrogen in *Torula*-Yeast Fed with Potassium Nitrate (Prof. Artturi I. Virtanen and Tihamér Z. Csáky), 814
Formation and Breakdown of Serpulid Tubes (Jean Hanson), 610
Formulation of D.D.T. with Selective Properties : New (Dr. W. E. Ripper, R. M. Greenslade, J. Heath and K. Barker), 484
Fortpflanzungsprozesses : Die hormonalen Aspekte des (Dr. Jules Samuels), *review*, 297
Forze creatrici dell'uovo : Le (Prof. Pasquale Pasquini), *review* by C. H. W., 831
Fossil Primates discovered during 1947 : African (Prof. W. E. Le Gros Clark), 667
Foundations of Chemical Theory (Charles Simpson), *review*, 503
Founder's Medal for 1948 of the Royal Geographical Society awarded to Wilfred Thesiger, 553
Fourier Method of Crystal Structure Analysis (Dr. W. Cochran), 765
Fourier Refinement Technique : A New (Andrew D. Booth), 765
Fowl (Domestic) : Relationship of Glioma to Encephalitis in the, and an Associated Parasitic Agent (Prof. Cecil Jackson), 441
Fractional Distillation and its Application in the Concentration of the Heavy Isotopes of Oxygen and Hydrogen (Dr. I. Dostrovsky, Prof. E. D. Hughes and Dr. D. R. Llewellyn), 858
Fracture : Nitrogen Metabolism after (Dr. H. N. Munro and M. C. Cumming), 560
Fracture of Glass under Tension, Torsion and Radial Pressure : Delayed (C. Gurney), 729
Frames and Cloches : Crop Production in (Ministry of Agriculture Bulletin 65), 196
Framework of Human Behaviour (Dr. Julian Blackburn), *review*, 502
Frazer Lecture for 1947 (Prof. H. J. Fleure), 746
Free Society : The (John Middleton Murry), 538
Free-living Nematodes in Genetic Research : Possible Significance of (Dr. Ellsworth C. Dougherty and Hermione Grant Calhoun), 29
Free-Swimming Planktonic Copepoda (Lieut.-Colonel R. B. Seymour Sewell), 822
Freedom : The European Tradition of, 413
  Science and (Dr. Lyman Bryson), 577
Freedom in the Good Society, 577
Freedom End : Where does (British Social Hygiene Council Ethics and Science conference on), 843
Freedom and Civilization (Bronislaw Malinowski), *review* by Dr. E. R. Leach, 457

Freedom and Loyalty, 537
Freedom and Social Responsibility : Individual (Conference on), 843
French Conference on Ageing of Population, 163
French Scientific Periodicals : Photocopies of, 429
Frequency Range 1–30 Mc./s. : Survey of Existing Information and Data on Radio Noise over the (Dr. H. A. Thomas and R. E. Burgess), 107
Frequency Variation of the Intensity of Cosmic Radio Noise (Jack W. Herbstreit and Joseph R. Johler), 515
Fringilla coelebs Linn. : Chronometric Observations of the Song of (D. R. Barber), 277
Fructose : Condensation of 2 : 4 : 5-Triamino-6-hydroxy-pyrimidine with Glucose and (H. S. Forrest and Dr. James Walker), 308
Fruit Tree Red Spider Mite : Toxicity of Azo-Compounds and other Substances to the (Dr. J. K. Eaton and R. G. Davies), 644
Fruits of *Ammi majus* L. : Xanthotoxin from the (Prof. Alexander Schönberg and Aly Sina), 481
Fuel Economy in Switzerland, 253
Fuel Problems : Britain's (Dr. D. T. A. Townend), 669
Fuel Systems for the Aero-Gas Turbine (Dr. E. A. Watson), 196
Fuel Technology at the University of Durham : Chemical Engineering and, 965
Fuel and Power Industries : The British (Political and Economic Planning Report on), 669
Fuels (Liquid) : Modern Applications of (Institute of Petroleum and the Institute of Fuel joint conference on), 677, 1007
Fundamental Concept of Number : Calculus based on the, *review* by F. G. W. Brown, 261
Fundamental Equation of the Statistical Atom Theory : An Asymptotic Solution of the (Dr. J. I. Hórvath), 26
Fungal Spores : A Method for Estimating Percentage Germination of (O. L. Davies, R. B. Duckworth and G. C. M. Harris), 642
Fungi : Type Cultures of, 16
Fungus : A *Chaetomium*-like Thermophile (C. J. La Touche), 320
Furnace Models : Open Hearth (A. J. Philip), 479

GALAXIES (Harlow Shapley), *review* by H .S. J., 460
Gamma-Isomer of Benzene Hexachloride : Polarographic Determination of the (G. B. Ingram and H. K. Southern), 437
Gamma Radiation (Magnetic Dipole) : Spin-Dependence of, and the Nuclear Level Scheme of Pb^{208} (Dr. H. O. W. Richardson), 516
γ-Radiation from Light Elements Bombarded with α-Particles from Polonium : Excitation Curves for the (Prof. Hilding Slätis), 899
γ-Radiations : Fluorescence of Highly Insulating Dielectrics produced by X- and (Dr. C. W. Wilson), 520
Garden : Good Health to the (Plant Protection, Ltd.), *review*, 188
Garden Pests : The Detection and Control of (G. Fox Wilson), *review* by A. D. I., 419
Gas (Luminous) : A Bunsen Flame as a Column of (Dr. A. S. Leah and Prof. W. T. David), 524
Gas Discharges at Centimetre Wave-lengths (W. A. Prowse and R. Cooper), 310
Gas Industry in Britain (Dr. E. V. Evans), 832
Gas Phase : The Kinetics and Mechanism of Combustion and Ignition Reactions in the (International symposium on), 347
Gas Turbines : Modern (Arthur W. Judge), *review* by E. G. Sterland, 910
Gaseous Elements : Mass-Spectrographic Separation of Isotopes of (Dr. J. Koch), 566
Gases (Flame) : Atomic Oxygen and Dissociation in (Prof. W. T. David, C. Rounthwaite and N. Carpenter), 726
Gases Liberated from Explosions Initiated by Impact (Dr. A. J. B. Robertson and A. Yoffe), 806
Gases and Liquids (Dense) : Coefficients of Viscosity and Thermal Conduction in (L. M. Yang), 523
Gazetteer of British Somali Place Names, 195
Gemmologists' Compendium (Robert Webster), second edition, *review*, 297
General Electric in World War II : Men and Volts at War, the Story of (John Anderson Miller), *review* by Sir Arthur Fleming, 113
Generation of Electricity from Wind Power, 162
Genes Allelomorphic to *C* : *Rh* (Dr. R. R. Race, Dr. Ruth Sanger and Mrs. Sylvia D. Lawler), 316
Genetic Research : Possible Significance of Free-living Nematodes in (Dr. Ellsworth C. Dougherty and Hermione Grant Calhoun), 29
Genetics : Congress of (To be held at the Centro di Genetica del Consiglio Nazionale delle Ricerche in Pavia), 429, 966
  Corn (*Zea Mays* L.), in the United States (Gordon Haskell), 42
Genetics of Cancer (Genetical Society of Great Britain and the British Empire Cancer Campaign symposium on), 843
Genetics and Algal Life-Histories (Dr. Kathleen M. Drew), 223
Genetics and Medicine : Animal (Dr. Hans Grüneberg), *review* by Prof. C. H. Waddington, 543
Genus Crepis : The (Ernest Brown Babcock), *review* by Prof. I. Manton, 455
Geodesy : Eclipse Observations for, 196, 389, 879
Geographical Approach to the History of the British Isles, *review* by D. B. Harden, 746
Geographical Distribution of Deaths from Cancer, 17
Geography : Plant, *review* by Sir Edward Salisbury, 704 ; (Prof. Ronald Good), 857
Geography at Bedford College, London, 511
Geography of the Flowering Plants (Prof. Ronald Good), *review* by Sir Edward Salisbury, 704, 857
Geography of Southwest Guatemala : Cultural and Historical (Felix Webster McBryde), 697
Geological Congress : International, 88
Geological Survey Service: Colonial, 50
Geological Time : The Succession of Life through (British Museum (Natural History) exhibits), 429
Geology of the Cantal Region, Central France : Mr. E. Westlake and the (G. Maynard and Aubrey T. Westlake), 485
Geology at Newcastle-upon-Tyne, 1003
Geology of the Salt Range of the Punjab (Sir Edward Bailey), 265
Geomagnetic Field : Final Values of the Elements of the, at 5-Degree Intervals of Latitude and Longitude, Epoch 1945 (L. Laporte, C. Cooper, I. Lange, W. C. Hendrix and E. H. Vestine), 161
  The Main (Royal Astronomical Society Geophysical Discussion on), 462
Geomagnetic Intensity with Depth : Variation of (Prof. Sydney Chapman), 52 ; (S. K. Runcorn), 52
Géomancie à l'ancienne Cote des Esclaves (Bernard Maupoil), *review* by G. I. Jones, 663
Geometry (Algebraic) : Foundations of (Prof. André Weil), *review* by Prof. H. T. H. Piaggio, 787
Geometry (Analytical) : An Introduction to (A. Robson), Vol. 2, *review* by Prof. H. T. H. Piaggio, 705
Geophysical Surveys (Electrical Resistivity) : Interpretation of Data from (J. M. Hough), 812
Geophysics at Hamburg, 1006
German Books and Periodicals : Union Catalogue of (National Central Library), 1006
German Books, Periodicals and Newspapers : First Post-war Exhibition of (European Periodicals Publicity and Advertising Co., Ltd.); 595
German Educational Reconstruction Series, No. 5, Public Libraries in Germany (H. Schurer), 90
German Research in World War II (Colonel Leslie E. Simon), *review*, 219
German Scientific and Technical Papers : Photostat Copies of, 90
German War-time Industry and Science : Reports on. 388
Germany : Public Libraries in (H. Schurer), 90
  Scientific Research in the British Zone of (Prof. F. A. Paneth), 191
Germany To-day : Economic Conditions of, and its International Repercussions (International Chamber of Commerce), 659
Germicidal, Erythemal and Infra-red Energy : Applications of (Dr. Matthew Luckiesh), *review* by H. G. Jenkins, 542
Germinal Epithelium : Control of the, *review* by Prof. S. Zuckerman, 221
Germination of Fungal Spores : A Method for Estimating Percentage (O. L. Davies, R. B. Duckworth and G. C. M. Harris), 642
Gibbs (Willard) Medal for 1948 of the Chicago Section of the American Chemical Society awarded to Prof. Carl F. Cori, 388
Gill Memorial for 1948 of the Royal Geographical Society awarded to William W. Williams, 553
Glacier Crystals : Growth of (G. Seligman), 485
Glaciers : The Flow of (British Glaciological Society, the British Rheologists' Club and the Institute of Metals discussion on), 819
Glass : Annealing of (S. M. Cox), 401, 813 ; (Dr. G. O. Jones), 813
  Transmission of Bactericidal Radiation through (J. E. Stanworth), 856 ; *erratum*, 882
Glass under Tension, Torsion and Radial Pressure : Delayed Fracture of (C. Gurney), 729
Glass Surfaces (Polished) : Structure of Calcium Fluoride Films Evaporated on (J. Bannon and C. E. Curnow), 136
Glass and Steatite Ceramic with Quaternary Ammonium Compounds for the Improvement of Electrical Insulation Resistance : Treatment of (J. S. Dryden and R. J. Meakins), 23
Glassware : Hand-blown Domestic (Working Party Report on the), 449
Glioma to Encephalitis in the Domestic Fowl : Relationship of, and an Associated Parasitic Agent (Prof. Cecil Jackson), 441
Glossary of Greek Fishes (Sir D'Arcy Wentworth Thompson), *review* by Sir John Myres, 185, 272
Glow to Arc Discharge : Transition from (Dr. Chas E. R. Bruce), 521
Glucose Absorption (Intestinal) : Effect of Insulin on, in Alloxan Diabetic Rats (Dr. A. Sols, S. Vidal and J. Larralde), 932
Glucose and Fructose : Condensation of 2 : 4 : 5-Triamino-6-hydroxy-pyrimidine with (H. S. Forrest and Dr. James Walker), 308
Glutamine Synthesis : Adenosinetriphosphate in (W. H. Elliott), 128
Glutamine-synthesizing System of *Staphylococcus aureus*, its Inhibition by Crystal Violet and Methionine-sulphoxide (W. H. Elliott and Dr. E. F. Gale), 129
Glycerol Dichlorhydrin and Vitamin A (D. D. Penketh), 893
Gold : A New Dry Test for (R. C. Mehrotra), 321
Gold Medal of the Institution of Mining and Metallurgy awarded to G. Carleton Jones, 923
Gold Medal for 1948 of the Linnean Society of London awarded to Dr. Agnes Arber, 272, 882
Gold Medal of the Royal Aeronautical Society awarded to Sir Bennett Melvill Jones, 593
Gold and Platinum : Magnetic Susceptibility of Borax Glasses containing Crystallites of Alkali Metal Salts, (Prof. Subodh Kumar Majumdar), 684
Gold, Silver and Copper : Amalgamation of some Alloys of (Dr. Douglas Rennie Hudson), 288
Gonadotrophic and Sex Hormones on the Gonads of Rats : Contribution to the Knowledge of the Influences of (J. H. Gaarenstroom and S. E. de Jongh), *review* by Prof. S. Zuckerman, 221
Gonads of Rats : Contribution to the Knowledge of the Influences of Gonadotrophic and Sex Hormones on the (J. H. Gaarenstroom and S. E. de Jongh), *review* by Prof. S. Zuckerman, 221
Gorini's Acid-Proteolytic Lactic Cocci with Penicillin : Behaviour of (Annamaria Torriani), 275
Governing of Men : The (Dr. A. H. Leighton), 578
Government : Local (Sir A. S. MacNalty), *review* by Lieut.-Colonel Eric Lowe, 870
  Local and Regional (G. D. H. Cole), 825
  Machinery of, 495
  The Web of (Prof. R. M. MacIver), 579
Government (Central) : The Efficiency of the (D. N. Chester), 496
Government in Britain : Local, 825
Government and the Citizen : Local, *review* by Lieut.-Colonel Eric Lowe, 870
Government Reform : Local (J. Blackburn), 825
Government Research in Britain, 214
Government Social Survey (Maurice Goldsmith), 573
Gramicidin-S : Synthetic Pentapeptides related to (J. I. Harris and T. S. Work), 804
Grammar School Science, *review* by W. L. Sumner, 114
Grand Cross of Alfonso X awarded to Sir Alexander Fleming, 966
Granular Material : Mechanics of Packings of (D. R. Hudson), 512
Grass Seedlings : Resistance to Inanition in (H. G. Chippindale), 65 ; (J. P. Cooper), 894
Grasshopper (Australian Plague) : Measurement of 'Environmental Resistance' in the (Dr. H. G. Andrewartha and L. C. Birch), 447
Gravity Survey in the English Channel : Submarine, 272

Gray (John) Jubilee Scholarship of the Society of Chemical Industry, 595
Grazing : Evaluation of Herbage for (W. F. Raymond), 937
Grazing Land (Hill) : Food Production from (Dr. George Dunlop), 585
Great Britain : The Electricity Grid in (R. W. Haywood), 822
  Seismological Research in, 615
  See also under Britain
Greece (southern) : Earthquake at Coroni on October 6, 306
Greek Fishes : A Glossary of (Sir D'Arcy Wentworth Thompson), *review* by Sir John Myres, 185, 272
Green Alga : Influence of Low Bicarbonate Concentrations on the (Sven Österlind), 319
Greenkeeping Research, 757
Grid System (British) : Load Dispatching and the (A. R. Cooper), 822
Ground Blocks of the Continents and Ocean Bottoms (Prof. H. Cloos), 71
Ground-State of Helium-like Atoms: Energy of the (H. A. S. Eriksson), 393
Growth of Crystals (Sir George Thomson), 800
Growth of the Explosion in Solids Initiated by Impact : Birth and (Dr. F. P. Bowden and O. A. Gurton), 348
Growth of Glacier Crystals (G. Seligman), 485
Growth of a Green Alga : Influence of Low Bicarbonate Concentrations on the (Sven Österlind), 319
Growth in Pigs by Iodinated Casein and Stilbœstrol : Stimulation of (Dr. R. Braude), 856
Growth and Nature of Egyptology (Prof. S. R. K. Glanville), 346
Growth-promoting Substances in Horticulture (Dr. T. Swarbrick), 656
Guatemala : Education in (Cameron D. Ebaugh), 945
Guatemala (southwest) : Cultural and Historical Geography of (Felix Webster McBryde), 697
Guiana (British) : Animal Health in (Prof. W. C. Miller), 345
Guildford : Health Education in, 635
Guinea Pig : Alkaline Phosphatase in various Cell Types of the Anterior Pituitary of the (Prof. Leo Abolins), 556
  Influence of Vitamin P (Vitamin C2) upon the Amount of Ascorbic Acid in the Organs of the (H. Cotereau, M. Gabe, E. Géro and Prof. J.-L. Parrot), 557
Gullmar Fjord and the Skagerak : Foraminifera in the (Hans Högland), 513
Guthrie Lecture of the Physical Society (Sir George Thomson), 800

HABITAT Groups : Booklets on (Glasgow Art Gallery and Museum), 90
Hadfield (Sir Robert) Medal for 1948 of the Iron and Steel Institute awarded to A. Preece, 512
Hæmoglobin and Erythroblastosis : Fœtal (Dr. J. H. P. Jonxis), 850
Hæmolytic System in the Blood of Malaria-infected Monkeys (Dr. H. Laser), 560
Hagfish : *Trypanosoma heptatretæ* sp. n., a Blood Parasite of the (Marshall Laird), 440
Halogen Compounds : Variation of the Force Constant with the Ionization Potential and the Polarizability for some (P. Torkington), 724
Harrison Memorial Prize for 1947 awarded to Dr. D. H. R. Barton, 270
Harwell : Disposal of Effluents from, 163
Hatfield Memorial Lecture of the Iron and Steel Institute (Prof. Robert E. Mehl), 592
Hawksley (Thomas) Lecture (Sir Alwyn Crow), 329
Head : Wounds of the (*British Journal of Surgery* War Surgery Supplement No. 1), 635
Health (Human) : Experimental Study of, *review* by Dr. G. Lapage, 336
Health to the Garden : Good (Plant Protection, Ltd.), *review*, 188
Health of the School Child (Dr. Robert Sutherland), 960
Health Education (Central Council for Health Education Summer School in), 842
Health Education in Guildford, 635
Hearing in Cetacea (Robert Clarke), 979
Heart Beat : Demonstration of the (Dr. C. A. Beevers), 65, 321 ; (Dr. Alan J. Hird), 321 ; (Dr. Ian F. S. Mackay), 771
Heart Muscle required for the Reduction of Cytochrome *c* by Cytochrome *b* : A Factor in (E. C. Slater), 405
Heart Wood of *Thuja plicata* Don. : Antibiotic Substances from the (Prof. Holger Erdtman and Dr. Jarl Gripenberg), 719
Heat Engines : Fundamentals of, *review* by R. W. Haywood, 829
Heating on *Rh*-Positive Human Red Cells : Action of (Dr. P. O. Hubinont), 642
Heavy Isotopes : Mass-Defects of the (A. H. Wapstra), 529
Heavy Isotopes of Oxygen and Hydrogen : Fractional Distillation and its Application in the Concentration of the (Dr. I. Dostrovsky, Prof. E. D. Hughes and Dr. D. R. Llewellyn), 858
Heavy Metals in Plant Nutrition : Antagonism between Molybdenum and certain (C. R. Millikan), 528
Hebrides : Ecological Problems of the Highlands and, *review* by Prof. A. D. Peacock, 457
Height of Meson Formation (Dr. A. Duperier), 645
Hekla : The New Eruption from (Dr. G. W. Tyrrell), 41
Heladas y la necrosis fria de las plantas (Plutarco Naranjo V), *review* by H. L. P., 706
Helium by Cosmic Rays : Production of (H. E. Hentley), 356
Helium II : Liquid (Dr. H. S. Green), 391
Helium Films (Liquid) : Transfer Rates in (K. R. Atkins), 925
Helium-like Atoms : Energy of the Ground-State of (H. A. S. Eriksson), 393
Helminthes : Parasites (animaux et végétaux) des (Dr. Robert Ph. Dollfus), *review* by Dr. G. Lapage, 662
Heparin : A New Extraction Procedure for the Preparation of (Olle Snellman, Robert Jensen and Dr. Bengt Sylvén), 639
Hepatic Lesions and Protein Deficiency : Dietetic (Dr. M. V. Radhakrishna Rao), 446
Hepatic Structure and Function : Effect of Under-Nutrition in Man on (Sheila Sherlock and Veryan Walshe), 604
Herbage for Grazing : Evaluation of (W. F. Raymond), 937
Heterocycles (Simple) : Nitration of (K. Schofield and T. Swain), 690
Heterogeneous Catalysis : Adsorption and (Prof. Eric K. Rideal), 461
Heterolytic Reactions : Effect of Ionic Charges on the Energy and Entropy of (J. Gripenberg, Prof. E. D. Hughes and Prof. C. K. Ingold), 480
Hevea Latex (Fresh) : Complexity of (L. N. S. Thomas, J. W. van Dalfsen and G. E. van Gils), 177
Hexosediphosphatase : Inhibition of, by Sulphhydryl Reagents and by Ascorbic Acid (Dr. E. O'F. Walsh and Mrs. G. Walsh), 976
High Explosives : Initiation of (Prof. G. Herzberg and G. R. Walker), 647
  Spread of Detonation in (Elwyn Jones and Dugald Mitchell), 98
High Altitude Measurements on Cosmic Rays—Penetrating Bursts (Dr. E. P. George and P. T. Trent), 248
High Altitude Measurements on Cosmic Rays—Penetrating Cosmic Ray Showers (Dr. E. P. George and A. C. Jason), 248
High-Frequencies (Ultra) : Electrical Breakdown Strength of Air at (J. A. Pim), 683
High-Frequency Characteristics of Lead Sulphide and Lead Selenide Layers (R. P. Chasmar), 281
High-Frequency Current in Surgery : Use of (A. W. Lay), 167
High-Frequency Ultrasonic Waves : Diffraction of Light by Very (Prof. S. Bhagavantam and B. Ramachandra Rao), 927
High Initial Permeability : Metastable States of Nickel Characterized by a (Dr. J. L. Snoek and J. F. Fast), 887
High Permittivity Values at Centimetre Wave-lengths : Measurement of (J. G. Powles), 25
High Polymers : Branched-Chain (Prof. H. W. Melville and G. W. Youngson), 803
High Pressures : Collision Broadening of the Ammonia Inversion Spectrum at (Dr. B. Bleaney and J. H. N. Loubser), 522
High Temperature : Reversal of Vernalization by (Prof. F. G. Gregory and Dr. O. N. Purvis), 859
High Temperatures : Preparation of Œstrogens from Urine by Application of (Dr. Felix Sulman), 605
High-Vacuum Equipment (W. Edwards and Co., Ltd.), 676
High-Voltage Multi-Stage Electron Accelerator : Effect of the Electron Beam on the Voltage Distribution of a (F. W. Waterton), 563
Higher Fatty Acid Dehydrogenase of Mammalian Liver (K. Burton), 606
Highland Communities of Central Peru (Harry Tschopik, Jr.), 697
Highlands and Hebrides : Ecological Problems of the, *review* by Prof. A. D. Peacock, 457
Highlands and Islands : Natural History in the (Dr. F. Fraser Darling), *review* by Prof. A. D. Peacock, 457
Hilbert's Inequality : Empirical Data on (E. H. Copsey, H. Frazer and W. W. Sawyer), 361
Hill Grazing Land : Food Production from (Dr. George Dunlop), 585
Histaminolytic Activity of a Copper Protein in Serum (Dr. C. G. Holnberg and C.-B. Laurell), 236
History : The Use of (A. L. Rowse), 866
  Science and, 865
History (European) : Farewell to, or the Conquest of Nihilism (Alfred Weber), translated from the German by R. F. C. Hull, *review* by Maurice Bruce, 151
History of the British Isles : Geographical Approach to the, *review* by D. B. Harden, 746
History and Philosophy : Explanation in (Aristotelian Society Supplementary Vol. 21), *review* by F. I. G. Rawlins, 665
History of Science in Education : The Place of the (British Society for the History of Science, the Science Masters' Association, the Historical Association and the Association of Women Science Teachers joint discussion on), 347, 572
Holiday Centre : International (To be organised by the French Association of Scientific Workers), 1007
Holland : Optics in, *review* by S. Weintroub, 704
Holweck Prize and Medal awarded to Prof. Yves Rocard, 552
Homing Flights : Orientation of Birds on Migratory and (Linnean Society discussion on), 996
Honey Farming (R. O. B. Manley), *review* by Dr. C. G. Butler, 544
Honeydew on Lime Trees (C. A. Mawson), 176
Honours : New Year, 48
Honours List : The King's Birthday, 963
Hopkins (Sir Frederick Gowland) Memorial Lecture of the Chemical Society (Sir Edward Mellanby), 164
Horizontal Magnetic Force at the Magnetic Equator : Daily Variation of the (J. Egedal), 443
Hormonalen Aspekte des Fortpflanzungsprozesses : Die (Dr. Jules Samuels), *review*, 297
Hormone (Œstrogenic) : Podocarpic Acid as a Source of (C. W. Brandt and D. J. Ross), 892
Hormone Research : Recent Progress in (Proceedings of the Laurentian Hormone Conference, Vol. I, edited by Gregory Pincus), *review* by Prof. S. Zuckerman, 295
Hormone-Mimetic and other Responses of the Silkworm (*Bombyx mori* L.) to some Polyploidogenic Agents (L. J. Havas and J. Kahan), 570
Hormones : Radiophysiologie expérimentale, cancer et, 6, Étude de la cancérisation par les substances chimiques exogènes (Antoine Lacassagne), *review* by Prof. E. Boyland, 621
Hormones (Œstrogenic) : Nature of the *C*/*D* Ring Union in the (Dr. C. W. Shoppee), 207
Hormonversorgung des Fœtus : Die (Dr. Jules Samuels), *review*, 297
Horticulture : Growth-promoting Substances in (Dr. T. Swarbrick), 656
Hot Climates : Medical Diseases in, *review* by Dr. N. Hamilton Fairley, 499
Hot-Wire Vacuum Gauge : A New (H. von Ubisch), 927
Housing the Country Worker (Michael F. Tilley), *review* by R. B., 665
Human Behaviour : The Framework of (Dr. Julian Blackburn), *review*, 502
Human Blood Cells at Birth : Nicotinic Acid in (R. F. A. Dean and W. I. M. Holman), 439
Human Cholera Infection : A New Sulpha Compound ('6257') and its Use in (Dr. S. S. Bhatnagar, F. Fernandes, J. de Sa and P. V. Divekar), 395
Human Evolution : Story of, *review*, 579
Human Factor in Industry (P.E.P. Broadsheet No. 14), 780
Human Factors in Industry (British Association, Division for Social and International Relations of Science, conference on), 514, 791
Human Health : Experimental Study of, *review* by Dr. G. Lapage, 336
Human Life : Atomic Energy in Cosmic and (Prof. George Gamow), *review* by Prof. J. A. Crowther, 4
Human Red Cells : Action of Heating on *Rh*-Positive (Dr. P. O. Hubinont), 642
  Enzymic Action of Viruses and Bacterial Products on (C. M. Chu), 606
Human Sex Behaviour : Animal and, 124
Human Structure : Some Complexities of (Dr. W. L. H. Duckworth), 628

Human Urine : Isolation of Stilbœstrol Monoglucuronide from (K. S. Dodgson and Dr. R. Tecwyn Williams), 604
  Presence of Substances Inhibitory to Acid Phosphatase in Normal (Dr. Alice M. Robinson and Dr. F. L. Warren), 397
Humanism in Chemistry : Humour and (Prof. John Read), *review* by Denis I. Duveen, 869
Humming-Birds : The Food of (Frank Bené), 881
Humour and Humanism in Chemistry (Prof. John Read), *review* by Denis I. Duveen, 869
Humus and the Soil : Chemicals, (Donald P. Hopkins), *review*, 39
Husbandry, Agricultural Economics, Statistics and Agricultural and Dairy Engineering : Postgraduate Scholarships in (Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland), 637
Huxley Memorial Lecture for 1947 (Dr. W. L. H. Duckworth), 628
Hydatid Cyst Fluid : A Polysaccharide from (Gwen M. Macnab), 310
Hydraulic Engineering : Scale Models in (Prof. J. Allen), *review* by Prof. J. Th. Thijsse, 219
Hydraulic Measurements (Prof. Herbert Addison), second edition, *review* by B. C., 79
Hydraulics : Model Research in, *review* by Prof. J. Th. Thijsse, 219
Hydrocarbon Compounds : Encyclopedia of (compiled by Dr. Joseph Escott Faraday), Vol. 4, C_9, *review*, 583
Hydrocarbon Pentalene : The Non-Benzenoid Aromatic (D. P. Craig and Allan Maccoll), 481
Hydrocarbons (Higher) : 'Low-Temperature' Oxidation of, at Atmospheric Pressure (Dr. G. Friedlander and L. Grunberg), 360
Hydrocorals of the John Murray Expedition to the Indian Ocean (Dr. Hjalmar Broch), 822
Hydrogen : Fractional Distillation and its Application in the Concentration of the Heavy Isotopes of Oxygen and (Dr. I. Dostrovsky, Prof. E. D. Hughes and Dr. D. R. Llewellyn), 858
Hydrogen and Hydroxyl Ions in Aqueous Solutions : Mechanism of Conductance by (Dr. S. I. Weissman), 241
Hydrogen Ion in Oxygen-containing Solvents : Solvation of (Dr. Ernest A. Braude and E. S. Stern), 169
Hydrogen Peroxide : Reaction between Catalase and (R. Lemberg and E. C. Foulkes), 131
Hydrolysates (Bacterial) : New Amino-Acids in (A. Polson), 351
Hydrolysis and Utilization of Polysaccharide-like Substances ('Mucin') in Saliva : Bacterial (Dr. H. J. Rogers), 815
Hydroquinone on Mitosis : Early Effects of (R. Parmentier and Dr. P. Dustin, jun.), 527
Hydroxy Peroxides : Formation of (C. A. Bunton, E. S. Halberstadt, A. J. Everett and Dr. G. J. Minkoff), 172
p-Hydroxybenzil (John H. Gorvin), 208
Hydroxyl Ions in Aqueous Solutions : Mechanism of Conductance by Hydrogen and (Dr. S. I. Weissman), 241
Hymenoptera (Social) : Regulation of Oviposition in (M. V. Brian and A. D. Brian), 854

ICE Cream Industry (Grover Dean Turnbow, Prof. Paul Hubert Tracy and Lloyd Andrew Raffetto), second edition, *review* by Dr. L. H. Lampitt, 500
Identification of Important Indian Timbers, 881
Identification of Methylated Sugars on the Paper Chromatogram : Separation and (F. Brown, Prof. E. L. Hirst, L. Hough, Dr. J. K. N. Jones and H. Wadman), 720
Ignition Reactions in the Gas Phase : The Kinetics and Mechanism of Combustion and (International symposium on), 347
Illumination (Artificial) : Progress in, 821
Impact : Birth and Growth of the Explosion in Solids Initiated by (Dr. F. P. Bowden and O. A. Gurton), 348
  Gases Liberated from Explosions Initiated by (Dr. A. J. B. Robertson and A. Yoffe), 806
Importation of Books into Britain (Lord Balfour of Inchrye), 304 ; (Lord Chorley), 304
Imports of Scientific and Technical Books, 75
Inactivation of Flavine Adenine Dinucleotide by Tissue Extracts (R. S. Comline and F. R. Whatley), 350
Inanition in Grass Seedlings : Resistance to (H. G. Chippindale), 65 ; (J. P. Cooper), 894
Inbred Strains of Mice : Ultracentrifugation and Electron Microscope Studies of Tissues of (Prof. R. D. Passey, Dr. L. Dmochowski, Prof. W. T. Astbury, Dr. R. Reed and Dr. P. Johnson), 759
Incentives in Industry (Prof. C. A. Mace), 429
Incidents and Reflections (J. B. Atkin), 866
India : Mathematics in, *review* by Prof. E. H. Neville, 580
  Scientific Research in (National Institute of Sciences of India symposium on), 513
  Vegetable Tanning Materials of, 255
India (Netherlands) : Colonial Policy and Practice, a Comparative Study of Burma and (J. S. Furnivall), *review* by Maurice Bruce, 908
Indian Art : Exhibition of (Prof. J. H. Hutton), 119
Indian Mathematics and Vedha : Ancient (Prof. L. V. Gurjar), *review* by Prof. E. H. Neville, 580
Indian Timbers : Identification of Important, 881
Indians before Columbus (Paul S. Martin, George I. Quimby and Donald Collier), *review* by Dr. G. H. S. Bushnell, 501
Indium : Interaction of Fast Neutrons with (S. G. Cohen), 475
Individual : Society and the (British Social Hygiene Council Ethics and Science conference on), 197
Individual Freedom and Social Responsibility : Conference on, 843
Inductance : Thermal Mutual (Dr. R. C. L. Bosworth), 166
Induction of Tumours by Chemical Compounds, *review* by Prof. E. Boyland, 621
Industrial Co-operation : The Short Road to (British Association for Commercial and Industrial Education), 571
Industrial Development : Scientific Research and, 699
Industrial Experimentation (K. A. Brownlee), third edition, *review* by M. R. Sampford, 747
Industrial Fibres (Commonwealth Economic Committee), 961
Industrial Research, 1947 (edited by Dr. Percy Dunsheath), *review* by R. Brightman, 705
Industrial Research in East Africa, 122
Industrial Research in Palestine : Scientific and, 800
Industries : Plan your Own (M. P. Fogarty), 183
Industries (Nationalized) : Responsibility in, 619
Industry : Conscription and (D. R. O. Thomas), 304
  Democracy and (C. Reaveley and J. Winnington), 109
  Democracy in, 109
  Electronics for (W. I. Bendz, with the assistance of C. A. Scarlott), *review* by Prof. J. Hollingworth, 582
  The Human Factor in (P.E.P. Broadsheet No. 14), 780
  Human Factors in (British Association, Division for Social and International Relations of Science, conference on), 514, 791
  Incentives in (Prof. C. A. Mace), 429
  Learning and, 881
  The Psychology of (Prof. James Drever), second edition, *review* by T. H. Hawkins, 955
  Research in—Working Party Reports, 448
  Science and the Progress of (Sir Edward Appleton), 368
  Scientific Research and, 368
  The Scientist in (Sir Edward Appleton), 508, 537
Industry and Commerce : Education in, 801
Industry and Research : Electronics and their Application in (edited by Dr. Bernard Lovell), *review* by Dr. T. E. Allibone, 702
Industry and Research in Wales (Industrial Research Committee of the Federation of British Industries and the Industrial Association of Wales and Monmouthshire joint regional conference on), 233
Industry to Science : A Tribute of, 508
Industry and Society : Men of Science in, *review* by R. Brightman, 374
Infection in *Coffea arabica* L. : Latent (R. W. Rayner), 245
Infections : Natural Amœbic, in Laboratory Rodents (Dr. J. D. Fulton and J. P. Joyner), 66
Infectious Diseases : Thyroid Gland as a Special Factor Influencing the Conditional Disposition to (Dr. S. Zimanyi), 57
Influence of Temperature on the Urea Denaturation of β-Lactoglobulin (C. F. Jacobsen and L. Korsgaard Christensen), 30
Influence of Vitamin P (Vitamin C_2) upon the Amount of Ascorbic Acid in the Organs of the Guinea Pig (H. Cotereau, M. Gabe, E. Géro and Prof. J.-L. Parrot), 557
Information : British Sources of Reference and (edited by Theodore Besterman), *review* by R. Brightman, 789
Information on Atomic Energy : Release of, 146
Infra-Red Absorption Spectra of Crystals (Sir C. V. Raman), 165
Infra-Red Energy : Applications of Germicidal, Erythemal and (Dr. Matthew Luckiesh), *review* by H. G. Jenkins, 542
Infra-Red Radiation : Biological Applications of Ultra-violet and, *review* by H. G. Jenkins, 542
Infra-Red Spectroscopy : Lead Telluride Cells for (O. Simpson, Dr. G. B. B. M. Sutherland and Dr. D. E. Blackwell), 281
Inheritance of Sex Forms in *Luffa acutangula* Roxb. (H. B. Singh, S. Ranmanujam and B. P. Pal), 775
Inhibition of SH Enzymes by Methyl Bromide (S. E. Lewis), 692
Inhibition of Hexosediphosphatase by Sulphhydryl Reagents and by Ascorbic Acid (Dr. E. O'F. Walsh and Mrs. G. Walsh), 976
Inhibition of the Photodynamic Action of 3 : 4 Benzpyrene (G. Calcutt and J. P. Newhouse), 53
Initiation of Explosives by Adiabatic Compression of their own Vapour (A. Yoffe), 349
Initiation of High Explosives (Prof. G. Herzberg and G. R. Walker), 647
Inland Fisheries : Report on Sea and (Government of Northern Ireland), 451
Inland Waters : Ciliate Protozoan Fauna of Soil and (Ernest Gray), 854
Inner-Complex Salts of Trivalent Thallium (Prof. Fr. Feigl), 436
Insect Pests of Flour (J. A. Freeman and E. E. Turtle), 554
Insecticidal Smokes, 574
Insecticides : 'Agrocide' Range of (Plant Protection, Ltd.), 595
Insects : Simple Experiments with (Dr. H. Kalmus), *review* by Dr. V. B. Wigglesworth, 955
Insemination (Artificial) : First International Congress on the Physiology and Pathology of Animal Production and on, 197
Insemination of Farm Animals : The Artificial (John W. Bartlett, George E. Taylor, Joseph Edwards, Clair E. Terrill, Victor Berliner and Fred P. Jeffrey), edited by Enos J. Perry, *review* by Dr. John Walton, 831
Instruction : Audiovisual Aids to (William Exton Jr.), *review* by Lieut.-Colonel Eric Lowe, 745
Instruments : British Scientific (Dr. A. B. Wood), 732
  Export Organisation for, 345
Insulating Materials and Methods for Use at Low Temperatures (Low Temperature Group of the Physical Society discussion on), 323
Insulation Resistance (Electrical) : Treatment of Glass and Steatite Ceramic with Quaternary Ammonium Compounds for the Improvement of (J. S. Dryden and R. J. Meakins), 23
Insulin (Pancreatic) : Relation of Intermediary Metabolites to the Lowering of the Potency of, in the Animal System (Prof. M. C. Nath and H. D. Brahmachari), 18
Insulin on Intestinal Glucose Absorption in Alloxan Diabetic Rats : Effect of (Dr. A. Sols, S. Vidal and J. Larralde), 932
Intelligence (National) : The Trend of (Prof. Godfrey Thomson, with a Symposium by Sir Alexander Carr-Saunders, Sir Cyril Burt, Prof. Lionel Penrose and Prof. Godfrey Thomson), *review* by Dr. Julian Blackburn, 37
Intelligent Man's Guide to the Post-War World (G. D. H. Cole), *review* by Maurice Bruce, 151
Intensity of Cosmic Radio Noise : Frequency Variation of the (Jack W. Herbstreit and Joseph R. Johler), 515
Interaction of Fast Neutrons with Indium (S. G. Cohen), 475
Interaction of Water and Porous Materials (Faraday Society General discussion on), 307, 629
Interaction Terms in Molecular Vibrations (D. F. Heath and Dr. J. W. Linnett), 243
Interferometry (Multiple-Beam) : Application of, to the Study of Oscillating Quartz Crystals (Prof. S. Tolansky and W. Bardsley), 925
Intermediary Metabolites : Relation of, to the Lowering of the Potency of Pancreatic Insulin in the Animal System (Prof. M. C. Nath and H. D. Brahmachari), 18

Internal Secretion, *review* by Dr. F. H. A. Marshall, 953
Internal Stresses in Metals (W. A. Wood and N. Dewsnap), 682 ; (G. B. Greenough), 683
Internal Stresses in Metals and Alloys (Institute of Metals, in association with the Faraday Society, the Institute of Physics, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Physical Society and the Royal Aeronautical Society symposium on), 70
Internal Stresses in Silver Chloride caused by Plastic Deformation : Photo-elastic Investigation of (J. F. Nye), 367
Internal Waves in certain Types of Density Distribution (Dr. P. Groen), 92
International Aspects of the Radio-Frequency Spectrum, 863
International Colloquium on Isotope Exchange and Molecular Structure, 901
International Conference on Large Electric Systems, 163
International Conference on the Emission Spectra of the Night Sky and Auroras : Physical Society to arrange for separate publication of papers read before the, 514
International Conference on the Physics of Metals (Netherlands Physical Society), 389
International Conference on Powder Metallurgy (Steirmark Branch of the Association of Austrian Chemists), 307
International Conference on Sleeping Sickness, 306
International Congress of Anthropological and Ethnological Sciences, 88
International Congress of Applied Mechanics : Seventh, 232
International Congress of Crystallography, 124
International Congress on the Physiology and Pathology of Animal Production and of Artificial Insemination : First, 197
International Congress on Population and World Resources in relation to the Family (Planning Association of Great Britain), 882
International Congress of Zoology : Thirteenth, 924
International Control of Atomic Energy, 291
International Co-operation : Colonial Development and, 371
International Geological Congress, 88
International Holiday Centre (To be organised by the French Association of Scientific Workers), 1007
International Meeting on Animal Production (I. L. Mason), 322
International Pharmacopœia : Towards an, 33
International Plastics Annual 1947 : The British, *review* by Dr. S. R. Carter, 581
International Radio Conferences in Stockholm, 695
International Radio and Telecommunication Conferences at Atlantic City, 863
International Repercussions : Economic Conditions of Germany To-day and its (International Chamber of Commerce), 659
International Rheological Congress at Scheveningen, 105, 636
International Seismological Summary, 923
International Sericultural Congress : Seventh (French National Institute of Agronomic Research), 307
International Study of Rheology, 104
International Symposium on the Kinetics and Mechanism of Combustion and Ignition Reactions in the Gas Phase, 347
International Symposium on Noise (Acoustics Group of the Physical Society and the Royal Institute of British Architects), 197
International Telecommunication and Radio Conferences at Atlantic City, 863
International and Cultural Relations of Social Biology (British Social Hygiene Council Summer School on), 842
Interspecific Fertilization in Ascidians (Dr. Antonio Minganti), 643
Intestinal Glucose Absorption in Alloxan Diabetic Rats : Effect of Insulin on (Dr. A. Sols, S. Vidal and J. Larralde), 932
Intracellular Determination of Protein by X-Ray Microspectrography (Dr. A. Engström and M. A. Jakus), 168
Intravenous Methylene Blue, a New Method for Studying the Nervous System (W. H. Feindel, D. C. Sinclair and Dr. G. Weddell), 318
Inventions Bill : Development of, 700
Iodinated Casein and Stilbœstrol : Stimulation of Growth in Pigs by (Dr. R. Braude), 856
Ion-Exchange Treatment on the Stability of Apple Juice : Effect of (Dr. S. W. Challinor, Margaret E. Kieser and Dr. A. Pollard), 1023
Ion-Exchangers (Synthetic Resin) : Separation of Pyrimidine Nucleosides by (D. T. Elmore), 931
Ionic Charges on the Energy and Entropy of Activation of Heterolytic Reactions : Effect of (J. Gripenberg, Prof. E. D. Hughes and Prof. C. K. Ingold), 480
Ionic Splitting of Rays Reflected from the F_2 Region : Triple Magneto (Gordon Newstead), 312
Ionization Potential and the Polarizability for some Halogen Compounds : Variation of the Force Constant with the (P. Torkington), 724
Ionizing Radiations : Chemical Effects of (Gabriel Stein and Dr. Joseph Weiss), 650
Ionogenic Surfaces : Adsorption on to (Dr. P. H. Plesch and R. H. S. Robertson), 1020
Dehydro-β-Ionone : Synthesis of (Dr. H. B. Henbest), 481
Ionosphere at Calcutta : Abnormalities in the *F*-Region of the (S. S. Baral, S. N. Ghosh and M. Debray), 24
Ionospheric Absorption : Anomalous Effect of (Sir Edward Appleton, W. J. G. Beynon and W. R. Piggott), 967
Ionospheric *D*-Layer : Electrical Conductivity of the (Prof. T. G. Cowling and R. Borger), 515
Ionospheric Rays : Triple Splitting (J. H. Meek), 597 ; (T. L. Eckersley), 597
Ireland : Megalithic Tombs in Scotland and (Prof. V. Gordon Childe), 841
Ireland (Northern) : Scientific Research and Development in, 162
Iron Alum Acetocarmine Method for Algæ (Dr. M. B. E. Godward), 203
Iron Status of Plants : Relation of Manganese and some other Metals to the (Eric J. Hewitt), 489
Irrigation (Ministry of Agriculture Bulletin 138), 196
Islands : Natural History in the Highlands and (Dr. F. Fraser Darling), *review* by Prof. A. D. Peacock, 457
Isolation in Chick Embryos of a Filtrable Agent possibly related etiologically to Lumpy Skin Disease of Cattle (Prof. M. van den Ende, P. Don, A. Kipps and R. Alexander), 526
Isolation of a New Androstenol-3(α)-on-17 from the Urine of a Patient with Adrenal Cancer (Dr. Elizabeth Dingemanse, Leonora G. Huis in 't Veld and S. Lore Hartogh-Katz), 848
Isolation of Stilbœstrol Monoglucuronide from Human Urine (K. S. Dodgson and Dr. R. Tecwyn Williams), 604
Isomerization of Dienœstrol (W. Hausmann and Dr. A. E. Wilder Smith), 892
Isotope Exchange and Molecular Structure : International Colloquium on, 901
Isotopes (Radioactive and Stable Tracer) : Determination of (Physical Methods Group of the Society of Public Analysts and other Analytical Chemists symposium on), 693
Isotopes of Gaseous Elements : Mass-Spectrographic Separation of (Dr. J. Koch), 566
Isotopes of Oxygen and Hydrogen : Fractional Distillation and its Application in the Concentration of the Heavy (Dr. I. Dostrovsky, Prof. E. D. Hughes and Dr. D. R. Llewellyn), 858
Isotopes (Heavy) : Mass-Defects of the (A. H. Wapstra), 529
Itaconic Acid and Kojic Acid : Production of, by a Species of *Aspergillus* (John L. Yuill), 397
Italy : Earthquake at Lado d'Iseo on December 25, 306

JADE : Adventure in (James Lewis Kraft), *review*, 786
Japanese Culture : A Study of, *review* by Peter Lawrence, 77
Jellyfish from the Basal Cambrian in South Australia (Reg. C. Sprigg), 568
Jewett (Frank B.) Fellowship Awards for 1948–49 (American Telephone and Telegraph Co.), 429
Joints (Normal and Infected) : Absorption of Protein and Bacteria from (Torbjörn Edlund), 102
Journalism (Scientific) : Awards for, 125
Jubilee of the Discovery of the Electron, 16
Juice (Apple) : Effect of Ion-Exchange Treatment on the Stability of (Dr. S. W. Challinor, Margaret E. Kieser and Dr. A. Pollard), 1023
Jute : X-Ray Investigation of the Structure of (M. K. Sen and H. J. Woods), 768

KASHMIR : Occurrence of Volcanic Bomb in the Agglomeratic Slates of (Dr. R. C. Misra), 895
Kauri in New Zealand : Preservation of the (Prof. V. J. Chapman), 72 ; (Prof. H. G. Champion), 72
Keith Prize for 1945–47 of the Royal Society of Edinburgh awarded to Dr. Charlotte Auerbach, 716
Khartoum : Extermination of *Aedes aegypti* in (R. Kirk), 139
Kidney (Aglomerular Fish) : A Vasodilator, Adrenolytic Substance in (Dr. Benjamin Jablons), 100
Kinetics and Mechanism of Combustion and Ignition Reactions in the Gas Phase : International symposium on, 347
Klystrons and Microwave Triodes (Prof. Donald R. Hamilton, Prof. Julian K. Knipp and J. B. Horner Kuper), *review* by Prof. J. T. Randall, 952
Kojic Acid : Production of Itaconic Acid and, by a Species of *Aspergillus* (John L. Yuill), 397
Koper als onmisbaar element voor plant en dier (W. J. Melchers en H. J. Gerritsen), *review*, 624

LA Venta : Some Implications of the Ceramic Complex of (Dr. Philip Drucker), 594
Laboratory Animals : The UFAW Handbook on the Care and Management of (edited by Prof. Alastair N. Worden), *review* by Frances Pitt, 664
Laboratory Conditions (Customary) : pH of Trisodium Citrate Solutions stored under (J. Jordan and Dr. M. Bobtelsky), 240
Laboratory Rodents : Natural Amœbic Infections in (Dr. J. D. Fulton and J. P. Joyner), 66
Lachrymators with Enzymes and Proteins : Reactions of (Dr. M. Dixon), 226
Lactic Cocci (Gorini's Acid-Proteolytic) : Behaviour of, with Penicillin (Annamaria Torriani), 275
β-Lactoglobulin : Influence of Temperature on the Urea Denaturation of (C. F. Jacobsen and L. Korsgaard Christensen), 30
Lake Windermere in relation to the Quaternary History of the British Isles : Bottom Deposits of (Dr. H. G. Baker), 987
Lamb Serum Before and After Transfer of Colostrum : Electrophoretic Patterns of (P. A. Charlwood and A. Thomson), 59
Lamellibranchia : Formation of Siphons in (Prof. C. M. Yonge), 198
Laminariales (Common British) : Seasonal Variation in Chemical Constitution of some (Dr. W. A. P. Black), 174
Laminating of Plastics : Low-Pressure (J. S. Hicks, assisted by R. J. Francis), *review* by J. M. J. Estevez, 788
Lamm Scale Method for Measuring Refractive Index Gradients : A Short-Focus Modification of the (Harry Svensson), 234
Land : The Schools and the (British Social Hygiene Council Summer School on), 470
Land and Landscape (Brenda Colvin), *review* by Prof. L. Dudley Stamp, 868
Land Use and Service Requirements in Britain, 149
Land Utilization : Food Production and, 905
Land of Britain, its Use and Misuse : The (Prof. L. Dudley Stamp), *review* by Sir John Russell, 906
Landscape : Land and (Brenda Colvin), *review* by Prof. L. Dudley Stamp, 868
Landscape Architecture, *review* by Prof. L. Dudley Stamp, 868
Langley Memorial Prize for 1948, 233
Language : A Planned Auxiliary (H. Jacob), *review*, 665
Larvæ of Anuran Amphibia : Mauthner's Cells in the (A. G. Willis), 65
Lasker Group Award for 1947 presented by the American Public Health Association to the British Ministries of Food and Health, 16
Late-Glacial *Armeria* : Significance of Pollen Dimorphism in (Dr. H. G. Baker), 770
Latent Infection in *Coffea arabica* L. (R. W. Rayner), 245
Latex (Fresh *Hevea*) : Complexity of (L. N. S. Homans, J. W. van Dalfsen and G. E. van Gils), 177
Latin America : Forage Resources of (Hugo W. Alberts), 657
Latin American Cultures (Dr. G. H. S. Bushnell), 697
Lattice Distortions on the Mean Rate of Propagation of Large Barkhausen Discontinuities : Effect of (Dr. L. J. Dijkstra and Dr. J. L. Snoek), 886

Laurentian Hormone Conference, *review* by Prof. S. Zuckerman, 295
Law (Dr. Bimala Churn) Gold Medal of the Royal Asiatic Society of Bengal awarded to Dr. B. M. Barua, 553
Law (Joy Gobind) Memorial Medal of the Royal Asiatic Society of Bengal awarded to Dr. Lieven Ferdinand de Beaufort, 553
Layman: Atoms for the, *review* by Prof. P. B. Moon, 582
Lead : Scattering of Neutrons by (R. Latham and J. M. Cassels), 282
Pb^{208} : Spin-Dependence of Magnetic Dipole Gamma Radiation and the Nuclear Level Scheme of (Dr. H. O. W. Richardson), 516
Lead Selenide : Spectral Response of (T. S. Moss and R. P. Chasmar), 244
Lead Selenide Layers : High-Frequency Characteristics of Lead Sulphide and (R. P. Chasmar), 281
Lead Sulphide and Lead Selenide Layers : High-Frequency Characteristics of (R. P. Chasmar), 281
Lead Telluride Cells for Infra-Red Spectroscopy (O. Simpson, Dr. G. B. B. M. Sutherland and Dr. D. E. Blackwell), 281
Lead Telluride Layers : Spectral Sensitivity of (T. S. Moss), 766
Leadership (Personal) : Power and, 654
Leaf Rust of Wheat : The Nature and Prevention of Cereal Rusts as Exemplified in the (Dr. K. Starr Chester), *review* by P. H. Gregory, 220
Learning and Industry, 881
Leaves (Foliage) : Threshold Value of Carbon Dioxide Concentration in Photosynthesis of (Dr. E. K. Gabrielsen), 138
Lens-cleaning Tissues (J. Barcham Green, Ltd.), 514
Lenses (Electrostatic) : Chromatic Aberration of (W. A. Le Rütte), 392
Letters from Skokholm (R. M. Lockley), *review* by Frances Pitt, 5
Leucocyte Count in Leukæmia : Effect of *p*-Aminobenzoic Acid on the (Dr. J. Bichel), 353
Leukæmia : Effect of *p*-Aminobenzoic Acid on the Leucocyte Count in (Dr. J. Bichel), 353
Lewis Acids : Olefine Reactions Catalysed by (Dr. John W. Baker), 171
Libraries : Public, in Germany (H. Schurer), 90
Lice (Dr. John Smart), second edition, 389
Life : Controlling the Staff of, *review* by A. L. Bacharach, 293
Life (Cosmic and Human) : Atomic Energy in (Prof. George Gamow), *review* by Prof. J. A. Crowther, 4
Life (Volitional) : An Analysis of (C. Lambek), translated from the Danish by Agnete Kortsen, *review* by Dr. Clifford Allen, 789
Life through Geological Time : The Succession of (British Museum (Natural History) exhibits), 429
Life, Literature and Art : The Alchemist in (Prof. John Read), *review* by T. I. W., 787
Light : Diffraction of, by Very High Frequency Ultrasonic Waves (Prof. S. Bhagavantam and B. Ramachandra Rao), 927
  Radiation Damping and Velocity of (Prof. W. Heitler), 678
Light, Vision and Seeing (Dr. Matthew Luckiesh), fourth printing, *review* Dr. R. W. Pickford, 40
Light Elements Bombarded with α-Particles from Polonium : Excitation Curves for the γ-Radiation from (Prof. Hilding Slätis), 899
Lighting : Exhibition of the Development of (Science Museum), 674, 821
Lightning Arrester Discharge Currents (Robert C. Cuffe), 885
Lime Trees : Honeydew on (C. A. Mawson), 176
Limitation of Bacteria by Micro-Predators in Soil (Dr. F. J. Anscombe and Dr. B. N. Singh), 140
Linnean Gold Medal for 1948 awarded by the Linnean Society of London to Dr. Agnes Arber, 272, 882
Linoleic Acid in Oxidation with Lipoxidase : Total Conjugation of (Prof. Sune Bergström and Ralph T. Holman), 55
Lipidic Layer in the Liver Cell : A Cytochemical Study of the Perinuclear (Dr. C. A. Baud), 559
Lipoids : Physiology and Biochemistry of Fats and (Le Centre National de le Recherche scientifique symposium on), 534
Lipoxidase : Total Conjugation of Linoleic Acid in Oxidation with (Prof. Sune Bergström and Ralph T. Holman), 55
Liquid Fuels : Modern Applications of (Institute of Petroleum and the Institute of Fuel joint conference on), 677, 1007
Liquid Helium II (Dr. H. S. Green), 391
Liquid Helium Films : Transfer Rates in (K. R. Atkins), 925
Liquids : Coefficients of Viscosity and Thermal Conduction in Dense Gases and (L. M. Yang), 523
Liquids (Organic) : Ultrasonic Dispersion in (Dr. A. Schallamach), 476
Literature (Scientific) : References in (Prof. R. A. Peters), 731
Literature on Silk : Bibliography of the Technical (Dr. F. O. Howitt), *review* by Prof. J. B. Speakman, 790
Literature and Art : The Alchemist in Life, (Prof. John Read), *review* by T. I. W., 787
Li^8 in the Explosive Disintegration of Nuclei : Emission of (C. Franzinetti and R. M. Payne), 735
Live in the Sea : They (Douglas P. Wilson), *review* by Dr. L. Harrison Matthews, 40
Liver : Purification of Anti-pernicious Anæmia Factors from (Dr. E. Lester Smith), 638, 676
Liver (Mammalian) : Higher Fatty Acid Dehydrogenase of (K. Burton), 606
Liver Cell : A Cytochemical Study of the Perinuclear Lipidic Layer in the (Dr. C. A. Baud), 559
Lives of the Alchemists : Private, *review* by T. I. W., 787
Living Lymphocytes *in vitro* : Failure of Adrenal Cortical Extracts to cause Lysis of (J. S. Robertson), 814
Living Plant : Botany of the (Prof. F. O. Bower), fourth edition, *review* by Prof. F. T. Brooks, 153
Lloyd George Mountains in Northern Canadian Rockies : Exploration of the (Dr. N. E. Odell), 327
Load Dispatching and the British Grid System (A. R. Cooper), 822
Local Government (Sir A. S. MacNalty), *review* by Lieut.-Colonel Eric Lowe, 870
Local Government in Britain, 825
Local Government and the Citizen, *review* by Lieut.-Colonel Eric Lowe, 870
Local Government Reform (J. Blackburn), 825
Local and Regional Government (G. D. H. Cole), 825
Locomotion of Whales : Aspects of the (R. W. L. Gawn), 44 ; (Prof. J. Gray), 199 ; (Dr. D. A. Parry), 200
Locust Integument : The Carotenoids of the (T. W. Goodwin and S. Srisukh), 525
Locusts : Aircraft Attack on (Dr. D. L. Gunn), 342
Logic : A Preface to (Morris R. Cohen), *review* by Prof. A. D. Ritchie, 623
Logical Realism, *review* by Prof. A. D. Ritchie, 623
Logik und Erfahrung : Mathematik, (Prof. Dr. Victor Kraft), *review* by F. I. G. Rawlins, 666
London's Transport System (R. H. Macmillan), 942
Long-Distance Correlation of Boulder Clays (D. F. W. Baden-Powell), 287
Lorentz-like Transformations (P. T. Landsberg), 208 ; (Prof. Herbert Dingle), 209
Louse : The (Prof. Patrick A. Buxton), second edition, *review* by Dr. A. D. Imms, 418
Low-Frequency Noise from Thermionic Valves working under Amplifying Conditions (Dr. E. J. Harris and P. O. Bishop), 971
Low-Pressure Laminating of Plastics (J. S. Hicks, assisted by R. J. Francis), *review* by J. M. J. Estevez, 788
Low-Temperature Oxidation of Higher Hydrocarbons at Atmospheric Pressure (Dr. G. Friedlander and L. Grunberg), 360
Low-Temperature Physics (Dr. K. Mendelssohn), 732
Low Temperatures : Insulating Materials and Methods for Use at (Low Temperature Group of the Physical Society discussion on), 323
Lowering of the Potency of Pancreatic Insulin in the Animal System : Relation of Intermediary Metabolites to the (Prof. M. C. Nath and H. D. Brahmachari), 18
Loyalty : Freedom and, 537
Luffa acutangula Roxb. : Inheritance of Sex Forms of (H. B. Singh, S. Ramanujam and B. P. Pal), 775
Luminescence in Zinc Sulphide : Relation between Photoconduction and (Dr. M. H. F. Wilkins and Dr. G. F. J. Garlick), 565
Luminescence Efficiency Changes in Zinc Sulphide Phosphors below Room Temperature (Dr. G. F. J. Garlick and A. F. Gibson), 359
Luminous Gas : A Bunsen Flame as a Column of (Dr. A. S. Leah and Prof. W. T. David), 524
Lumpy Skin Disease of Cattle : Isolation in Chick Embryos of a Filtrable Agent possibly related etiologically to (Prof. M. van den Ende, P. Don, A. Kipps and R. Alexander), 526
Lyell Fund of the Geological Society awarded to Dr. Dorothy Rayner and W. D. Ware, 122
Lyell Medal of the Geological Society awarded to Prof. A. H. Cox, 122
Lymnæa truncatula : A Culture Method for (E. L. Taylor and Alan Mozley), 894
Lymphocytes *in vitro* : Failure of Adrenal Cortical Extracts to cause Lysis of Living (J. S. Robertson), 814
Lysis of Living Lymphocytes *in vitro* : Failure of Adrenal Cortical Extracts to cause (J. S. Robertson), 814

MACHINERY of Government, 495
Macromolecules : Normal Stress Coefficient in Solutions of (R. S. Rivlin), 567
Macropus : Vascular Patterns in the Testis, with particular reference to (Dr. R. G. Harrison), 399
Magnetic Alloy : "Supermalloy," a New (O. L. Boothby and R. M. Bozorth), 554
Magnetic Data : World (Comdr. Elliott B. Roberts), 677
Magnetic Dipole Gamma Radiation and the Nuclear Level Scheme of Pb^{208} : Spin-Dependence of (Dr. H. O. W. Richardson), 516
Magnetic Equator : Daily Variation of the Horizontal Magnetic Force at the (J. Egedal), 443
Magnetic Field : Optical Transmission of a Colloidal Solution in a (F. D. Stott and Dr. A. von Engel), 728
Magnetic Field of Massive Rotating Bodies (Prof. H. T. H. Piaggio), 450
Magnetic Field of the Moon : Cosmic Rays and the (Dr. M. S. Vallarta), 646
Magnetic Field of Rotating Bodies : Blackett's Hypothesis of the (Dr. Niels Arley), 598 ; (Dr. J. Fuchs), 599
Magnetic Fluctuations : Audio-Frequency (H. F. Willis), 887
Magnetic Force at the Magnetic Equator : Daily Variation of the Horizontal (J. Egedal), 443
Magnetic Observations and Thermometry in the Region of Millidegrees Absolute (D. de Klerk), M. J. Steenland and Prof. C. J. Gorter), 678
Magnetic Susceptibility : Catalytic Poisons and (M. H. Dilke, Dr. D. D. Eley and Dr. E. B. Maxted), 804
Magnetic Susceptibility of Borax Glasses containing Crystallites of Alkali Metal Salts, Gold and Platinum (Prof. Subodh Kumar Majumdar), 684
Magnetic Susceptibility of Mica (J. T. Kendall and D. Yeo), 476
Magnetism : Elementary Theory of Electricity and, *review* by Prof. L. F. Bates, 829
  Modern (Prof. L. F. Bates), second edition, *review* by E. C. S., 871
Magnetism and Modern Physics : Electricity, (Dr. G. T. P. Tarrant), *review* by Prof. L. F. Bates, 829
Magneto Ionic Splitting of Rays Reflected from the F_2 Region : Triple (Gordon Newstead), 312
Magnetrons : Pinhole Radiography of (Dr. R. Dunsmuir, Dr. C. J. Milner and A. J. Spayne), 244
Malaria Parasites (Mammalian) : Pre-erythrocytic Stage in (Prof. H. E. Shortt and P. C. C. Garnham), 126 ; (Dr. Frank Hawking), 175
Malaria-infected Monkeys : Hæmolytic System in the Blood of (Dr. H. Laser), 560
Maleic Anhydride to Anethole : Addition of (Prof. V. Bruckner and Dr. J. Kovács), 651
Mammalian Liver : Higher Fatty Acid Dehydrogenase of (K. Burton), 606
Mammalian Malaria Parasites : Pre-erythrocytic Stage in (Prof. H. E. Shortt and P. C. C. Garnham), 126 ; (Dr. Frank Hawking), 175
Mammals of Eastern Asia (G. H. H. Tate), *review* by T. C. S. M.-S., 188
Mammary Gland : Respiratory Quotient of the (Dr. S. J. Folley and T. H. French), 933
Man : The Argument from Mouse to, *review* by Prof. C. H. Waddington, 543
  Effect of Under-Nutrition in, on Hepatic Structure and Function (Sheila Sherlock and Veryan Walshe), 604
Man in the Desert : Physiology of (E. F. Adolph and associates), *review* by Dr. B. McArdle, 744
Man's Guide to the Post-War World : The Intelligent (G. D. H. Cole), *review* by Maurice Bruce, 151
Man's Organs of Speech (Prof. H. A. Harris), 628

Man-Power in Britain : Mobility of, 453
Management : Research on, *review* by E. F. L. Brech, 869
  Scientific, *review* by J. Leigh, 910
  Skill and (G. E. Milward), *review* by J. Leigh, 910
Management (Business) : The Board of Directors and (Melvin T. Copeland and Asst. Prof. Andrew R. Towl), *review* by E. F. L. Brech, 869
Management of Laboratory Animals : The UFAW Handbook on the Care and (edited by Prof. Alastair N. Worden), *review* by Frances Pitt, 664
Manganese and some other Metals : Relation of, to the Iron Status of Plants (Eric J. Hewitt), 489
Manganese Dioxide : Reaction between Manganous Ion and (J. M. Cowley and Allan Walkley), 173
Manganous Ion and Manganese Dioxide : Reaction between (J. M. Cowley and Allan Walkley), 173
Manipur : War-time Explorations in (F. Kingdon Ward), 636
Mankind So Far (Prof. William Howells), *review*, 579
Manx Shearwater (*Puffinus p. puffinus*) : Puffinosis, a Virus Epizootic of the (J. A. R. Miles and M. G. P. Stoker), 1016
Mare (Pregnant) : Ovarian Activity in the (Prof. E. C. Amoroso, J. L. Hancock and Dr. I. W. Rowlands), 355
Marine Biology : Recent Research in (Dr. N. B. Eales), 737
Marine Fish Cultivation : An Experiment in (L. H. N. Cooper and G. A. Steven), 631
Marketing Agricultural Produce (Thomas Shaw), 470
Mars : Atmosphere of (Dr. G. P. Kuiper), 594
Mass of Mesons : A New Method for the Determination of the (Dr. C. F. Powell and Dr. S. Rosenblum), 473
Mass of σ-Mesons (S. Lattimore), 518
Mass-Defects of the Heavy Isotopes (A. H. Wapstra), 529
Mass-Spectrographic Separation of Isotopes of Gaseous Elements (Dr. J. Koch), 566
Massive Rotating Bodies: Magnetic Field of (Prof. H. T. H. Piaggio), 450
Material (Granular) : Mechanics of Packings of (D. R. Hudson), 512
Materials : Aircraft Strength of (Dr. H. D. Conway), *review*, 503
Materials (Porous) : Interaction of Water and (Faraday Society discussion on), 629
Mathematical Congress, Montreal 1945 : Proceedings of the First Canadian, *review* by H. T. H. P., 666
Mathematical Journal : A New, 636
Mathematical Theory of Rocket Flight (Prof. J. Barkley Rosser, Dr. Robert R. Newton and Dr. George L. Gross), *review* by Dr. R. A. Rankin, 3
Mathematical Theory of Tetraploidy (Prof. R. A. Fisher), 758
Mathematics : Modern Electrical Engineering (S. Austen Stigant), *review* by V. J. Francis, 541
Mathematics at Birkbeck College, London, 756
Mathematics for Electrical Engineering, *review* by V. J. Francis, 541
Mathematics in India, *review* by Prof. E. H. Neville, 580
Mathematics of Statistics (John F. Kenney), Part I, second edition, *review* by P. A. Moran, 544
Mathematics at the University of Leeds, 467
Mathematics at University College, Leicester, 344
Mathematics and Mechanics : Manual of (Prof. Guy Roger Clements and Prof. Levi Thomas Wilson), second edition, *review*, 789
Mathematics and Vedha : Ancient Indian (Prof. L. V. Gurjar), *review* by Prof. E. H. Neville, 580
Mathematik, Logik und Erfahrung (Prof. Dr. Victor Kraft), *review* by F. I. G. Rawlins, 666
Mathematische Werke (Johann Heinrich Lambert), Band I, Arithmetik, Algebra und Analysis, I, herausgegeben von Andreas Speiser, *review* by Prof. E. H. Neville, 186
Matrimonial Causes : Final Report of the Committee on Procedure in, 539
Matter-Radiation Cycle in the Cosmos (and the Second 'Law')—the Sun's Equilibrium (Alfred Lauck Parson), 802
Mauthner's Cells in the Larvæ of Anuran Amphibia (A. G. Willis), 65
Measurement : Temperature, *review* by S. Weintroub, 624
Measurement of Birefringence : A Large Field Compensator for (P. E. Jellyman and A. J. Milne), 477 ; (A. A. Wells), 602
Measurement for Engineers : Precise (Film on the work of the Metrology Division of the National Physical Laboratory), 717
Measurement of High Permittivity Values at Centimetre Wave-lengths (J. G. Powles), 25
Measuring Temperature : Methods of (Dr. Ezer Griffiths), third edition, *review* by S. Weintroub, 624
Mechanical Admittances and their Applications to Oscillation Problems (Prof. W. J. Duncan), *review* by Prof. W. G. Bickley, 954
Mechanical Behaviour of Crystal Boundaries in Metals (R. King, R. W. Cahn and Dr. B. Chalmers), 682
Mechanical Engineering : Photo-Elasticity in (Dr. E. K. Frankl), 329 ; (W. A. P. Fisher), 329
Mechanical Vibration Problems : A Technique for, *review* by Prof. W. G. Bickley, 954
Mechanical Vibrations (Prof. J. P. Den Hartog), third edition, *review* by A. L. P., 503
Mechanical Wear (Massachusetts Institute of Technology, the American Society of Mechanical Engineers, the General Motors Corporation and the Chrysler Corporation conference on), 758
Mechanics (Prof. John C. Slater and Prof. Nathaniel H. Frank), *review* by J. H. Pearce, 376
  Manual of Mathematics and (Prof. Guy Roger Clements and Prof. Levi Thomas Wilson), second edition, *review*, 789
Mechanics of Packings of Granular Material (D. R. Hudson), 512
Mechanism : Elements of (Peter Schwamb, Allyne L. Merrill and Walter H. James), sixth edition revised by Prof. Venton Levy Doughtie, *review* by F. G. W. Brown, 79
Mechanism of Combustion and Ignition Reactions in the Gas Phase : The Kinetics and (International symposium on), 347
Mechanism of Conductance by Hydrogen and Hydroxyl Ions in Aqueous Solutions (Dr. S. I. Weissman), 241
Mechanism of the Emission Spectrum of Active Nitrogen (L. Herman and R. Herman), 1018
Mechanism of Substitution in the Naphthalene Nucleus (Dr. N. M. Cullinane and S. J. Chard), 690
Mechanisms of Reactions at Carbon-Carbon Double Bonds (Prof. Charles C. Price), *review* by Dr. J. Sheridan, 626
Medal of Freedom awarded by the Government of the United States to Dr. James Craigie and Amherst F. H. Thomson, 215 ; to Prof. W. Norman Thomas, 716
Medal of Freedom with Bronze Palm awarded by the Government of the United States to Sir Charles Darwin, J. N. D. Heenan, Sir Ian Heilbron, Charles Lea, Andrew Stratton and T. W. J. Taylor, 215
Medal of Freedom with Silver Palm awarded by the Government of the United States to Sir Henry Dale, Sir Jack Drummond, Sir Alfred Egerton, Sir Melvill Jones, Dr. Alexander King, Sir Edward Mellanby, Dr. Hugh M. Sinclair, Cyril G. Trotman and Dr. Hector F. Willis, 215 ; to Prof. S. Zuckerman, 716
Medal for Merit awarded by the Government of the United States to Sir Alexander Fleming and Sir Howard Florey, 800
Medical Diseases in Tropical and Sub-Tropical Areas : Memoranda on (War Office), eighth edition, *review* by Dr. N. Hamilton Fairley, 499
Medical Films : Catalogue of (Royal Society of Medicine and the Scientific Film Association), 594
Medical Group Practice in the United States (P.E.P. Broadsheet No. 274), 841
Medical Research in South Africa, 162
Medical Research during War-time (Dr. G. Lapage), 998
Medical and Agricultural Physiology : Co-operation between, *review*, 113
Medicine : Animal Genetics and (Dr. Hans Grüneberg), *review* by Prof. C. H. Waddington, 543
Megalithic Tombs in Scotland and Ireland (Prof. V. Gordon Childe), 841
Melanin Problem—a Synthesis of 5 : 6–Dihydroxyindole (Dr. R. J. S. Beer, K. Clarke, H. G. Khorana and Prof. A. Robertson), 525 ; (Prof. H. Burton and J. A. Duffield), 725
'Melarsen' and 'Melarsen Oxide' (J. Williamson and Dr. E. M. Lourie), 103
'Melarsen Oxide' : 'Melarsen' and (J. Williamson and Dr. E. M. Lourie), 103
Meldola Medal for 1947 of the Society of Maccabæans awarded to Dr. J. Baddiley, 715
Men : The Governing of (Dr. A. H. Leighton), 578
Men (Oligospermic) : Variations in Spermatogenesis of (Prof. B. Zondek, Y. M. Bromberg and Z. Polishuk), 176
Men of Science in Industry and Society, *review* by R. Brightman, 370
Men and Volts at War, the Story of General Electric in World War II (John Anderson Miller), *review* by Sir Arthur Fleming, 113
Menschen : Die Bluteiweisskörper des (Dr. F. Wuhrmann und Dr. Ch. Wunderly), *review*, 376
Mental Disease : Sociology of (National Association for Mental Health conference on), 407
Meristematic Plant Tissues: Chromatographical Study of (Dr. A. Allsopp), 833
Meson Field and the Equation of Motion of a Spinning Particle (R. C. Majumdar and Dr. S. Gupta), 410
Meson Formation : Height of (Dr. A. Duperier), 645
Meson Scattering with Nuclear Excitation (Dr. H. J. Bhabha and R. R. Daniel), 883
Mesons : The Artificial Production of (Dr. G. P. S. Occhialini and Dr. C. F. Powell), 551
  A New Method for the Determination of the Mass of (Dr. C. F. Powell and Dr. S. Rosenblum), 473
σ-Mesons : The Mass of (S. Lattimore), 518
Mesons (Negative) : Capture of, by Nuclei (J. A. Lodge), 809
Mesons of Different Masses (Prof. J. Barnothy), 681
Mesons and Nucleons (Prof. O. Klein), 897
Mesophilic Bacteria in Composts : Aerobic (D. M. Webley), 174
Mesotrons and Cosmic Rays : Electrons (+ and −), Protons, Photons, Neutrons, (Robert Andrews Millikan), revised edition, *review* by Dr. L. G. H. Huxley, 789
Mesures physiques : Les (Albert Pérard), *review* by S. Weintroub, 955
Metabolic Aspects of Convalescence (M. W. Grant), 535
Metabolism of Tissue Cells *in vitro* : Amino-acid (Dr. Albert Fischer), 1008
Metabolites (Intermediary) : Relation of, to the Lowering of the Potency of Pancreatic Insulin in the Animal System (Prof. M. C. Nath and H. D. Brahmachari), 18
Metal and Metal Powders (Deformed Solid) : X-Ray Diffraction Rings from (Dr. W. A. Wood and W. A. Rachinger), 93
Metal Complexes: Order of Stability of (Dr. D. P. Mellor and L. Maley), 436
Metal Films at a Frequency of 24,000 Mc./s. : Surface Resistance of (Dr. L. Speirs), 601
Metal Physics : Summer School in (Cavendish Laboratory), 637
Metal Powders : X-Ray Diffraction Rings from Deformed Solid Metal and (Dr. W. A. Wood and W. A. Rachinger), 93
Metal Salts (Alkali), Gold and Platinum : Magnetic Susceptibility of Borax Glasses containing Crystallites of (Prof. Subodh Kumar Majumdar), 684
Metallic Carbonyls and Nitrosyls : Constitution of certain Binuclear (Dr. R. V. G. Ewens), 530
Metallic State : The (Prof. Linus Pauling), 1019
Metallographic and X-Ray Measurements of Retained Austenite : Comparison of (William J. Harris, jun.), 315
Metallurgy (Powder) : International Conference on (Steirmark of the Association of Austrian Chemists), 307
Metals : Electron Theory of (Dr. G. V. Raynor), 264
  Internal Stresses in (W. A. Wood and N. Dewsnap), 682 ; (G. B. Greenough), 683
  International Conference on the Physics of (Netherlands Physical Society), 389
  Relation of Manganese and some other, to the Iron Status of Plants (Eric J. Hewitt), 489
  Mechanical Behaviour of Crystal Boundaries in (R. King, R. W. Cahn and Dr. B. Chalmers), 682
  Structure and Physical Properties of (X-Ray Analysis Group of the Institute of Physics discussion on), 263
  Theory of the Anomalous Skin Effect in (G. E. H. Reuter and E. H. Sondheimer), 395
  Theories of Creep in, 233
Metals (Alkali) : Electrical Resistivity of, below 20° K. (Dr. D. K. C. MacDonald and Dr. K. Mendelssohn), 972
Metals (Heavy) : Antagonism between Molybdenum and certain, in Plant Nutrition (C. R. Millikan), 528
Metals (Non-ferrous) : Refining of (Institution of Mining and Metallurgy symposium on), 924

Metals and Alloys : Internal Stresses in (Institute of Metals, in association with the Faraday Society, the Institute of Physics, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Physical Society and the Royal Aeronautical Society symposium on), 70
Metapenæus monoceros Fabricius : Active Regulation of Chloride in (N. Kesava Panikkar and R. Viswanathan), 137
Metasequoia in China : Discovery of a Living (Prof. E. D. Merrill), 594
Metastable States of Nickel Characterized by a High Initial Permeability (Dr. J. L. Shoek and J. F. Fast), 887
Meteor Whistles (H. V. Griffiths, S. E. Martingell and R. W. Bayliff), 478
Meteorologist (Professional) : Meteorology for the, *review* by Prof. P. A. Sheppard, 625
Meteorology of the Australasian Antarctic Expedition, 1911–14 (Dr. Edward Kidson), 709
Meteorology for the Professional Meteorologist, *review* by Prof. P. A. Sheppard, 625
Meteorology, Theoretical and Applied (Dr. E. Wendell Hewson and Richard W. Longley), *review* by Prof. P. A. Sheppard, 625
Meteorology and the Propagation of Radio Waves (Dr. R. L. Smith-Rose), 145
Meteorology and Weather Prediction : Organisation, *review* by M. K. Miles, 540
Meteors Measured by Diffraction of Radio Waves from Trails during Formation : Velocity of (C. D. Ellyett and J. G. Davies), 596
Méthodes statistiques modernes des administrations fédérales aus États-Unis (Pierre Thionet), *review* by Dr. F. Yates, 153
Methodology in Ethnography, *review* by Dr. A. I. Richards, 111
Methyl Bromide : Inhibition of SH Enzymes by (S. E. Lewis), 692
Methyl Iodide : Bond-Strength of C—Cd in Cadmium Methyl and of C—I in (A. S. Carson, K. Hartley and Dr. H. A. Skinner), 725
  Extinction of Petrol Fires by (Dr. Oliver C. de C. Ellis), 402
Methyladrenaline : Demonstration and Separation of Noradrenaline, Adrenaline and (Dr. W. O. James), 851
Methylated Sugars on the Paper Chromatogram : Separation and Identification of (F. Brown, Prof. E. L. Hirst, L. Hough, Dr. J. K. N. Jones and H. Wadman), 720
Methylene Blue : Intravenous—a New Method for Studying the Nervous System (W. H. Feindel, D. C. Sinclair and Dr. G. Weddell), 318
Metric Values in Scientific Papers : Use of Equivalent, 144
Mica : Magnetic Susceptibility of (J. T. Kendall and D. Yeo), 476
Mice : Ultracentrifugation and Electron Microscope Studies of Tissues of Inbred Strains of (Prof. R. D. Passey, Dr. L. Dmochowski, Prof. W. T. Astbury, Dr. R. Reed and Dr. P. Johnson), 759
Michigan (southern) : Earthquake on August 10, 657
Microbiological Assay Procedure : A Modified (Dr. Trevor I. Williams), 19 ; (Stanley A. Price), 20
Microbiology : Annual Review of (edited by Charles E. Clifton, Sidney Raffel and H. Albert Baker), Vol. I, *review* by Sir Paul Fildes, 995
Microcalorimetry (Prof. W. Swietoslawski), *review* by Dr. Ezer Griffiths, 460
Micro-Chemical Techniques : Summer School in (Queen's University, Belfast), 125
Microdiffusion Analysis and Volumetric Error (Prof. Edward J. Conway), revised edition, *review*, 583
Micro-Estimation of Amino-Nitrogen and its Application to Paper Partition Chromatography (A. J. Woiwod), 169
Micro-film Technique : Standardization of (British Standard Specification 1371 : 1947), 346
Microflora of the Rumen (C. A. McGaughey and K. C. Sellers), 1014
Micro-Predators in Soil : Limitation of Bacteria by (Dr. F. J. Anscombe and Dr. B. N. Singh), 140
Microsynthesis of C^{14}-Labelled Ethyl Iodide (Dr. W. J. Arrol and Raymond Glascock), 932
Micro-technique : Petrographic (A. V. Weatherhead), *review* by F. I. G. Rawlins, 626
Microscope : The (J. H. Wredden), *review*, 626
  The Electron (Dr. V. E. Cosslett), *review* by G. D. P., 955
  The Intelligent Use of the (C. W. Olliver), *review*, 626
  The Reflecting (Dr. C. R. Burch), 732
Microscope (Reflecting) : Applications of the, to the Nuclear Plates Technique (Dr. W. J. Bates and Dr. G. P. S. Occhialini), 473
Microscopic Plant and Animal Cells : Photo-electric Counting of Individual (Carl Lagercrantz), 25
Microscopic Principle : A New (Dr. D. Gabor), 777
Microspectrography (X-Ray) : Intracellular Determination of Protein by (Dr. A. Engström and M. A. Jakus), 168
Microwave Electronic Valves, *review* by Prof. J. T. Randall, 952
Microwave Power into a Resonator having a Fine Mode Structure : A Method of Feeding (G. R. Newbery and W. E. Willshaw), 519
Microwave Solar Radiation (Enhanced) : Emission of (R. G. Giovanelli), 133
Microwave Triodes : Klystrons and (Prof. Donald R. Hamilton, Prof. Julian K. Knipp and J. B. Horner Kuper), *review* by Prof. J. T. Randall, 952
Middle and Far East : Fish Farming in the (Dr. C. F. Hickling), 748
Migration : Butterfly (Dr. C. B. Williams), 636
Migrations of Floras : Origins of Species and, *review* by Prof. I. Manton, 455
Migratory and Homing Flights : Orientation of Birds on (Linnean Society discussion on), 996
Milk Production : Cattle Health and, 1005
Millidegrees Absolute : Magnetic Observations and Thermometry in the Region of (D. de Klerk, M. J. Steenland and Prof. C. J. Gorter), 678
Mind : Brain and, *review* by Dr. O. A. Trowell, 498
Mineral Resources of the United States (Staffs of the Bureau of Mines and Geological Survey), *review* by Dr. K. C. Dunham, 991
Minimum Perceptible Energy and Brownian Motion in Sensory Processes (Dr. Hl. de Vries), 63
Missouri Development Program : Prehistory and the (W. R. Wedel), 636
Missouri Valley : Archæology of the, 636
Mitosis : Early Effects of Hydroquinone on (R. Parmentier and Dr. P. Dustin, jun.), 527
Mobility of Man-Power in Britain, 453
Moche, a Peruvian Coastal Community (John Gillin), 697
Model for Representing the Optic Orientation of Biaxial Crystals : A Simple Universal (Dr. N. H. Hartshorne), 94
Model Research in Hydraulics, *review* by Prof. J. Th. Thijsse, 219
Models : Nuclear (Dr. I. N. Sneddon and B. F. Touschek), 61
Modern World : Reason in the, *review*, 664
Molds, Yeasts and Actinomycetes (the late Dr. A. T. Henrici), second edition by Dr. Charles E. Skinner, Dr. Chester W. Emmons and Dr. Henry M. Tsuchiya, *review*, 40
Mole-Cricket (European) : Chromosomal Evolution in the (Tuviah Kushnir), 531
Molecular Arrangement in Tobacco Necrosis Virus Crystals (Roy Markham, Dr. Kenneth M. Smith and Dr. Ralph W. G. Wyckoff), 760
Molecular Structure : Isotope Exchange and (International Colloquium on), 901
Molecular Vibrations : Interaction Terms in (D. F. Heath and Dr. J. W. Linnett), 243
  A Suggested New Force Field for (D. F. Heath and Dr. J. W. Linnett), 314
Molecular Vibrations and Bond-forming Orbitals : A Correlation between (Dr. J. W. Linnett and P. J. Wheatley), 971
Molecular Weight of *n*-Paraffins : Critical Temperature and (L. Grunberg and Dr. A. H. Nissan) 170
Molecules : Reactivity and Structure of (Prof. F. A. Paneth), 901
  Separation of Polar from Non-Polar (Prof. G. Karagounis), 855
Molecules of Biological Interest : Nature of Forces between Large (Prof. Linus Pauling), 707
Molecules without the Formation of Chemical Bonds between Them : Beta-quinol, an Example of the Firm Union of (H. M. Powell and P. Riesz), 52
Molecules containing Rotating Polar Goups : Dielectric Relaxation of (Prof. A. Budó), 133
Molybdenum and certain Heavy Metals in Plant Nutrition : Antagonism between (C. R. Millikan), 528
Monazite : Constitution of (Dr. A. W. Wylie), 97
Monkeys (Malaria-infected) : Hæmolytic System in the Blood of (Dr. H. Laser), 560
Monsters : Embryology of (Dr. Viktor Hamburger), 88 ; (Dr. Wolfgang Born), 88
Monuments : Exploring our National Parks and (Devereux Butcher), *review* by Frances Pitt, 376
Moon : Cosmic Rays and the Magnetic Field of the (Dr. M. S. Vallarta), 646
Moon (New) : Brightness of the (Dr. J. A. M. van Liempt), 27
Mosquito Eradication Campaigns : Recent (Dr. J. R. Busvine), 189
Mosses as Soil Indicators (H. Watson), 823
Motility : Bacterial Flagella and (Prof. Adrianus Pijper), 200
Motion of a Spinning Particle : The Meson Field and the Equation of (R. C. Majumdar and Dr. S. Gupta), 410
Mould Inhibition : Dosage/Response Relations in (J. N. Phillips and J. M. Vincent), 210
Mouse to Man : The Argument from, *review* by Prof. C. H. Waddington, 543
Moving-Boundary Apparatus : A Simple (E. G. Baxter and Dr. V. Gold), 403 ; (R. H. Davies), 1021
Mucosa (Nasal) : Alkaline Phosphatase in Taste Buds and (Dr. Geoffrey H. Bourne), 445
Multiple-Beam Interferometry to the Study of Oscillating Quartz Crystals : Application of (Prof. S. Tolansky and W. Bardsley), 925
Murchison Fund of the Geological Society awarded to Dr. F. W. Cope, 122
Murchison Grant for 1948 of the Royal Geographical Society awarded to Robert W. Steel, 553
Murchison Medal of the Geological Society awarded to Dr. J. Phemister, 122
Muscle (Isolated) : A Possible Relation between the Action of Clover Juice on, and 'Bloat' in Cattle (W. S. Ferguson), 816
Museum in Education : The (Cleveland Museum of Natural History), 677
Music : The Borderline of Psychology, Physics and (Acoustics Group of the Physical Society symposium on), 589
Mustard Gas in Aqueous Solution : The Reactions of (Dr. A. G. Ogston), 225
Mustard Gas on Enzymes and Tissues : Effects of (Dr. D. M. Needham), 225
Mustard Gas with Proteins : Reaction of (Dr. J. C. Boursnell), 225
Mustard-gas Mutation in *Aspergillus nidulans* (Donald Hockenhull), 100
Mustards : Nitrogen (Dr. E. Boyland), 226
Mutants of Diptera : White-eyed (Dr. P. Tate), 641
Mutation in *Aspergillus nidulans* : Mustard-gas (Donald Hockenhull), 100
Mycobacterium tuberculosis : Effect of Antibacterial Analogues of Vitamin K on (C. N. Iland), 1010
Mycological Education (British Mycological Society discussion on), 507
Myosin : Effect of Calcium Ions on the Charge of (Olle Snellman and Thomas Erdös), 526

NAPHTHALENE Nucleus : Mechanism of Substitution in the (Dr. N. M. Cullinane and S. J. Chard), 690
β-Naphthol with l-α and l-β-Phellandrene : Reaction of (G. G. Acheson and Dr. T. F. West), 976
Naphthoresorcinol Reaction for Uronic Acids : The Tollens (A. H. Guerrero and Dr. R. Tecwyn Williams), 930
Nasal Mucosa : Alkaline Phosphatase in Taste Buds and (Dr. Geoffrey H. Bourne), 445
Nation : Family and (P.E.P. Broadsheet), 539
National Intelligence : The Trend of (Prof. Godfrey Thomson, with a Symposium by Sir Alexander Carr-Saunders, Sir Cyril Burt, Prof. Lionel Penrose and Prof. Godfrey Thomson), *review* by Dr. Julian Blackburn, 37
National Parks in Britain, 783
National Parks and Monuments : Exploring our (Devereux Butcher , *review* by Frances Pitt, 376
Nationalized Industries : Responsibility in, 619
Native Peoples of the Pacific World (Prof. Felix M. Keesing), *review* by M. C. B., 419
Natural Amœbic Infections in Laboratory Rodents (Dr. J. D. Fulton and L. P. Joyner), 66
Natural History of Butterflies, 636
Natural History in the Highlands and Islands (Dr. F. Fraser Darling), *review* by Prof. A. D. Peacock, 457
Natural History Books : Old Scientific and, 305
Natural History Journals, 923
Natural Selection of *Drosophila* (Dr. F. W. Sansome), 409
Natural Vegetation of Trinidad (Prof. C. W. Wardlaw), 31 ; (Dr. J. S. Beard), 31
Naturalists from Neckam to Ray : English (Dr. Charles E. Raven), *review* by Prof. F. J. Cole, 373
Nature of the Bromate Effect : Studies on the (Dr. Holger Jørgensen), 294

Nature of Egyptology : Growth and (Prof. S. R. K. Glanville), 346
Nature of Forces between Large Molecules of Biological Interest (Prof. Linus Pauling), 707
Nature Lover : Fisherman and, *review* by Seton Gordon, 951
Nature Stories : Gathered, *review* by Seton Gordon, 744
Nature's Own Zoo (C. M. Beadnell), *review* by Seton Gordon, 744
Navaho : The (Clyde Kluckhohn and Dorothea Leighton), *review* by Dr. G. H. S. Bushnell, 545
Navigation : Radio Aids to (Dr. R. A. Smith), *review* by Dr. R. L. Smith-Rose, 334
Neckam to Ray : English Naturalists from (Dr. Charles E. Raven), *review* by Prof. F. J. Cole, 373
Necrosis Virus Crystals (Tobacco) : Molecular Arrangement in (Roy Markham, Dr. Kenneth M. Smith and Dr. Ralph W. G. Wyckoff), 760
Necturus, and the Cat : Guide to the Study of the Anatomy of the Shark, (Prof. Samuel Eddy, Prof. Clarence P. Oliver and Prof. John P. Turner), second edition, *review* by Dr. P. D. F. Murray, 955
Negative Mesons by Nuclei : Capture of (A. S. Lodge), 809
Negative Sequences in Polyphase Supply : Bridge Networks discriminating between Positive and (N. F. Barber), 685
Neill Prize for 1945–47 of the Royal Society of Edinburgh awarded to Dr. Robert Broom, 716
Nematodes in Genetic Research : Possible Significance of Free-living (Dr. Ellsworth C. Dougherty and Hermione Grant Calhoun), 29
Nematology : Research on, 1006
Nerven : Die Signalübermittlung im (Prof. Alexander v. Muralt), *review* by Prof. J. Z. Young, 76
Nerves : Transmission in, *review* by Prof. J. Z. Young, 76
Nervous System : Intravenous Methylene Blue—a New Method for Studying the (W. H. Feindel, D. C. Sinclair and Dr. G. Weddell), 318
Netherlands : *Elminius modestus* in the (Prof. H. Boschma), 403
Netherlands India : Colonial Policy and Practice, a Comparative Study of Burma and (J. S. Furnivall), *review* by Maurice Bruce, 908
Neurohypophysis in the Conscious Animal : Electrical Stimulation of the (G. W. Harris), 739
Neurosecretory Cells in the Brain of Adult *Calliphora erythrocephala* Meig. : Effect of Removal of (Dr. Ellen Thomsen), 439
Neutron Reactions : Cloud Chamber Investigation of Straggling of Short-Range Particles produced by Slow (Dr. J. K. Bøggild), 810
Neutrons : Scattering of, by Lead (R. Latham and J. M. Cassels), 282
Neutrons (D—D) : Scattering of, by Deuterium (J. F. Darby and J. B. Swan), 22
Neutrons (100-MeV.) : Scattering of, by Protons (F. C. Barker), 726
Neutrons (220 and 900 keV.) : Comparison of Cross-sections for the Capture of (R. Allen, G. R. Bishop, P. Demers and Dr. H. Halban), 727
Neutrons (Fast) : Interaction of, with Indium (S. G. Cohen), 475
Neutrons, Mesotrons and Cosmic Rays : Electrons (+ and −), Protons, Photons, (Robert Andrews Millikan), revised edition, *review* by Dr. L. G. H. Huxley, 789
New Forest : The Future of the (Prof. H. G. Champion), 547
New Guinea and South Australia : Newly Discovered Submarine Canyons of (Reg. C. Sprigg), 246
New Moon : Brightness of the (Dr. J. A. M. van Liempt), 27
New Year Honours, 48
New Zealand : Earthquakes during October 1947, 306
  Earthquakes registered in, during February 1948, 1006
  Preservation of the *Kauri* in (Prof. V. J. Chapman), 72 ; (Prof. H. G. Champion), 72
Newspapers : German Books, Periodicals and (European Periodicals Publicity and Advertising Co., Ltd., First Post-War Exhibition of), 595
Nickel Characterized by a High Initial Permeability : Metastable States of (Dr. J. L. Snoek and J. F. Fast), 887
Nicotinic Acid in Human Blood Cells at Birth (R. F. A. Dean and W. I. M. Holman), 439
Nigerian Freedom : Path to (Obafemi Awolowo), 332
Nihilism : Farewell to European History, or the Conquest of (Alfred Weber), translated from the German by R. F. C. Hull, *review* by Maurice Bruce, 151
Nitration of Simple Heterocycles (K. Schofield and T. Swain), 690
Nitrification : Trace Elements and (Dr. Howard Lees and Jane Meiklejohn), 398
Nitrogen (Active) : Mechanism of the Emission Spectrum of (L. Herman and R. Herman), 1018
Nitrogen Atoms in the Upper Atmosphere : Production of (Prof. G. Herzberg and L. Herzberg), 283
Nitrogen Metabolism after Fracture (Dr. H. N. Munro and M. C. Cumming), 560
Nitrogen Mustards (Dr. E. Boyland), 226
Nitrogen Trichloride on Proteins : Action of—Production of Toxic Derivative (H. R. Bentley, Dr. R. G. Booth, E. N. Greer, J. G. Heathcote, Dr. J. B. Hutchinson and Dr. T. Moran), 126
Nitrogenous Constituents of the Potato (Dr. E. B. Slack), 211
Nitrosyls : Constitution of certain Binuclear Metallic Carbonyls and (Dr. R. V. G. Ewens), 530
Noble Sugar-Canes (*Saccharum officinarum* L.) : Origin of (Dr. N. Parthasarathy), 608
Noise : International Symposium on (Acoustics Group of the Physical Society and the Royal Institute of British Architects), 197
Nomenclature : *Rh* (Dr. A. E. Mourant), 492
Nomenclature of the anti-*Rh* Typing Sera (W. B. Castle, M. W. Wintrobe and L. H. Snyder), 492
Nomenclature of the Shaddock or Pomelo : Botanical (Dr. D. Chatterjee), 770
Non-Acoustic Functions of the Vertebrate Ear : Oscillographic Analysis of the (Dr. Otto Lowenstein), 652
Non-Benzenoid Aromatic Hydrocarbon Pentalene (D. P. Craig and Allan Maccoll), 481
Non-Ferrous Metals : Refining of (Institution of Mining and Metallurgy symposium on), 924
Non-Polar Molecules : Separation of Polar from (Prof. G. Karagounis), 855
Non-Specific Competition in Tubular Excretion : Specific and (I. Sperber), 236
Noradrenaline, Adrenaline and Methyladrenaline : Demonstration and Separation of (Dr. W. O. James), 851
North America : The Fall Webworm of, in Europe (Dr. Paul Surányi), 512
North American Archæology, *review* by Dr. G. H. S. Bushnell, 501
Northern Hemisphere Surface Pressure and Climatic Fluctuations and Vegetation Growth in Northern Finland (G. W. Brier), 730
Northern Ireland : Scientific Research and Development in, 162
Northern Ireland Fishing Industry Developments during the War Years, 451
Northern States and Canada East of the Rocky Mountains : Handbook of the Trees of the (Romeyn Beck Hough), *review* by Sir Edward Salisbury, 497
Northern Waters : Climatic and Ecological Changes in, 428
Norway (southern) : Auroral Activity in, from the Middle of August to the Middle of October 1947 (Prof. Carl Störmer), 208
Nuclear Change in Differentiation : Significance of (Dr. K. Mather), 872
Nuclear Disintegration in Photographic Emulsions Exposed to Cosmic Rays—Double Stars : Anomalous Distribution of (L. Leprince-Ringuet and J. Heidmann), 844 ; (T. T. Li and D. H. Perkins), 844
Nuclear Excitation : Meson Scattering with (Dr. H. J. Bhabha and R. R. Daniel), 883
Nuclear Level Scheme of Pb^{208} : Spin-Dependence of Magnetic Dipole Gamma Radiation and the (Dr. H. O. W. Richardson), 516
Nuclear Models (Dr. I. N. Sneddon and B. F. Touschek), 61
Nuclear Physics : Data for, *review* by Sir John Cockcroft, 418
  An Introduction to (S. Fluegge), *review* by Sir John Cockcroft, 418
Nuclear Physics in Photographs (Dr. C. F. Powell and Dr. G. P. S. Occhialini), *review* by Prof. P. I. Dee, 333
Nuclear Physics Tables (J. Mattauch), and An Introduction to Nuclear Physics, by S. Fluegge, *review* by Sir John Cockcroft, 418
Nuclear Plates Technique : Applications of the Reflecting Microscope to the (Dr. W. J. Bates and Dr. G. P. S. Occhialini), 473
Nuclear Reactions with Improved Yield : Discharge Tube for (Jaroslav Pachner), 252
Nuclei : Capture of Negative Mesons by (A. S. Lodge), 809
  Emission of Li^8 in the Explosive Disintegration of (C. Franzinetti and R. M. Payne), 735
Nuclei (Highly Excited) : Disintegration of (D. H. Perkins), 486
Nucleic Acid in the *Drosophila* Egg : Ribose (H. G. Callan), 440
Nucleolus of the Apodan Sertoli Cell (B. R. Seshachar), 558
Nucleons : Mesons and (Prof. O. Klein), 897
Nucleotides (Flavine) : Paper Chromatography of (Dr. J. L. Crammer), 349
Nudibranch Genera *Pellibrancus* and *Okadaia* : Synonymy of the (Patricia M. Ralph), 528
Nuffield (Penicillin) Research Fellowships, 16
Number : Calculus based on the Fundamental Concept of, *review* by F. G. W. Brown, 261
Numerals : 'Semaphore' (Prof. W. G. Bickley), 807
Nursey Premium of the Society of Engineers awarded to R. Cecil Smart, 346
Nutrition in relation to Cancer (New York Academy of Sciences symposium on), 106
Nutritional Requirements of *Drosophila melanogaster* (Dr. Michael Begg and Dr. Forbes W. Robertson), 769
Nutritional Status : Chemical Composition of Plants as an Index of their (Dr. D. W. Goodall and Dr. F. G. Gregory), 406

OAK Mildew : Perithecia of (J. Mary Knoyle), 938
Ocean Bottoms : Ground Blocks of the Continents and (Prof. H. Cloos), 71
Oceans : Sublimation in the Atmosphere over the (Dr. B. Cwilong), 62
Œstrogenic Hormone : Podocarpic Acid as a Source of (C. W. Brandt and D. J. Ross), 892
Œstrogenic Hormones : Nature of the *C/D* Ring Union in the (Dr. C. W. Shoppee), 207
Œstrogens from Urine by Application of High Temperatures : Preparation of (Dr. Felix Sulman), 605
Œstrogens (Synthetic) : Configuration of (H. P. Koch), 309
Œstrone and Equilenin : The *C/D* Ring Union in (Dr. W. Klyne), 434 ; *errata*, 514
Oil : The Race for, *review* by H. B. Milner, 186
Oil Industry during the War-Years : Progress in the, *review* by H. B. Milner, 703
Oil Operations Abroad : American (Leonard M. Fanning), *review* by H. B. Milner, 186
Oils and Fats : World Supplies of, 123
Okadaia : Synonymy of the Nudibranch Genera *Pellibranchus* and (Patricia M. Ralph), 528
Olefine Reactions Catalysed by Lewis Acids (Dr. John W. Baker), 171
Oligospermic Men : Variations in Spermatogenesis of (Prof. B. Zondek, Y. M. Bromberg and Z. Polishuk), 176
Onmisbaar element voor plant en dier : Koper als (W. J. Melchers en H. J. Gerritsen), *review*, 624
Open-Hearth Furnace Models (A. R. Philip), 479
Operational Research (Sir Charles Goodeve), 377, 609 ; (Prof. C. H. Waddington), 404 ; (Dr. F. Yates), 609
Operational Research in the Research Associations (Committee of Directors of Research Associations conference on), 584
Optic Orientation of Biaxial Crystals : A Simple Universal Model for Representing the (Dr. N. H. Hartshorne), 94
Optical Transmission of a Colloidal Solution in a Magnetic Field (F. D. Stott and Dr. A. von Engel), 728
Optics : Achievements in (A. Bouwers), *review* by S. Weintroub, 704
Optics in Holland, *review* by S. Weintroub, 704
Orbitals (Bond-forming) : A Correlation between Molecular Vibrations and (Dr. J. W. Linnett and P. J. Wheatley), 971
Orchestia bottae M. Edwards in Britain : Second Occurrence and Persistence of the Amphipod (A. J. Cain and D. H. Cushing), 483
Orchestia bottae and other Organisms in Britain : Occurrence of the Amphipod (D. M. Reid), 609
Order of Stability of Metal Complexes (Dr. D. P. Mellor and L. Maley), 436
Organ : The Electronic (L. E. A. Bourne), 196
Organic Liquids : Ultrasonic Dispersion in (Dr. A. Schallamach), 476
Organic Materials : Production of an Antibiotic Substance on Wheat Straw and other, and in the Soil (Erna Grossbard), 614
Organisation of the Cell Walls of Tracheids and Wood Fibres (A. B. Wardrop and Dr. R. D. Preston), *erratum*, 90
Organisation of the Textile Industry (Textile Institute conference on), 842
Organisation, Meteorology and Weather Prediction, *review* by M. K. Miles, 540

TITLE INDEX

Organism : An Adaptation Mechanism of the, to Damage—the Role of 'Resistine' (Dr. S. Karády and Dr. A. Kovács), 688
Organisms in Britain : Occurrence of the Amphipod *Orchestia bottae* and other (D. M. Reid), 609
Organs of Speech : Man's (Prof. H. A. Harris), 628
Oribatid Mites and their Economic Importance (M. Anantaraman), 409
Orientation of Biaxial Crystals : A Simple Universal Model for Representing the Optic (Dr. N. H. Hartshorne), 94
Orientation of Birds on Migratory and Homing Flights (Linnean Society discussion on), 996
Origins of Species and Migrations of Flora, *review* by Prof. I. Manton, 455
Oscillating Quartz Crystals : Application of Multiple-Beam Interferometry to the Study of (Prof. S. Tolansky and W. Bardsley), 925
Oscillation Problems : Mechanical Admittances and their Applications to (Prof. W. J. Duncan), *review* by Prof. W. G. Bickley, 954
Oscillatory Time-Series : Contributions to the Study of (Maurice G. Kendall), *review* by David G. Kendall, 187
Oscillograph Signals : Reproduction of Photographically Recorded (R. L. F. Boyd), 227
Oscillograph Traces : Simultaneous Recording of Related, 89
Oscillographic Analysis of the Non-Acoustic Functions of the Vertebrate Ear (Dr. Otto Lowenstein), 652
Osmium : Reported Radioactivity of (A. H. W. Aten, Jun.), 1019
Osmium Tetroxide : Oxidation of Anthracene by (Prof. J. W. Cook and Dr. R. Schoental), 237
Osmotic Work performed by the Renal Tubules (David F. Cole), 640
Output of Sodium and Chlorine in Fasting Rats : Premortal Increase in the (Dr. Peter Bálint and Dr. Helene Kabdebó), 57
Ovalbumins (Modified) : Electrophoretic Behaviour of (Gertrude E. Perlmann), 720
Ovalene : Synthesis of (Dr. E. Clar), 238
Ovarian Activity in the Pregnant Mare (Prof. E. C. Amoroso, J. L. Hancock and Dr. I. W. Rowlands), 355
Overseas Territories of Western Europe (Allied Circle, Amsterdam, and the British Society for International Understanding, Study Conference on), 843
Oviposition in Social Hymenoptera : Regulation of (M. V. Brian and A. D. Brian), 854
Oxford : Archæology at, *review* by Miles Burkitt, 459
Oxidation of Anthracene by Osmium Tetroxide (Prof. J. W. Cook and Dr. R. Schoental), 237
Oxidation with Lipoxidase : Total Conjugation of Linoleic Acid in (Prof. Sune Bergström and Ralph T. Holman), 55
Oxide-coated Cathodes under Electron Bombardment : Electron Emission from (T. J. Jones), 846
Oxime-Nitrogen in *Torula*-Yeast Fed with Potassium Nitrate : Formation of (Prof. Artturi I. Virtanen and Tihamér Z. Csáky), 814
Oxygen Molecule : New Bands in the Schumann-Runge System of the (Lalji Lal), 477
Oxygen and Dissociation in Flame Gases : Atomic (Prof. W. T. David, C. Rounthwaite and N. Carpenter), 726
Oxygen and Hydrogen : Fractional Distillation and its Application in the Concentration of the Heavy Isotopes of (Dr. I. Dostrovsky, Prof. E. D. Hughes and Dr. D. R. Llewellyn), 858
Oxygen-containing Solvents : Solvation of Hydrogen Ion in (Dr. Ernest A. Braude and E. S. Stern), 169
Oyster Beds (East Coast) : *Elminius modestus*, another Imported Pest of (E. W. Knight Jones), 201
Ozone and Auroral Spectra (Dr. A. Vassy and E. Vassy), 566

PACIFIC (Southwest) : Birds of the (Ernst Mayr), *review* by Frances Pitt, 545
Pacific Region : The Bikini Bomb and the Seismology of the (Prof. K. E. Bullen), 62
Pacific World : Native Peoples of the (Prof. Felix M. Keesing), *review* by M. C. B., 419
Pacifique-nord : Archéologie du (Dr. André Leroi-Gourhan), *review* by Prof. J. H. Hutton, 545
Packings of Granular Material : Mechanics of (D. R. Hudson), 512
Page Prizes for 1947 of the Institution of Electrical Engineers awarded to D. T. Hollingsworth and M. K. Taylor, 90
Paget (Stephen) Memorial Lecture of the Research Defence Society (Prof. P. A. Buxton), 802
Pain : Victory over (Dr. Victor Robinson), *review* by Dr. G. Edwards, 458
Paints and their Uses : Cementiferous (Prof. G. Wesley Austin), 569
Palæobotany : An Introduction to (Prof. Chester A. Arnold), *review* by Prof. John Walton, 623
Palestine : Fauna and Flora of, 902
    Scientific and Industrial Research in, 800
Pancreatic Insulin in the Animal System : Relation of Intermediary Metabolites to the Lowering of the Potency of (Prof. M. C. Nath and H. D. Brahmachari), 18
Paper Chromatogram : Separation and Identification of Methylated Sugars on the (F. Brown, Prof. E. L. Hirst, L. Hough, Dr. J. K. N. Jones and H. Wadman), 720
Paper Chromatography : Quantitative (R. B. Fisher, D. S. Parsons and G. A. Morrison), 764
    Use of Ultra-Violet Fluorescence in (D. M. P. Phillips), 53
Paper Chromatography of Anthycyanins and related Substances in Petal Extracts (E. C. Bate-Smith), 835
Paper Chromatography of Flavine Nucleotides (Dr. J. L. Crammer), 349
Paper Chromatography of Sugars : Colour Reagents for the (Dr. W. G. C. Forsyth), 239
Paper Partition Chromatography : Micro Estimation of Amino-Nitrogen and its Application to (A. J. Wolwod), 169
Parade of the Animal Kingdom (Prof. Robert Hegner, assisted by Jane Z. Hegner), *review* by Dr. Edward Hindle, 501
n-Paraffins : Critical Temperature and Molecular Weight of (L. Grunberg and Dr. A. H. Nissan), 170
Parallelism between Atomic and Planetary Properties, 780
Parasites (animaux et végétaux) des helminthes (Dr. Robert Ph. Dollfus), *review* by Dr. G. Lapage, 662
Parasites (Mammalian Malaria) : Pre-erythrocytic Stage in (Prof. H. E. Shortt and P. C. C. Garnham), 126 ; (Dr. Frank Hawking), 175
Parasitic Agent : Relationship of Glioma to Encephalitis in the Domestic Fowl, and an Associated (Prof. Cecil Jackson), 441
Parks in Britain : National, 783
Parks and Monuments : Exploring our National (Devereux Butcher), *review* by Frances Pitt, 376
Particle (Spinning) : The Meson Field and the Equation of Motion of a (R. C. Majumdar and Dr. S. Gupta), 410
Particle-size Measurement (Gervase L. Mills), 313
Particles (Penetrating) : Showers of (Prof. G. Wataghin), 91
Particles (Thibaud's) : Electronic Waves and (W. E. Benham), 93
Particles of Different Sizes : Principle of a Counter-streaming Centrifuge for the Separation of (Per Eric Lindahl), 648
Partition Chromatography (Paper) : Micro Estimation of Amino-Nitrogen and its Application to (A. J. Wolwod), 169
Pastures and Pasture Research (C. M. Donald), second edition, *review* by Dr. John Grainger, 747
Pathology of Animal Reproduction and on Artificial Insemination : First International Congress on the Physiology and, 197
Patient with Adrenal Cancer : Isolation of a New Androstenol-3(α)-on-17 from the Urine of a (Dr. Elizabeth Dingemanse, Leonora G. Huis in 't Veld and S. Lore Hartogh-Katz), 848
Patron's Medal for 1948 of the Royal Geographical Society awarded to Thomas H. Manning, 553
Pea (Wrinkled and the Smooth) : Starches of the (Dr. S. Peat, Dr. E. J. Bourne and Mary J. Nicholls), 206
Peace and Atomic Power, 741
Peace or Power (Sir Harold Butler), 414
Peace and the Public (Mass-Observation), 415
Peek (Cuthbert) Grant for 1948 of the Royal Geographical Society awarded to Dr. Donald F. Thomson, 553
Pellibranchus and *Okadaia* : Synonymy of the Nudibranch Genera (Patricia M. Ralph), 528
Penetrating Particles : Showers of (Prof. G. Wataghin), 91
Penetrating Showers : Extensive (B. Chaudhuri), 680
Penetration of Fat into Adipose Tissue : Active (B. Shapiro, D. Weissmann, V. Bentor and E. Wertheimer), 482
Penicillin : American Awards for Work on, 800
    The Assaying of (Biological Methods and Physical Methods Groups of the Society of Public Analysts and other Analytical Chemists discussion on), 285
    Behaviour of Gorini's Acid-Proteolytic Lactic Cocci with (Annamaria Torriani), 275
    Cytology of Staphylococci before and after Treatment with (Prof. R. Tulasne and Dr. R. Vendrely), 316
Penicillin (Radioactive) : Studies with (Dr. D. Rowley, J. Miller, S. Rowlands and Dr. E. Lester-Smith), 1009
Penicillin Assay Plates : Evidence for an Electrostatic Field on (Dr. Jean Dufrenoy and Prof. Robertson Pratt), 849
Penicillin Research Fellowships : Nuffield, 16
Penicillin Solutions : Factors involved in the Deactivation of, by Rubber Tubing (Dr. L. J. Bellamy and C. H. Watt), 940
Pentalene : The Non-Benzenoid Aromatic Hydrocarbon (D. P. Craig and Allan Maccoll), 481
Pentapeptides related to Gramicidin-*S* : Synthetic (J. I. Harris and T. S. Work), 804
People Are : What (Clark W. Heath, in collaboration with Lucien Brouha, Lewise W. Gregory, Carl C. Seltzer, Frederic L. Wells and William L. Woods), *review*, 502
Peoples of the Pacific World : Native (Prof. Felix M. Keesing), *review* by M. C. B., 419
Percentage Germination of Fungal Spores : A Method for Estimating (O. L. Davies, R. B. Duckworth and G. C. M. Harris), 642
Perceptible Energy and Brownian Motion in Sensory Processes : Minimum (Dr. Hl. de Vries), 63
Perception : The Physical Background of (Prof. E. D. Adrian), *review* by Dr. O. A. Trowell, 498
Perinuclear Lipidic Layer in the Liver Cell : A Cytochemical Study of the (Dr. C. A. Baud), 559
Periodicals : Recent Sociological (Prof. P. Sargant Florence), 450
Periodicals (French Scientific) : Photocopies of; 429
Periodicals and Newspapers : German Books, (European Periodicals Publicity and Advertising Co., Ltd., First Post-War Exhibition of), 595
Periodograms from Time-Series with Continuous Spectra : Smoothing (Prof. M. S. Bartlett), 686
Peripheral Action of Botulinum Toxin (Dr. N. Ambache), 482
Perithecia of Oak Mildew (J. Mary Knoyle), 938
Permanent Set : Chemical Mechanism of (A. J. Farnworth and Prof. J. B. Speakman), 890
Permeability (High Initial) : Metastable States of Nickel Characterized by a (Dr. J. L. Snoek and J. F. Fast), 887
Permittivity Values (High) : Measurement of, at Centimetre Wavelengths (J. G. Powles), 25
Peromyscus : Aggression, a Component of Post-Epileptic Automatism in (M. R. A. Chance), 101
Peroxides : The Enzyme-Substrate Compounds of Catalase and (Britton Chance), 914
Perseid Meteor Shower of 1947 : Combined Radar, Photographic and Visual Observations of the (Dr. Peter M. Millman, Dr. D. W. R. McKinley and Miriam S. Burland), 278 ; (Dr. A. C. B. Lovell), 280
Personal Leadership : Power and, 654
Personality, *review* by Prof. T. H. Pear, 622
    The Cultural Background of (Prof. Ralph Linton), *review* by Prof. T. H. Pear, 622
    The Dynamics of Power and (Prof. H. D. Lasswell), 654
Peru : Earthquake north-east of Lima on November 1, 306
Peru (Central) : Highland Communities of (Harry Tschopik, Jr.), 697
Pests (Garden) : The Detection and Control of (G. Fox Wilson), *review* by A. D. I., 419
Pests of Flour : Insect (J. A. Freeman and E. E. Turtle), 554
Petal Extracts : Paper Chromatography of Anthocyanins and related Substances in (E. C. Bate-Smith), 835
Petrographic Micro-technique (A. V. Weatherhead), *review* by F. I. G. Rawlins, 626

Petrol Fires : Extinction of, by Methyl Iodide (Dr. Oliver C. de C. Ellis), 402
Petroleum Production (Park J. Jones), Vol. 3, Oil Production by Water, *review* by H. B. Milner, 666
Petroleum Technology : Reviews of, Vol. 7 (covering 1941–45), *review* by H. B. Milner, 703
*p*H of Trisodium Citrate Solutions stored under Customary Laboratory Conditions (J. Jordan and Dr. M. Bobtelsky), 240
*p*H Values : Universal and Comparator Test-papers for the Measurement of (Johnson and Sons, Ltd.), 823
Phage Action : Calcium-Deficient Media—their Effect on (H. Williams Smith), 397
Pharmacological Activities in Different Rodent Species of *d*-Tubocurarine Chloride and the Dimethyl Ether of *d*-Tubocurarine Iodide (Dr. H. O. J. Collier, Sheila K. Paris and Dr. L. I. Woolf), 817
Pharmacology of Ch'ang Shan (*Dichroa febrifuga*), a Chinese Antimalarial Herb (Dr. C. S. Jang, F. Y. Fu, K. C. Huang and C. Y. Wang), 400 ; (T. S. Work), 401
Pharmacopœia (International) : Towards an, 33
Phase Memory of the Ear, a Proof of the Resonance Hypothesis (Dr. R. J. Pumphrey and T. Gold), 640
Phase-Angle Determination in X-Ray Crystallography (Dr. Alexander R. Stokes), 679
Phase-Contrast in Polarized Light (Prof. A. Kastler and R. Montarnal), 357
l-α- and *l*-β-Phellandrene : Reaction of β-Naphthol with (G. G. Acheson and Dr. T. F. West), 976
Phenols in Aqueous Solutions of Soap : Bactericidal Activity of (Prof. H. Berry and H. S. Bean), 396
Philippines : Earthquake on January 25, 232
Philosophy : Explanation in History and (Aristotelian Society Supplementary Vol. 21), *review* by F. I. G. Rawlins, 665
Philosophy (Contemporary) : The Revival of Realism, Critical Studies in (James Feibleman), *review* by Prof. A. D. Ritchie, 623
Phosphate Exchange by Yeasts : Riboflavin Enhancement of Radioactive (Dr. Walker J. Nickerson and Dr. Lorin J. Mullins), 939
Phosphorolysis of the Amylose and Amylopectin Fractions of Starch : Arsenolysis and (Dr. Joseph Katz, Dr. W. Z. Hassid and Dr. Michael Doudoroff), 96
Photochemical Degradation of Starch (Dr. S. Peat, Dr. E. J. Bourne and W. J. Whelan), 763
Photoconduction and Luminescence in Zinc Sulphide : Relation between (Dr. M. H. F. Wilkins and Dr. G. F. J. Garlick), 565
Photocopies of French Scientific Periodicals, 429
Photodynamic Action of 3 : 4 Benzpyrene : Inhibition of the (G. Calcutt and J. P. Newhouse), 53
Photo-Elastic Investigation of Internal Stresses in Silver Chloride caused by Plastic Deformation (J. F. Nye), 367
Photo-Elasticity : Some Modern Applications of (R. B. Heywood), 329
Photo-Elasticity in Mechanical Engineering (Dr. E. K. Frankl), 329 ; (W. A. P. Fisher), 329
Photo-electric Colorimetry : Units and Useful Range in (Dr. Walter Koch and Dr. Deborah Kaplan), 247 ; (Dr. J. R. Edisbury, R. J. Taylor and N. T. Gridgeman), 247
Photo-electric Counting of Individual Microscopic Plant and Animal Cells (Carl Lagercrantz), 25
Photographic Emulsions : Electron Tracks in (R. W. Berriman), 432 ; (Dr. R. H. Herz), 928
Photographic Emulsions Exposed to Cosmic Rays—Double Stars : Anomalous Distribution of Nuclear Disintegration in (L. Leprince-Ringuet and J. Heidmann), 844 ; (T. T. Li and D. H. Perkins), 844
Photographic Method : Investigation of the Radioactivity of Rocks by the (Dr. J. H. J. Poole and J. W. Bremner), 884
Photographic and Visual Observations of the Perseid Meteor Shower of 1947 : Combined Radar, (Dr. Peter M. Millman, Dr. D. W. R. McKinley and Miriam S. Burland), 278 ; (Dr. A. C. B. Lovell), 280
Photographically Recorded Oscillograph Signals : Reproduction of (R. L. F. Boyd), 227
Photographing Spectra : A Simple Way of (Dr. R. A. Houstoun), 973
Photographs : Nuclear Physics in (Dr. C. F. Powell and Dr. G. P. S. Occhialini), *review* by Prof. P. I. Dee, 333
Photography on Selenium (Dr. P. Selényi), 522
Photometer : Pulse-Counting, 635
Photometric Measurement of Specific Surface (B. A. Scott), 358
Photons, Neutrons, Mesotrons and Cosmic Rays : Electrons (+ and —), Protons, (Robert Andrews Millikan), revised edition, *review* by Dr. L. G. H. Huxley, 789
Photostat Copies of German Scientific and Technical Papers, 90
Photosynthesis of Foliage Leaves : Threshold Value of Carbon Dioxide Concentration in (Dr. E. K. Gabrielsen), 138
Physical Background of Perception (Prof. E. D. Adrian), *review* by Dr. O. A. Trowell, 498
Physical Chemistry at the Mellon Institute of Industrial Research, 89
Physical Measurements : Blinking, its Role in (Dr. Robert W. Lawson), 154
Physical Patterns of Speech, *review* by Dr. W. G. Radley, 334
Physical Planning in the South-West of England, *review* by Prof. L. Dudley Stamp, 786
Physical Properties of Metals : Structure and (X-Ray Analysis Group of the Institute of Physics discussion on), 263
Physical Science : The Growth of (Sir James Jeans), *review* by Prof. J. A. Crowther, 260
Physics : College (Prof. John A. Eldridge), third edition, *review* by S. Weintroub, 954
    College Technical (Robert L. Weber, Marsh W. White and Kenneth V. Manning), *review* by S. Weintroub, 954
    Low-Temperature (Dr. K. Mendelssohn), 732
    Metal (Summer School in the Cavendish Laboratory), 637
Physics (Modern) : Electricity, Magnetism and (Dr. G. T. P. Tarrant), *review* by Prof. L. F. Bates, 829
    Introduction to (F. K. Richtmyer and E. H. Kennard), fourth edition, *review* by Prof. L. F. Bates, 912
Physics at the University of Bristol, 755
Physics of Metals : International Conference on the (Netherlands Physical Society), 389
Physics of Solids : Summer School in (University of Bristol in co-operation with the Institute of Physics), 233, 636
Physics and Music : The Borderline of Psychology, (Acoustics Group of the Physical Society symposium on), 589
Physiological Chemistry : Practical (Dr. Philip B. Hawk, Dr. Bernard L. Oser and Dr. William H. Summerson), twelfth edition, *review*, 830
Physiological and Psychological Factors in Sex Behaviour (New York Academy of Sciences conference on), 124
Physiology : Advances in, *review* by Dr. O. A. Trowell, 542
    Annual Review of (edited by Victor E. Hall, Jefferson M. Crismon and Arthur C. Giese), Vol. 9, *review* by Dr. O. A. Trowell, 542
    Elementary, *review* by Prof. W. C. Cullis, 828
    Introduction to (Prof. W. H. Newton), *review* by Prof. W. C. Cullis, 828
Physiology (Medical and Agricultural) : Co-operation between, *review*, 113
Physiology (Sex and Reproductive) : Recent Advances in (Dr. J. M. Robson), third edition, *review* by Dr. F. H. A. Marshall, 790
Physiology at St. Andrews, 922
Physiology of Man in the Desert (E. F. Adolph and associates), *review* by Dr. B. McArdle, 744
Physiology and Biochemistry of Fats and Lipoids (Le Centre National de la Recherche scientifique symposium on), 534
Physiology and Pathology of Animal Production and on Artificial Insemination : First International Congress on the, 197
Physiology of Resistance to Disease in Plants (Royal Society symposium on), 422
Physiques : Les mesures (Albert Pérard), *review* by S. Weintroub, 955
Picture : Trees in Prose and, *review* by Sir Edward Salisbury, 497
Pie was Opened" : "When the, *review* by Prof. E. H. Neville, 186
Piezo-Electric Constants of α- and β-Quartz : Calculation of the (Dr. Bishambhar Dayal Saksena), 283
Piezo-Electric Resonance of Barium Titanate Crystals : Dielectric Constant and (Bernd T. Matthias), 325
Piezo-Electricity : Equations of (Richard K. Cook), 524
Pigment-fillings held in Cellulose Acetate Moulds : Recording Crevices in Plane Surfaces by (Dr. A. T. J. Dollar), 358
Pigmentation and Colour Vision : Race, (Dr. R. W. Pickford), 687
Pigs : Stimulation of Growth in, by Iodinated Casein and Stilbœstrol (Dr. R. Braude), 856
Pinhole Radiography of Magnetrons (Dr. R. Dunsmuir, Dr. C. J. Milner and A. J. Spayne), 244
Pituitary of the Guinea Pig : Alkaline Phosphatase in various Cell Types of the Anterior (Prof. Leo Abolins), 556
Plague Grasshopper (Australian) : Measurement of 'Environmental Resistance' in the (Dr. H. G. Andrewartha and L. C. Birch), 447
Plan your own Industries (M. P. Fogarty), 183
Planck (Max) Memorial Ceremony at Göttingen (Prof. E. N. da C. Andrade), 751
Plane Surfaces : Recording Crevices in, by Pigment-fillings held in Cellulose Acetate Moulds (Dr. A. T. J. Dollar), 358
Planetary Properties : Parallelism between Atomic and, 780
Planets : Between the (Fletcher G. Watson), *review* by H. S. J., 460
Planktonic Copepoda : The Free-Swimming (Lieut.-Colonel R. B. Seymour Sewell), 822
Planning in Scientific Research : Limitations of, 35
Planning in the South-West of England : Physical, *review* by Prof. L. Dudley Stamp, 786
Plant (Living) : Botany of the (Prof. F. O. Bower), fourth edition, *review* by Prof. F. T. Brooks, 153
Plant en dier : Koper als onmisbaar element voor (W. J. Melchers en H. J. Gerritsen), *review*, 624
Plant in the Food Industry : Cleaning and Sterilizing of (Royal Sanitary Institute and the Food Group of the Society of Chemical Industry discussion on), 1025
Plant Analysis and Fertilizer Requirements, 406
Plant Cells : Quantitative Relation between Salt Accumulation and Salt Respiration in (Dr. R. N. Robertson and Marjorie Wilkins), 101
Plant Collecting in the Far East (Dr. George Taylor), 635
Plant Disease caused by a Spore-forming Bacterium under Natural Conditions (Z. Volcani and Dr. W. J. Dowson), 980
Plant Disease Charts (*Plant Protection, Ltd.*), 389
Plant Ecology : Introduction to (A. G. Tansley), 158
Plant Ecology and the School (A. G. Tansley and E. Price Evans), 158
Plant Geography, *review* by Sir Edward Salisbury, 704 ; (Prof. Ronald Good), 857
Plant Nutrition : Antagonism between Molybdenum and certain Heavy Metals in (C. R. Millikan), 528
Plant Pathology at the Rothamsted Experimental Station, 676
Plant Physiology : Trace Elements in (International Union of Biological Sciences symposium on), 364
Plant Species : Differential Effect of 2-Benzoylbenzoic Acid and its Derivatives upon (Dr. W. A. Sexton and Dr. W. G. Templeman), 974
Plant Tissues (Meristematic) : Chromatographical Study of (Dr. A. Allsopp), 833
Plant Virus Diseases, 945
Plant Virus Proteins and Antibody-Antigen Reactions (R. E. F. Matthews), 611
Plant Virus Research at Cambridge (Dr. Kenneth M. Smith), 776
Plant and Animal Cells : Photo-electric Counting of Individual Microscopic (Carl Lagercrantz), 25
Plant-growth Substances : Treatment of Apple Canker Lesions with (S. H. Crowdy), 320
Plantas : Las heladas y la necrosis fria de la (Plutarco Naranjo V), *review* by H. L. P., 706
Plants : British Bee (edited by A. F. Harwood), 470
    Chemical Promotion of Rooting in, *review* by Prof. M. Thomas, 993
    Relation of Manganese and some other Metals to the Iron Status of (Eric J. Hewitt), 489
    Physiology of Resistance to Disease in (Royal Society symposium on), 422
Plants (Flowering) : Critical British Groups of (J. E. Lousley), 733
    The Geography of the (Prof. Ronald Good), *review* by Sir Edward Salisbury, 704, 857
Plants as an Index of their Nutritional Status : Chemical Composition of (Dr. D. W. Goodall and Dr. F. G. Gregory), 406
Plasma (Ether-extracted) : Sodium Citrate Concentration in (Margaret E. Mackay and W. d'A. Maycock), 235
Plasma of Rats : Effect of Thyroid Deficiency on the Level of Pseudo-Cholinesterase in the (R. D. Hawkins, Prof. B. Mendel and M. Nishikawara), 639
Plasma Protease : Staphylokinase, an Activator of (Charles H. Lack), 559

Plasmodia by Acridines and Antimalarial Action : Absence of Correlation between Respiratory Inhibition of (Dr. Adrien Albert and P. B. Marshall), 1008
Plasteins : Structure of (Prof. Artturi I. Virtanen and Heikki K. Kerkkonen), 888
Plastetics, *review* by Dr. S. R. Carter, 581
Plastic Deformation : Photo-elastic Investigation of Internal Stresses in Silver Chloride caused by (J. F. Nye), 367
Plastics : Low-Pressure Laminating of (J. S. Hicks, assisted by R. J. Francis), *review* by J. M. J. Estevez, 788
Plastics Annual 1947 : The British International, *review* by Dr. S. R. Carter, 581
Platinum : Magnetic Susceptibility of Borax Glasses containing Crystallites of Alkali Metal Salts, Gold and (Prof. Subodh Kumar Majumdar), 684
Plato's Theory of Education (Prof. R. C. Lodge), *review*, 376
Playfair (Lyon) and Technical Education in Britain (W. H. G. Armytage), 752
Plerocercoid Fragments : Development of Cestodes *in vitro*—Production of Fertile Eggs ; Cultivation of (Dr. J. D. Smyth), 138
Plesianthropus : Size of the Brain in the Ape-Man, (Dr. R. Broom and J. T. Robinson), 438
Plumbaginaceæ : Relationships in the (Dr. H. G. Baker), 400
Plymouth : A Submerged Ancient Cliff near (Dr. L. H. N. Cooper), 280
Podocarpic Acid as a Source of an Œstrogenic Hormone (C. W. Brandt and D. J. Ross), 892
Poisoning : Food (Elliot B. Dewberry), second edition, *review*, 540
Poisons and Magnetic Susceptibility : Catalytic (M. H. Dilke, Dr. D. D. Eley and Dr. E. B. Maxted), 804
Polar from Non-Polar Molecules : Separation of (Prof. G. Karagounis), 855
Polar Groups (Rotating) : Dielectric Relaxation of Molecules containing (Prof. A. Budó), 133
Polarizability for some Halogen Compounds : Variation of the Force Constant with the Ionization Potential and the (P. Torkington), 724
Polarized Light : Phase-Contrast in (Prof. A. Kastler and R. Montarnal), 357
Polarographic Determination of the Gamma-Isomer of Benzene Hexachloride (G. B. Ingram and H. K. Southern), 437
Polished Glass Surfaces : Structure of Calcium Fluoride Films Evaporated on (J. Bannon and C. E. Curnow), 136
Political Behaviour : The Analysis of (Harold D. Lasswell), *review* by Prof. D. W. Brogan, 950
Political Testament of an Anthropologist, *review* by Dr. E. R. Leach, 457
Politics : Science and (Prof. D. W. Brogan), 6 ; (Prof. A. D. Ritchie), 6
Pollen Dimorphism in Late-Glacial *Armeria* : Significance of (Dr. H. G. Baker), 770
Polonium : Excitation Curves for the γ-Radiation from Light Elements Bombarded with α-Particles from (Prof. Hilding Slätis), 899
Polyglutamic Acid : Synthetic (W. E. Hanby, S. G. Waley and J. Watson), 132
Polymeric Systems : Cross-Linking in (Dr. G. F. Bloomfield), 298
Polymers : Branched-Chain High (Prof. H. W. Melville and G. W. Youngson), 803
Polymethylene *bis*-Quaternary Ammonium Salts : Curare-like Action of (Dr. R. B. Barlow and Dr. H. R. Ing), 718 ; (Dr. W. D. M. Paton and Dr. E. J. Zaimis), 718
Polyphase Supply : Bridge Networks discriminating between Positive and Negative Sequences in (N. F. Barber), 685
Polyploidogenic Agents : Hormone-Mimetic and other Responses of the Silkworm (*Bombyx mori* L.) to some (L. J. Havas and J. Kahan), 570
Polysaccharide from Hydatid Cyst Fluid (Gwen M. Macnab), 310
Polysaccharide-like Substances ('Mucin') in Saliva : Bacterial Hydrolysis and Utilization of (Dr. H. J. Rogers), 815
Polysaccharides : Reaction of Boric Acid with (Dr. H. Deuel, H. Neukom and F. Weber), 96
Polysaccharides (Bacterial) : Adsorption of, to Erythrocytes (Dr. E. V. Keogh, Dr. E. A. North and M. F. Warburton), 687
Polyvinyl Alcohol : Crystal Structure of (C. W. Bunn), 929
Pomelo : Botanical Nomenclature of the Shaddock or (Dr. D. Chatterjee), 770
Population of France : Scientific Research on Ageing in the (French National Union of Prevention of Depopulation and the French National Demographic Institute conference on), 163
Population and World Resources in relation to the Family : International Congress on (Family Planning Association of Great Britain), 882
Porometer in the Investigation of Stomatal Aperture : Studies in Stomatal Action—Adequacy of the (Dr. O. V. S. Heath and Dr. W. T. Williams), 178
Porous Materials : Interaction of Water and (Faraday Society General Discussion on), 307, 629
Portugal : Earthquake at Santarem on October 3, 306
Positive Electrons from β-Emitters : Apparent Emission of (C. B. A. McCusker), 564
Positive and Negative Sequences in Polyphase Supply : Bridge Networks discriminating between (N. F. Barber), 685
Post-Epileptic Automatism in *Peromyscus* : Aggression, a Component of (M. R. A. Chance), 101
Post-War World : The Intelligent Man's Guide to the (G. D. H. Cole), *review* by Maurice Bruce, 151
Potassium Nitrate : Formation of Oxime-Nitrogen in *Torula*-Yeast Fed with (Prof. Artturi I. Virtanen and Tihamér Z. Csáky), 814
Potato : Nitrogenous Constituents of the (Dr. E. B. Black), 211
Potato Blight and the Weather in Britain (A. Beaumont), 429
Potato Sets in Acid Soils : Effect of Calcium Deficiency on (Prof. T. Wallace and E. J. Hewitt), 28
Potency of Pancreatic Insulin in the Animal System : Relation of Intermediary Metabolites to the Lowering of the (Prof. M. C. Nath and H. D. Brahmachari), 18
Potential (Streaming) : Theory of the (G. A. H. Elton), 847
Potential Field Distributions : An Electrolytic Tank for Exploring (R. Makar, A. R. Boothroyd and E. C. Cherry), 845
Potential Theory of Aerofoils, *review* by Prof. W. J. Duncan, 703
Powder Metallurgy : International Conference on (Steirmark of the Association of Austrian Chemists), 307
Power : Peace or (Sir Harold Butler), 414
Power (Micro-Wave) : A Method of Feeding, into a Resonator having a Fine Mode Structure (G. R. Newbery and W. E. Willshaw), 519
Power and Personal Leadership, 654
Power and Personality : The Dynamics of (Prof. H. D. Lasswell), 654
Power Industries : The British Fuel and (Political and Economic Planning Report on), 669
Precipitation and Crystallization of Proteins : Use of Solubility Curves at Varying *p*H and Constant Ionic Strength for the (A. Distèche), 130
Precise Measurement for Engineers (Film on the work of the Metrology Division of the National Physical Laboratory), 717
Pre-erythrocytic Stage in Mammalian Malaria Parasites (Prof. H. E. Shortt and P. C. C. Garnham), 126 ; (Dr. Frank Hawking), 175
Pregnancy Test using the Male Toad (Dr. Octavio Rodrigues Lima and Dr. Oswaldo Gelli Pereira), 676
Pregnanediol : A Rapid Method for the Estimation of (J. Rabinovitch), 605
Pregnant Mare : Ovarian Activity in the (Prof. E. C. Amoroso, J. L. Hancock and Dr. I. W. Rowlands), 355
Prehistoric Industry : Earliest Known (T. T. Paterson), 278
Prehistory and the Missouri Development Program (W. R. Wedel), 636
Premortal Increase in the Output of Sodium and Chlorine in Fasting Rats (Dr. Peter Bálint and Dr. Helene Kabdebó), 57
Preparation of Heparin : A New Extraction Procedure for the (Olle Snellman, Robert Jensen and Dr. Bengt Sylvén), 639
Press : Science and the (Association of British Science Writers Forum Discussion on), 882
Prestwich Medal of the Geological Society awarded to the Abbé Henri Breuil, 122
Primary Calcification in Bone: The Theory of (Dr. Marcel J. Dallemagne), 115
Primary Cells : Air-depolarized (British Standard 1335 : 1946), 51
Primates discovered during 1947 : African Fossil (Prof. W. E. Le Gros Clark), 667
Probit Analysis (D. J. Finney), *review* by Prof. J. H. Gaddum, 417
Production of Mesons : The Artificial (Dr. G. P. S. Occhialini and Dr. C. F. Powell), 551
Professional Meteorologist : Meteorology for the, *review* by Prof. P. A. Sheppard, 625
Progress of Cancer Research (Dr. I. Hieger), 385
Progress of Industry : Science and the (Sir Edward Appleton), 368
Propagation of Large Barkhausen Discontinuities : Effect of Lattice Distortions on the Mean Rate of (Dr. L. J. Dijkstra and Dr. J. L. Snoek), 886
Prose and Picture : Trees in, *review* by Sir Edward Salisbury, 497
Protanopes : Darkening of Red in (Dr. R. W. Pickford), 27
Protease (Plasma) : Staphylokinase, an Activator of (Charles H. Lack), 559
Protein by X-Ray Microspectrography : Intracellular Determination of (Dr. A. Engström and M. A. Jakus), 168
Protein Complexes and the van den Bergh Reaction : Bilirubin-Serum (C. H. Gray and Dr. R. A. Kekwick), 274
Protein Deficiency : Dietetic Hepatic Lesions and (Dr. M. V. Radhakrishna Rao), 446
Protein and Bacteria from Normal and Infected Joints : Absorption of (Torbjörn Edlund), 102
Protein-Free Media : Animal Tissue Cells in (Aage Bohus Jensen), 273
Proteins : Action of Nitrogen Trichloride on—Production of Toxic Derivative (H. R. Bentley, Dr. R. G. Booth, E. N. Greer, J. G. Heathcote, Dr. J. B. Hutchinson and Dr. T. Moran), 127
    Reaction of Mustard Gas with (Dr. J. C. Boursnell), 225
    Reactions of Lachrymators with Enzymes and (Dr. M. Dixon), 226
    Use of Solubility Curves at Varying *p*H and Constant Ionic Strength for the Precipitation and Crystallization of (A. Distèche), 130
Proteins and Antibody-Antigen Reactions : Plant Virus (R. E. F. Matthews), 611
Prothrombin : Dicumarol Poisoning and Vitamin K Deficiency in relation to Quick's Concept of the Composition of (Prof. Henrik Dam), 1010
Prothrombin Activity : Regeneration of, by Carbon Dioxide (I. M. Chak and Dr. K. V. Giri), 354
Protons : Scattering of 100-MeV. Neutrons by (F. C. Barker), 726
Protons, Photons, Neutrons, Mesotrons, and Cosmic Rays : Electrons (+ and −), (Robert Andrews Millikan), revised edition, *review* by Dr. L. G. H. Huxley, 789
Protozoa : The Status of the (Dr. John R. Baker), 548, 587
Protozoan Fauna of Soil and Inland Waters : Ciliate (Ernest Gray), 854
Pseudo-Cholinesterase in the Plasma of Rats : Effect of Thyroid Deficiency on the Level of (R. D. Hawkins, Prof. B. Mendel and M. Nishikawara), 639
Psychological Factors in Sex Behaviour : Physiological and (New York Academy of Sciences conference on), 124
Psychology of Industry (Prof. James Drever), second edition, *review* by T. H. Hawkins, 955
Psychology, Physics and Music : The Borderline of (Acoustics Group of the Physical Society symposium on), 589
Pteridines : Reductone and the Synthesis of (Dr. H. S. Forrest and Dr. James Walker), 721
Public : Peace and the (Mass-Observation), 415
Public Administration : Study of (Dr. W. A. Robson), 879
Public Libraries in Germany (H. Schurer), 90
Public Welfare Medal for 1947 of the U.S. National Academy of Sciences awarded to Dr. Karl T. Compton, 50
Publication of Scientific Papers : Proposed Central (Sir George Thomson and Dr. John R. Baker), 771 ; (Prof. J. D. Bernal), 799 ; (Watson Davis), 896 ; (Mrs. Lucia Moholy), 922
Puffinosis, a Virus Epizootic of the Manx Shearwater (*Puffinus p. puffinus*), (J. A. R. Miles and M. G. P. Stoker), 1016
Pulmonary Artery Pressure : Effect of Renin on (E. G. Brewin, R. A. Kenney and D. H. Miller), 893
Pulse Counting Photometer, 635
Punjab : Geology of the Salt Range of the (Sir Edward Bailey), 265
Purification of Anti-pernicious Anæmia Factors from Liver (Dr. E. Lester Smith), 638, 676
Pyrenees : Earthquake on December 13, 306
Pyrimidine Nucleosides : Separation of, by Synthetic Resin Ion-Exchangers (D. T. Elmore), 931
Pyrimidine Nucleosides of Yeast Ribosenucleic Acid : Isolation and Separation of (Dr. R. J. C. Harris and J. F. Thomas), 931

QUAKES : When the Earth (Rev. James B. Macelwane), *review* by Ernest Tillotson, 459
Quality Control (British Standard 1313: 1947), 50

Quantitative Chromatographic Estimation of α-Amino-Acids (Dr. L. Naftalin), 763
Quantitative Paper Chromatography (R. B. Fisher, D. S. Parsons and G. A. Morrison), 764
Quantitative Relation between Salt Accumulation and Salt Respiration in Plant Cells (Dr. R. N. Robertson and Marjorie Wilkins), 101
α- and β-Quartz: Calculation of the Piezo-electric Constants of (Dr. Bishambhar Dayal Saksena), 283
Quartz Crystals (Oscillating): Application of Multiple-Beam Interferometry to the Study of (Prof. S. Tolansky and W. Bardsley), 925
Quaternary Ammonium Compounds for the Improvement of Electrical Insulation Resistance: Treatment of Glass and Steatite Ceramic with (J. S. Dryden and R. J. Meakins), 23
bis-Quaternary Ammonium Salts: Curare-like Action of Polymethylene (Dr. R. B. Barlow and Dr. H. R. Ing), 718; (Dr. W. D. M. Paton and Dr. E. J. Zaimis), 718
Quaternary History of the British Isles: Bottom Deposits of Lake Windermere in relation to the (Dr. H. G. Baker), 987
Quick's Concept of the Composition of Prothrombin: Dicumarol Poisoning and Vitamin K Deficiency in relation to (Prof. Henrik Dam), 1010
β-Quinol, an Example of the Firm Union of Molecules without the Formation of Chemical Bonds between Them (H. M. Powell and P. Riesz), 52

R.38 Memorial Prize of the Royal Aeronautical Society awarded to W. M. Widgery, 593
Rabbit Ova (Fertilized): Transplantation of—the Effect on Viability of Age, *in vitro* Storage Period, and Storage Temperature (Dr. Min-Chueh Chang), 978
Race for Oil: The, *review* by H. B. Milner, 186
Race, Pigmentation and Colour Vision (Dr. R. W. Pickford), 687
Race (Fisher and): Two Examples of Sera containing the Anti-*d* Agglutinin predicted by (Dr. Joseph M. Hill and Dr. Sol Haberman), 688
Radar: Development of, *review* by Sir Robert Watson-Watt, 867
Radar System Engineering (edited by Prof. Louis N. Ridenour), *review* by Sir Robert Watson-Watt, 867
Radar, Photographic and Visual Observations of the Perseid Meteor Shower of 1947: Combined (Dr. Peter M. Millman, Dr. D. W. R. McKinley and Miriam S. Burland), 278; (Dr. A. C. B. Lovell), 280
Radial Pressure: Delayed Fracture of Glass under Tension, Torsion and (C. Gurney), 729
Radiation (Bactericidal): Transmission of, through Glass (J. E. Stanworth), 856; *erratum*, 882
Radiation Damping and Velocity of Light (Prof. W. Heitler), 678
Radiations (Ionizing): Chemical Effects of (Gabriel Stein and Dr. Joseph Weiss), 650
Radio: Scientific (Radio Section of the Institution of Electrical Engineers and the British National Committee for Scientific Radio convention on), 233, 793
Radio Aids to Navigation (Dr. R. A. Smith), *review* by Dr. R. L. Smith-Rose, 334
Radio Conferences: International, 695
Radio Data Charts (Dr. R. T. Beatty), revised by J. McG. Sowerby, fourth edition, *review* by B. G. P., 871
Radio Engineering (Dr. E. K. Sandeman), Vol. I, *review* by Dr. L. E. C. Hughes, 706
Radio Field: British Research in the (Research Committee of the Institution of Electrical Engineers), 943
Radio-Frequency Radiation in the Constellation of Cygnus: Variable Source of (J. G. Bolton and G. J. Stanley), 312
Radio-Frequency Spectrum: International Aspects of the, 863
Radio Noise (Cosmic): Frequency Variation of the Intensity of (Jack W. Herbstreit and Joseph R. Johler), 515
Radio Noise over the Frequency Range 1–30 Mc./s.: Survey of Existing Information and Data on (Dr. H. A. Thomas and R. E. Burgess), 107
Radio Research in Britain (Prof. J. Greig), 943
Radio Research in Great Britain, 387
Radio Technique: Modern, *review* by Dr. R. L. Smith-Rose, 334
Radio Waves: Meteorology and the Propagation of (Dr. R. L. Smith-Rose), 145
Radio Waves from the Sun: Audio-Frequency (Dr. Donald H. Menzel and Winfield W. Salisbury), 91
Radio Waves from Trails during Formation: Velocity of Meteors Measured by Diffraction of (C. D. Ellyett and J. G. Davies), 596
Radio and Electrical Research in Canada, 513
Radio and Telecommunication Conferences at Atlantic City: International, 863
Radioactive Disintegration Products: Angular Distribution of (J. A. Spiers), 807
Radioactive Local Anæsthetic: A (Frank Howarth), 857
Radioactive Penicillin: Studies with (Dr. D. Rowley, J. Miller, S. Rowlands and Dr. E. Lester-Smith), 1009
Radioactive Phosphate Exchange by Yeasts: Riboflavin Enhancement of (Dr. Walter J. Nickerson and Dr. Lorin J. Mullins), 939
Radioactive Tracers in Biology (Prof. Martin D. Kamen), *review* by Prof. F. A. Paneth, 456
Radioactive and Stable Tracer Isotopes: The Determination of (Physical Methods Group of the Society of Public Analysts and other Analytical Chemists symposium on), 693
Radioactivity: Discovery of (Prof. Jean Becquerel), 609; (Prof. J. A. Crowther), 609
Radioactivity of Osmium: Reported (A. H. W. Aten, Jun.), 1019
Radioactivity of Rocks by the Photographic Method: Investigation of the (Dr. J. H. J. Poole and J. W. Bremner), 884
Radioelements as a Tool in Scientific Research, *review* by Prof. F. A. Paneth, 456
Radiography with Alpha Rays: Surface (C. Jech), 214
Radiography of Magnetrons: Pinhole (Dr. R. Dunsmuir, Dr. C. J. Milner and A. J. Spayne), 244
Radiophosphorus, $^{32}_{15}$P: Influence of Folliculin on Bone Metabolism, Studied by Means of (Dr. J. Govaerts and Prof. M. J. Dallemagne), 977
Radiophysiologie expérimentale, cancer et hormones, 6, Étude de la cancérisation par les substances chimiques exogènes (Antoine Lacassagne), *review* by Prof. E. Boyland, 621
Raman Spectra of some Synthetic Mixtures of α-Chloroacids (Dr. Marcel Renard), 354
Ramsay Memorial Fellowships for Chemical Research, 272
Rare-Earth Chlorides: Preparation of (F. R. Hartley and A. W. Wylie), 241
Rat Thymus: Weight of the (L. R. C. Agnew), 205
Rate of Wear in the Region of the Validity of Amontons' Law (Henry James Bezer and Dr. Robert Schnurmann), 728
Rats: Contribution to the Knowledge of the Influences of Gonadotrophic and Sex Hormones on the Gonads of (J. H. Gaarenstroom and S. E. de Jongh), *review* by Prof. S. Zuckerman, 221
  Effect of Feeding 2-Acetaminofluorene on the Adreno-Gonadal System of (Cornelia Hoch-Ligeti), 58
  Effect of Thyroid Deficiency on the Level of Pseudo-Cholinesterase in the Plasma of (R. D. Hawkins, Prof. B. Mendel and M. Nishikawara), 639
Rats (Alloxan Diabetic): Effect of Insulin on Intestinal Glucose Absorption in (Dr. A. Sols, S. Vidal and J. Larralde), 932
Rats (Fasting): Premortal Increase in the Output of Sodium and Chlorine in (Dr. Peter Bálint and Dr. Helene Kabdebó), 57
Rats' Eggs from the Fallopian Tubes: Improved Method of getting (S. A. Simpson and P. C. Williams), 237
Ray: English Naturalists from Neckam to (Dr. Charles E. Raven), *review* by Prof. F. J. Cole, 373
Rays Reflected from the F_2 Region: Triple Magneto Ionic Splitting of (Gordon Newstead), 312
Reaction: The Sommelet (Dr. S. J. Angyal and R. C. Rassack), 723
Reaction (van den Bergh): Bilirubin-Serum Protein Complexes and the (C. H. Gray and Dr. R. A. Kekwick), 274
Reaction of Boric Acid with Polysaccharides (Dr. H. Deuel, H. Neukom and F. Weber), 96
Reaction between Catalase and Hydrogen Peroxide (R. Lemberg and E. C. Foulkes), 131
Reaction between Manganous Ion and Manganese Dioxide (J. M. Cowley and Allan Walkley), 173
Reaction of Mustard Gas with Proteins (Dr. J. C. Boursnell), 225
Reaction of β-Naphthol with *l*-α- and *l*—β-Phellandrene (G. G. Acheson and Dr. T. F. West), 976
Reaction for Uronic Acids: The Tollens Naphthoresorcinol (A. H. Guerrera and Dr. R. Tecwyn Williams), 930
Reactions (Slow Neutron): Cloud Chamber Investigation of Straggling of Short-Range Particles produced by (Dr. J. K. Bøggild), 810
Reactions at Carbon-Carbon Double Bonds: Mechanisms of (Prof. Charles C. Price), *review* by Dr. J. Sheridan, 626
Reactions of Lachrymators with Enzymes and Proteins (Dr. M. Dixon), 226
Reactions of Mustard Gas in Aqueous Solution (Dr. A. G. Ogston), 225
Reactivity of Aromatic Double Bonds: Relative (Dr. G. M. Badger and Dr. R. I. Reed), 238
Reactivity and Structure of Molecules (Prof. F. A. Paneth), 901
Realism: Logical, *review* by Prof. A. D. Ritchie, 623
  The Revival of, Critical Studies in Contemporary Philosophy (James Feibleman), *review* by Prof. A. D. Ritchie, 623
Reason: Eclipse of (Max Horkheimer), *review* by A. D. R., 664
Reason in the Modern World, *review*, 664
Rebuilding Europe's Fat Supplies (G. Heyworth), 123
Reclamation Disease in Agriculture, *review*, 624
Recorded Sound: Proposed Institute of (Association of Special Libraries and Information Bureaux meeting to discuss the formation of a), 493
Recording of Related Oscillograph Traces: Simultaneous, 89
Recording Crevices in Plane Surfaces by Pigment-fillings held in Cellulose Acetate Moulds (Dr. A. T. J. Dollar), 358
Recovery: Design for (Design for Freedom Committee), 660
Red in Protanopes: Darkening of (Dr. R. W. Pickford), 27
Red Cell: Submicroscopic Structure of the (Dr. M. F. Perutz), 204
Red Cells (Human): Action of Heating on *Rh*-Positive (Dr. P. O. Hubinont), 642
  Enzymic Action of Viruses and Bacterial Products on (C. M. Chu), 606
Red Spider Mite: Toxicity of Azo-Compounds and other Substances to the Fruit Tree (Dr. J. K. Eaton and R. G. Davies), 644
Reduction of Cytochrome *c* by Cytochrome *b*: A Factor in Heart Muscle required for the (E. C. Slater), 405
Reduction of 1:4-Diketones (Dr. Neil Campbell and Nandoomal Khanna), 54
Reductone and the Synthesis of Pteridines (Dr. H. S. Forrest and Dr. James Walker), 721
Reference and Information: British Sources of (edited by Theodore Besterman), *review* by R. Brightman, 789
References in Scientific Literature (Prof. R. A. Peters), 731
Refining of Non-ferrous Metals (Institution of Mining and Metallurgy symposium on), 924
Reflecting Microscope: Applications of the, to the Nuclear Plates Technique (Dr. W. J. Bates and Dr. G. P. S. Occhialini), 473
Reflections: Incidents and (J. B. Atkin), 866
Refraction Effects in Electron Diffraction and in Electron Microscopy (Dr. H. Raether), 311
Refractive Index Gradients: A Short-Focus Modification of the Lamm Scale Method for Measuring (Harry Svensson), 234
Regeneration of Prothrombin Activity by Carbon Dioxide (I. M. Chak and Dr. K. V. Giri), 354
Regional Development Organisations in Britain, 183
Regional Government: Local and (G. D. H. Cole), 825
Rehabilitation of Europe, 659
Relation between the Action of Clover Juice on Isolated Muscle and 'Bloat' in Cattle: A Possible (W. S. Ferguson), 816
Relation of Intermediary Metabolites to the Lowering of the Potency of Pancreatic Insulin in the Animal System (Prof. M. C. Nath and H. D. Brahmachari), 18
Relation between Photoconduction and Luminescence in Zinc Sulphide (Dr. M. H. F. Wilkins and Dr. G. F. J. Garlick), 565
Relationships in the Plumbaginaceæ (Dr. H. G. Baker), 400
Relaxation of Molecules containing Rotating Polar Groups: Dielectric (Prof. A. Budó), 133
Relaxation Methods: Summer School in (Imperial College of Science and Technology), 717
Release of Information on Atomic Energy, 146
Removal of Neurosecretory Cells in the Brain of Adult *Calliphora erythrocephala* Meig.: Effect of (Dr. Ellen Thomsen), 439

Renal Circulation : Studies of the (Dr. Josep Trueta, Dr. Alfred E. Barclay, Dr. Kenneth F. Franklin, Peter M. Daniel, Marjorie M. L. Prichard), *review*, 663
Renal Tubules : Osmotic-Work performed by the (David F. Cole), 640
Renin on Pulmonary Artery Pressure : Effect of (E. G. Brewin, R. A. Kenney and D. H. Miller), 893
Renosine : Electron Microscope Observations of (A. G. Matoltsy), 353
Reproductive Physiology : Recent Advances in Sex and (Dr. J. M. Robson), third edition, *review* by Dr. F. H. A. Marshall, 790
Research : British Rocket Weapons (R. H. Macmillan), 329
  Colonial, 1946–47, 141
  Corrosion, in Canada, 553
  Electronics and their Application in Industry and (edited by Dr. Bernard Lovell), *review* by Dr. T. E. Allibone, 702
  Government, in Britain, 214
  Greenkeeping, 757
  Industrial, 1947 (edited by Dr. Percy Dunsheath), *review* by R. Brightman, 705
  Industrial, in East Africa, 122
  Medical, in South Africa, 162
  Medical, during War-time (Dr. G. Lapage), 998
  Operational (Sir Charles Goodeve), 377, 609 ; (Prof. C. H. Waddington), 404 ; (Dr. F. Yates), 609
  Operational, in the Research Associations (Committee of Directors of Research Associations conference on), 584
  Plant Virus, at Cambridge (Dr. Kenneth M. Smith), 776
  Radio, in Britain (Prof. J. Greig), 943
  Radio and Electrical, in Canada, 513
  Road, 231
  Scientific, in Belgium (Grants for), 634
  Scientific, in the British Zone of Germany (Prof. F. A. Paneth), 191
  Scientific, in India (National Institute of Sciences of India symposium on), 513
  Scientific, and Development in Northern Ireland, 162
  Scientific and Industrial, in Palestine, 800
  Scientific, and Industrial Development, 699
  Scientific, and Industry, 368
  Seismological, in Great Britain, 615
Research (Biophysical) : Amphibian Tissue Cultures for (M. M'E. Preston), 203
Research (Cancer) : Progress of (Dr. I. Hieger), 385
Research (Chemical) : Ramsay Memorial Fellowships for, 272
Research (Genetic) : Possible Significance of Free-living Nematodes in (Dr. Ellsworth C. Dougherty and Hermione Grant Calhoun), 29
Research (Hormone) : Recent Progress in (Proceedings of the Laurentian Hormone Conference, Vol. I, edited by Gregory Pincus), *review* by Prof. S. Zuckerman, 295
Research (Pasture) : Pastures and (C. M. Donald), second edition, *review* by Dr. John Grainger, 747
Research (Scientific) : Limitations of Planning in, 35
  Radioelements as a Tool in, *review* by Prof. F. A. Paneth, 456
Research in Central Africa, 230
Research at the University of Birmingham, 594
Research in Wales : Industry and (Industrial Research Committee of the Federation of British Industries and the Industrial Association of Wales and Monmouthshire joint regional conference on), 233
Research in World War II : German (Colonel Leslie E. Simon), *review*, 219
Research on the Biochemistry of Brain Tissue, 346
Research in Hydraulics : Model, *review* by Prof. J. Th. Thijsse, 219
Research in Industry—Working Party Reports, 448
Research on Management, *review* by E. F. L. Brech, 869
Research in Marine Biology : Recent (Dr. N. B. Eales), 737
Research on Nematology, 1006
Research in the Radio Field : British (Research Committee of the Institution of Electrical Engineers), 943
Research in Surveying at University College, London, 50
Research on the Trematoda, *review* by Dr. G. Lapage, 222
Research and Development in British Colonial Territories, 141
Research Associations : Operational Research in the (Committee of Directors of Research Associations conference on), 584
Research Fellowship : Dewar, 802
Research Fellowships : Nuffield (Penicillin), 16
Research Fellowships in the University of Cambridge (Imperial Chemical Industries, Ltd.), 90
Research Fellowships in Chemistry or Physics at the University of Glasgow and the Royal Technical College, Glasgow (J. and P. Coats, Ltd.), 164
Research Scholarship (Aluminium Development Association), 882
Residence : The Planning of University Halls of, 344
Resin Chemistry : Synthetic (Dr. S. R. W. Martin), *review* by Dr. P. D. Ritchie, 502
Resin Ion-Exchangers (Synthetic) : Separation of Pyrimidine Nucleosides by (D. T. Elmore), 931
Resistance to Disease in Plants : Physiology of (Royal Society symposium on), 422
Resistance to 'Inanition' in Grass Seedlings (H. G. Chippindale), 65 ; (J. P. Cooper), 894
Resistance of Metal Films at a Frequency of 24,000 Mc./s. : Surface (Dr. L. Speirs), 601
'Resistine' : An Adaptation Mechanism of the Organism to Damage—the Role of (Dr. S. Karády and Dr. A. Kovács), 688
Resolution Testing in Autoradiography (G. W. W. Stevens), 432
Resolving Power (10^{-8}–10^{-9} Sec.) : Coincidence Device of (Z. Bay and G. Papp), 59
Resonance Hypothesis : Phase Memory of the Ear, a Proof of the (Dr. R. J. Pumphrey and T. Gold), 640
Resonator having a Fine Mode Structure : A Method of Feeding Microwave Power into a (G. R. Newbery and W. E. Willshaw), 519
Resources : The Conservation and Utilization of (United Nations conference on), 617
Respiratory Inhibition of Plasmodia by Acridines and Antimalarial Action : Absence of Correlation between (Dr. Adrien Albert and E. B. Marshall), 1008
Respiratory Quotient of the Mammary Gland (Dr. S. J. Folley and T. H. French), 933
Responses of the Silkworm (*Bombyx mori* L.) to some Polyploidogenic Agents : Hormone-Mimetic and other (L. J. Havas and J. Kahan), 570
Responsibility in Nationalized Industries, 619
Responsibility (Social) : Individual Freedom and (Conference on), 843
Retained Austenite : Comparison of Metallographic and X-Ray Measurements of (William J. Harris, Jun.), 315
Reversal of Vernalization by High Temperature (Prof. F. G. Gregory and Dr. O. N. Purvis), 859
Reversion, a New Procedure in Absorptiometry (Dr. H. Irving, G. Andrew and E. J. Risdon), 805
Revival of Realism, Critical Studies in Contemporary Philosophy (James Feibleman), *review* by Prof. A. D. Ritchie, 623
Rh Genes Allelomorphic to *C* (Dr. R. R. Race, Dr. Ruth Sanger and Mrs. Sylvia D. Lawler), 316
Rh Nomenclature (Dr. A. E. Mourant), 492
Rh-Positive Human Red Cells : Action of Heating on (Dr. P. O. Hubinont), 642
Rheological Congress : International, 105, 636
Rheological Investigations for the British Armed Services : War-time (British Rheologists' Club meeting on), 252
Rheology : Some New Anisotropic Time Effects in (S. M. Freeman and K. Weissenberg), 324
  International Study of, 104
Rheology in the Textile Industries (British Rheologists' Club and others conference on), 307
Rhinarium (Rodent) : An Undescribed Structure in the (Dr. W. C. Osman Hill), 276
Rhodesia : The Romance of (Ardaser Sorabjee N. Wadia), *review*, 871
Riboflavin Enhancement of Radioactive Phosphate Exchange by Yeasts (Dr. Walter J. Nickerson and Dr. Lorin J. Mullins), 939
Ribonucleic Acid (Yeast) : Structure of (the late Prof. J. Masson Gulland and D. O. Jordan), 561
  Isolation and Separation of the Pyrimidine Nucleosides of (Dr. R. J. C. Harris and J. F. Thomas), 931
2-Deoxy *D*-Ribose and 3-Deoxy *D*-Xylose : Conversion of *D*-Arabinose into (Dr. P. W. Kent, Prof. M. Stacey and Dr. L. F. P. Wiggins), 21
Ribose Nucleic Acid in the *Drosophila* Egg (H. G. Callan), 440
Rice in Lower Burma : Results of the Continuous Use of an Ammonium Phosphate Fertilizer on (D. Rhind and U Tin), 105
Riddell Memorial Lectures : Nineteenth (Prof. A. D. Ritchie), 6
Right Way to Understand the Countryside (Stanley A. Manning), *review* by T. H. Hawkins, 995
C/D Ring Union in the Œstrogenic Hormones : Nature of the (Dr. C. W. Shoppee), 207
C/D Ring Union in Œstrone and Equilenin (Dr. W. Klyne), 434 ; *errata*, 514
River Never Sleeps : A (Roderick Haig-Brown), *review* by Seton Gordon, 951
Rivers : Our (J. W. Kempster), *review* by Dr. A. T. Doodson, 911
Road Research, 231
Rocket as a Weapon of War in the British Forces (Sir Alwyn Crow), 329
Rocket Flight : Mathematical Theory of (Prof. J. Barkley Rosser, Dr. Robert R. Newton and Dr. George L. Gross), *review* by Dr. R. A. Rankin, 3
Rocket Weapons Research : British (R. H. Macmillan), 329
Rockets : Exterior Ballistics of, *review* by Dr. R. A. Rankin, 3
Rocks : Investigation of the Radioactivity of, by the Photographic Method (Dr. J. H. J. Poole and J. W. Bremner), 884
Rocky Mountains : Handbook of the Trees of the Northern States and Canada East of the (Romeyn Beck Hough), *review* by Sir Edward Salisbury, 497
Rodent Rhinarium : An Undescribed Structure in the (Dr. W. C. Osman Hill), 276
Rodent Species : Pharmacological Activities in Different, of *d*-Tubocurarine Chloride and the Dimethyl Ether of *d*-Tubocurarine Iodide (Dr. H. O. J. Collier, Sheila K. Paris and Dr. L. I. Woolf), 817
Rodents (Laboratory) : Natural Amœbic Infections in (Dr. J. D. Fulton and J. P. Joyner), 66
Romance of Rhodesia : The (Ardaser Sorabjee N. Wadia), *review*, 871
Roofs Supported by Air Pressure (Herbert W. Stevens, Jun.), 613
Room Temperature : Luminescence Efficiency Changes in Zinc Sulphide Phosphors below (Dr. G. F. J. Garlick and A. Gibson), 359
Rooting in Plants : Chemical Promotion of, *review* by Prof. M. Thomas, 993
Rooting of Woody Cuttings : The Use of Auxins in the (Kenneth V. Thimann and Jane Behnke), *review* by Prof. M. Thomas, 993
Rotating Bodies : Blackett's Hypothesis of the Magnetic Field of (Dr. Niels Arley), 598 ; (Dr. J. Fuchs), 599
  Magnetic Field of Massive (Prof. H. T. H. Piaggio), 450
Rotating Polar Groups : Dielectric Relaxation of Molecules containing (Prof. A. Budó), 133
Royal Botanic Garden, Calcutta : Early History of the (Dr. D. Chatterjee), 362
Rubber Technology (Institution of the Rubber Industry conference on), 51
Rubber Tubing : Factors involved in the Deactivation of Penicillin Solutions by (Dr. L. J. Bellamy and C. H. Watt), 940
Rubber-proofed Clothing : Working Party Report on (Board of Trade), 448
Rumen : Microflora of the (C. A. McGaughey and K. C. Sellers), 1014
Rust-Affected Crop as Seed : Shrivelled Wheat Grain from (R. B. Ekbote and K. R. Sahasrabuddhe), 442

SALIVA : Bacterial Hydrolysis and Utilization of Polysaccharide-like Substances ('Mucin') in (Dr. H. J. Rogers), 815
Salmon (Thomas W.) Memorial Lectures (Prof. H. D. Lasswell), 654
Salmon and Animal Migration (Dr. A. G. Huntsman), 300
Salt Accumulation and Salt Respiration in Plant Cells : Quantitative Relation between (Dr. R. N. Robertson and Marjorie Wilkins), 101
Salt Range of the Punjab : Geology of the (Sir Edward Bailey), 265
Salt Respiration in Plant Cells : Quantitative Relation between Salt Accumulation and (Dr. R. N. Robertson and Marjorie Wilkins), 101
Salts : Inner-Complex, of Trivalent Thallium (Prof. Fr. Feigl), 436
Sampling Practice in the United States of America, *review* by Dr. F. Yates, 153
Sarcolemma : Electron Microscopy of the (W. M. Jones and Dr. Robert Barer), 1012
Sargent Diagram : A Revised (Prof. N. Feather), 431

Sarkar (Sir Jadunath) Gold Medal of the Royal Asiatic Society of Bengal awarded to Sir Panduranga S. S. Pissurlencar, 553
Scale of *Sciaena coitor* (Hamilton): An Atypical (Dr. Sivatosh Mookerjee), 64
Scale Models in Hydraulic Engineering (Prof. J. Allen), *review* by Prof. J. Th. Thijsse, 219
Scattering of Neutrons by Lead (R. Latham and J. M. Cassels), 282
Scattering of D—D Neutrons by Deuterium (J. F. Darby and J. B. Swan), 22
Scattering of 100-MeV. Neutrons by Protons (F. C. Barker), 726
Scholarship : John Gray Jubilee (Society of Chemical Industry), 595
  Research (Aluminium Development Association), 882
Scholarships : Agricultural and Veterinary (Ministry of Agriculture and Fisheries), 430
Scholarships for European Students : American Summer (Massachusetts Institute of Technology), 593 ; *erratum*, 637
Scholarships for 1948–49 at Foreign Universities (British Council), 347
Scholarships in Husbandry, Agricultural Economics, Statistics and Agricultural and Dairy Engineering : Postgraduate (Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland), 637
School : Plant Ecology and the (A. G. Tansley and E. Price Evans), 158
School Child : The Health of the (Dr. Robert Sutherland), 960
School Ecological Studies (Blundell's Scientific Publication), 271
Schools and the Land (British Social Hygiene Council Summer School on), 470
Schumann Region : Absorption Band Spectrum of S_2 in the (R. Maeder and Prof. E. Miescher), 393
Schumann-Runge System of the Oxygen Molecule : New Bands in the (Lalji Lal), 477
Sciaena coitor (Hamilton): An Atypical Scale of (Dr. Sivatosh Mookerjee), 64
Science : Ethics and (British Social Hygiene Council conference on), 197
  Grammar School, *review* by W. L. Sumner, 114
  A Short History of, *review* by Prof. J. A. Crowther, 260
  A Tribute of Industry to, 508
  On Understanding (Dr. J. B. Conant), 865
  World Co-operation in (Prof. J. D. Bernal), 840
  Written Expression in (Conference at Leicester on), 533
Science in Secondary Schools : The Teaching of (compiled by a Joint Committee of the Incorporated Association of Assistant Masters and the Science Masters' Association), *review* by W. L. Sumner, 114
Science in Social Affairs (Association of Scientific Workers conference on), 68
Science Advances (J. B. S. Haldane), *review* by R. Brightman, 747
Science and Freedom (Dr. Lyman Bryson), 577
Science and History, 865
Science and Politics (Prof. D. W. Brogan), 6 ; (Prof. A. D. Ritchie), 6
Science and the Press (Association of British Science Writers Forum Discussion on), 882
Science and the Progress of Industry (Sir Edward Appleton), 368
Science and Society in Ancient China (Dr. Joseph Needham), 305
Science and UNESCO, 159
Science at War (J. G. Crowther and R. Whiddington), *review* by S. Weintroub, 907
Scientific Aspects of the Work of the National Coal Board (John Crossland), 546
Scientific Centenaries in 1948 (Eng.-Capt. Edgar C. Smith), 11
Scientific Development of the West Indies : Social and, 181
Scientific Effort in Britain : The Deployment of, 1
Scientific Expedition to Arnhem Land (National Geographic Society, Smithsonian Institution and the Commonwealth of Australia), 195
Scientific Information Services (Royal Society conference on), 469
Scientific Instruments : Exhibition of (Physical Society), 732
Scientific Instruments : British (Dr. A. B. Wood), 732
  Export Organisation for, 345
Scientific Journalism : Awards for, 125
Scientific Literature : References in (Prof. R. A. Peters), 731
Scientific Management, *review* by J. Leigh, 910
Scientific and Natural History Books : Old, 305
Scientific Papers : Proposed Central Publication of (Sir George Thomson and Dr. John R. Baker), 771 ; (Prof. J. D. Bernal), 799 ; (Watson Davis), 896 ; (Mrs. Lucia Moholy), 922
  Use of Equivalent Metric Values in, 144
Scientific Periodicals : Photocopies of French, 429
Scientific Radio (Radio Section of the Institution of Electrical Engineers and the British National Committee for Scientific Radio convention on), 233, 793
Scientific Research : Limitations of Planning in, 35
  Radioelements as a Tool in, *review* by Prof. F. A. Paneth, 456
Scientific Research in Belgium : Grants for, 634
Scientific Research in the British Zone of Germany (Prof. F. A. Paneth), 191
Scientific Research in India (National Institute of Sciences of India symposium on), 513
Scientific Research and Development in Northern Ireland, 162
Scientific Research and Industrial Development, 699
Scientific Research and Industry, 368
Scientific and Industrial Research in Palestine, 800
Scientific and Technical Books : Imports of, 75
  Recent : Supp. ii, January 31 ; Supp. ii, February 28 ; Supp. ii, March 27 ; Supp. ii, April 24 ; Supp. ii, May 29 ; Supp. ii, June 26
Scientific War Effort : Britain's, *review* by S. Weintroub, 907
Scientific Workers (British) : American Awards to, 215, 390, 716, 800
Scientist in Industry (Sir Edward Appleton), 508, 537
Scotland and Ireland : Megalithic Tombs in (Prof. V. Gordon Childe), 841
Sea : They Live in the (Douglas P. Wilson), *review* by Dr. L. Harrison Matthews, 40
  This Great and Wide (R. E. Coker), *review*, 38
Sea and Inland Fisheries : Report on (Government of Northern Ireland), 451
Sea-urchin : Distribution of Alkaline Phosphatase in the Eggs of a (Elsa Wicklund), 556
Seasonal Variation in Chemical Constitution of some Common British Laminariales (Dr. W. A. P. Black), 174
Seaweed Survey : Sublittoral—Relationship of Algal Growth and Depth (F. T. Walker), 977
Secondary Schools : The Teaching of Science in (compiled by a Joint Committee of the Incorporated Association of Assistant Masters and the Science Masters' Association), *review* by W. L. Sumner, 114
Secondary Thickening in Excised Tomato Roots (Dr. K. J. Dormer and Dr. H. E. Street), 483
Secretion : Internal, *review* by Dr. F. H. A. Marshall, 953
Sedimentation : Influence of Solvent Movement on (Bertil Enoksson), 934
Seed : Shrivelled Wheat Grain from Rust-Affected Crop as (R. B. Ekbote and K. R. Sahasrabuddhe), 442
Seed of Sugar Beet : Transmission of a Disease Resembling Virus Yellows through the (Dr. Phyllis E. M. Clinch, J. B. Loughnane and R. McKay), 28
Seedlings (Grass) : Resistance to Inanition in (H. G. Chippindale), 65 ; (J. P. Cooper), 894
Seeing : Light, Vision and (Dr. Matthew Luckiesh), fourth printing, *review* by Dr. R. W. Pickford, 40
Séismes et volcans (Prof. J.-P. Rothé), *review* by Ernest Tillotson, 296
Seismological Observatories : British, 923
Seismological Research in Great Britain, 615
Seismological Summary : International, 923
Seismology : Pure and Applied, *review* by Ernest Tillotson, 459
Seismology of the Pacific Region : The Bikini Bomb and the (Prof. K. E. Bullen), 62
Selenium : Photography on (Dr. P. Selényi), 522
Semaphore Numerals (Prof. W. G. Bickley), 807
Semen : Citric Acid in (G. F. Humphrey and Dr. T. Mann), 352
Semiconductors and their Applications (Manchester and District Branch of the Institute of Physics conference on), 430
Sensory Processes : Minimum Perceptible Energy and Brownian Motion in (Dr. Hl. de Vries), 63
Separation of Particles of Different Sizes : Principle of a Counter-streaming Centrifuge for the (Per Eric Lindahl), 648
Separation and Identification of Methylated Sugars on the Paper Chromatogram (F. Brown, Prof. E. L. Hirst, L. Hough, Dr. J. K. N. Jones and H. Wadman), 720
Sequential Analysis (Prof. Abraham Wald), *review* by M. G. Kendall, 790
Sera containing the Anti-*d* Agglutinin Predicted by Fisher and Race : Two Examples of (Dr. Joseph M. Hill and Dr. Sol Haberman), 688
Sericultural Congress : Seventh International (French National Institute of Agronomic Research), 307
Serological Position of *Streptococcus bovis* (Dr. P. M. F. Shattock), 318
Serpulid Tubes : Formation and Breakdown of (Jean Hanson), 610
Sertoli Cell : The Nucleolus of the Apodan (B. R. Seshachar), 558
Serum : Effect of Under-Nutrition and Alterations in Diet on the Choline Esterase Activity of (Prof. R. A. McCance, E. M. Widdowson and A. O. Hutchinson), 56
  Histaminolytic Activity of a Copper Protein in (Dr. C. G. Holmberg and C.-B. Laurell), 236
Service Requirements in Britain : Land Use and, 149
Servomechanism Fundamentals (Henri Lauer, Robert Lesnick and Leslie E. Matson), *review*, 294
Servomechanisms : Theory of (edited by Prof. Hubert M. James, Nathaniel B. Nichols and Prof. Ralph S. Phillips), *review* by Prof. A. Porter, 994
Sesamum laciniatum Klein : Chromosome Number of (Dr. S. Ramanujam and A. B. Joshi), 99
Set (Permanent) : Chemical Mechanism of (A. J. Farnworth and Prof. J. B. Speakman), 890
Severn Tide (Brian Waters), *review* by A. T. D., 790
Sex Behaviour : Animal and Human, 124
  Physiological and Psychological Factors in (New York Academy of Sciences conference on), 124
Sex Forms of *Luffa acutangula* Roxb. ; Inheritance of (H. B. Singh, S. Ramanujam and B. P. Pal), 775
Sex Hormones on the Gonads of Rats : Contribution to the Knowledge of the Influences of Gonadotrophic and (J. H. Gaarenstroom and S. E. de Jongh), *review* by Prof. S. Zuckerman, 221
Sex Reversal in Copepods (J. G. Cattley), 937
Sex and Reproductive Physiology : Recent Advances in (Dr. J. M. Robson), third edition, *review* by Dr. F. H. A. Marshall, 790
SH Enzymes : Inhibition of, by Methyl Bromide (S. E. Lewis), 692
Shaddock or Pomelo: Botanical Nomenclature of the (Dr. D. Chatterjee), 770
Shallot : Bulb Formation in the (Dr. L. G. G. Warne), 935
Shark, *Necturus*, and the Cat : Guide to the Study of the Anatomy of the (Prof. Samuel Eddy, Prof. Clarence P. Oliver and Prof. John P. Turner), second edition, *review* by Dr. P. D. F. Murray, 955
Shearwater (*Puffinus p. puffinus*) : Puffinosis, a Virus Epizootic of the Manx (J. A. R. Miles and M. G. P. Stoker), 1016
Sheffield : Interchange of Technical Publications in, 305
Sherrington (Sir Charles) and Diphtheria Antitoxin (Dr. A. N. Drury), 266
Short-Focus Modification of the Lamm Scale Method for Measuring Refractive Index Gradients (Harry Svensson), 234
Short-Range Particles produced by Slow Neutron Reactions : Cloud Chamber Investigation of Straggling of (Dr. J. K. Bøggild), 810
Showers : Extensive Penetrating (B. Chaudhuri), 680
Showers of Penetrating Particles (Prof. G. Wataghin), 91
Shrinkage of Animal Cells due to Fixatives (Dr. Daya Krishna), 202
Shrivelled Wheat Grain from Rust-Affected Crop as Seed (R. B. Ekbote and K. R. Sahasrabuddhe), 442
Signalübermittlung im Nerven : Die (Prof. Alexander v. Muralt), *review* by Prof. J. Z. Young, 76
Significance of Free-living Nematodes in Genetic Research : Possible (Dr. Ellsworth C. Dougherty and Hermione Grant Calhoun), 29
Significance of Pollen Dimorphism in Late-Glacial *Armeria* (Dr. H. G. Baker), 770
Silicate Inclusions in Steel : Determination of (Prof. J. Kamecki and A. Kotlinski), 402
Silk : Bibliography of the Technical Literature on (Dr. F. O. Howitt), *review* by Prof. J. B. Speakman, 790
Silkworm (*Bombyx mori* L.) : Hormone-Mimetic and other Responses of the, to some Polyploidogenic Agents (L. J. Havas and J. Kahan), 570
Silver Chloride caused by Plastic Deformation : Photo-elastic Investigation of Internal Stresses in (J. F. Nye), 367
Silver Medal of the Royal Aeronautical Society awarded to I. I. Sikorsky, 593
Silver and Copper : Amalgamation of some Alloys of Gold, (Dr. Douglas Rennie Hudson), 288
Simms Gold Medal of the Royal Aeronautical Society awarded to Sir William T. Griffith, 593
Simms Gold Medal of the Society of Engineers awarded to J. G. Milton, 346
Simultaneous Recording of Related Oscillograph Traces, [illegible]89

TITLE INDEX

Siphons in Lamellibranchia : Formation of (Prof. C. M. Yonge), 198
Sizes (Different) : Principle of a Counter-streaming Centrifuge for the Separation of Particles of (Per Eric Lindahl), 648
Skagerak: Foraminifera in the Gullmar Fjord and the (Hans Högland), 513
Skating : Theory of (Dr. A. E. Bell), 391
Skill and Management (G. E. Milward), *review* by J. Leigh, 910
Skin (Cow) : Capillary Distribution in (Dr. J. D. Findlay and S. H. Yang), 1012
Skin Effect in Metals : Theory of the Anomalous (G. E. H. Reuter and E. H. Sondheimer), 394
Skokholm : Letters from (R. M. Lockley), *review* by Frances Pitt, 5
Sky : The Night, in January, 17 ; in February, 164 ; in April, 471 ; in May, 677 ; in June, 843
Sky (Night) and Auroras : Emission Spectra of the (Physical Society to arrange for separate publication of papers read before the International Conference on the), 514
Sleeping Sickness : International Conference on, 306
Sleeps: A River Never (Roderick Haig-Brown), *review* by Seton Gordon, 951
Slow Neutron Reactions : Cloud Chamber Investigation of Straggling of Short-Range Particles produced by (Dr. J. K. Bøggild), 810
Smithsonian Elliptic Functions Tables (G. W. and R. M. Spenceley), *review*, 747
Smoke (Arnold Marsh), *review* by F. I. G. Rawlins, 706
Smoothing Periodograms from Time-Series with Continuous Spectra (Prof. M. S. Bartlett), 686
Soap : Bactericidal Activity of Phenols in Aqueous Solutions of (Prof. H. Berry and H. S. Bean), 396
Social Affairs : Science in (Association of Scientific Workers conference on), 68
Social Biology : The International and Cultural Relations of (British Social Hygiene Council Summer School on), 842
Social Hymenoptera : Regulation of Oviposition in (M. V. Brian and A. D. Brian), 854
Social Responsibility : Individual Freedom and (Conference on), 843
Social Studies of the Elderly (Eleanor French), 253
Social Studies in Manchester, 15
Social Survey : The Government (Maurice Goldsmith), 573
Social and Scientific Development of the West Indies, 181
Society : Archæology and (Grahame Clark), second edition, *review* by Prof. C. F. C. Hawkes, 583
    The Engineer in (John Mills), *review* by R. Brightman, 374
    The Free (John Middleton Murry), 538
    Men of Science in Industry and, *review* by R. Brightman, 374
Society (Good) : Freedom in the, 577
Society in Ancient China : Science and (Dr. Joseph Needham), 305
Society and the Individual (British Social Hygiene Council Ethics and Science conference on), 197
Sociological Periodicals : Recent (Prof. P. Sargant Florence), 450
Sociology : Approaches to, *review* by Prof. D. W. Brogan, 950
    Essays in (from Max Weber), translated, edited and with an introduction by H. H. Gerth and C. Wright Mills, *review* by Prof. D. W. Brogan, 950
    A Handbook of (Prof. William F. Ogburn and Prof. Meyer F. Nimkoff), *review* by T. H. Hawkins, 188
Sociology of Mental Disease (National Association for Mental Health conference on), 407
Sodium and Chlorine in Fasting Rats : Premortal Increase in the Output of (Dr. Peter Bálint and Dr. Helene Kabdebó), 57
Sodium Citrate Concentration in Ether-extracted Plasma (Margaret E. Mackay and W. d'A. Maycock), 235
Soil : Chemicals, Humus and the (Donald P. Hopkins), *review*, 39
    Limitation of Bacteria by Micro-Predators in (Dr. F. J. Anscombe and Dr. B. N. Singh), 140
    Persistence of D.D.T. and Benzene Hexachloride in (Dr. M. S. Smith), 246
    Production of an Antibiotic Substance on Wheat Straw and other Organic Materials and in the (Erna Grossbard), 614
Soil Fertility, *review*, 39
Soil Indicators : Mosses as (H. Watson), 823
Soil Sterilization : Practical (Ministry of Agriculture, Bulletin 22), 196
Soil and Inland Waters : Ciliate Protozoan Fauna of (Ernest Gray), 854
Soils (Acid) : Effects of Calcium Deficiency on Potato Sets in (Prof. T. Wallace and E. J. Hewitt), 28
Soils and Water : Dielectric Properties of, at a Wave-length of 3·2 cm. (Prof. A. W. Straiton and C. W. Tolbert), 73
Solar Atmosphere : Spontaneous Waves in Discharge Tubes and in the (Prof. V. A. Bailey), 599
Solar Noise (E. C. Drewe and D. Maurice), 167
Solar Noise Outburst at 600 Mc./s. and 1200 Mc./s. (F. J. Lehany and D. E. Yabsley), 645
Solar Radiation (Enhanced Microwave) : Emission of (R. G. Giovanelli), 133
Solar Radio Emissions and Sunspots (I. L. Thomsen), 134 ; (M. Ryle), 136
Solar and Terrestrial Relationships, *review* by Dr. M. A. Ellison, 951
Solids : Physics of (University of Bristol in co-operation with the Institute of Physics Summer School in the), 233, 636
    Birth and Growth of the Explosion in, Initiated by Impact (Dr. F. P. Bowden and O. A. Gurton), 348
Solubility Curves at Varying *pH* and Constant Ionic Strength for the Precipitation and Crystallization of Proteins : Use of (A. Distèche), 130
Solution of the Fundamental Equation of the Statistical Atom Theory : An Asymptotic (Dr. J. I. Hórvath), 26
Solutions of Macromolecules : Normal Stress Coefficient in (R. S. Rivlin), 567
Solvation of Hydrogen Ion in Oxygen-containing Solvents (Dr. Ernest A. Braude and E. S. Stern), 169
Solvent Movement on Sedimentation : Influence of (Bertil Enoksson), 934
Solvents (Oxygen-containing) : Solvation of Hydrogen Ion in (Dr. Ernest A. Braude and E. S. Stern), 169
Somali Place Names (British) : A Gazetteer of, 195
Somaliland (British) : Report on the General Survey of (1945), 195
Somatic Tissues : Chromosome Multiplication and Reduction in (Prof. C. Leonard Huskins), 80
Sommelet Reaction (Dr. S. J. Angyal and R. C. Rassack), 723
Song of *Fringilla coelebs* Linn. : Chronometric Observations of the (D. R. Barber), [illegible]77
Sons of Cambridge, *review* by Prof. F. J. M. Stratton, 661
Sound (Recorded) : Proposed Institute of (Association of Special Libraries and Information Bureaux meeting to discuss the formation of a), 493
South Africa : Archæology in, 881
    Medical Research in, 162
South American Chemical Congress : The Fourth, 654
South Australia : Jellyfish from the Basal Cambrian in (Reg. C. Sprigg), 568
    Newly Discovered Submarine Canyons of New Guinea and (Reg. C. Sprigg), 246
South Georgia (near) : Earthquake on July 23, 657
Southwest Pacific : Birds of the (Ernst Mayr), *review* by Frances Pitt, 545
Soviet Economic Development since 1917 (Maurice Dobb), *review* by Maurice Bruce, 908
Spark Discharge : Development of the (Dr. T. E. Allibone), 970
Special Factor Influencing the Conditional Disposition to Infectious Diseases : Thyroid Gland as a (Dr. S. Zimanyi), 57
Special Librarianship : Study Group on (Association of Special Libraries and Information Bureaux), 430
Species : Origins of, and Migrations of Floras, *review* by Prof. I. Manton, 455
Specific and Non-specific Competition in Tubular Excretion (I. Sperber), 236
Specific Surface : Photometric Measurement of (B. A. Scott), 358
Spectra : A Simple Way of Photographing (Dr. R. A. Houstoun), 973
Spectra (Continuous) : Smoothing Periodograms from Time-Series with (Prof. M. S. Bartlett), 686
Spectra of Crystals : Infra-Red Absorption (Sir C. V. Raman), 165
Spectra of the Night Sky and Auroras : Emission (Physical Society to arrange for separate publication of papers read before the International Conference on the), 514
Spectral Response of Lead Selenide (T. S. Moss and R. P. Chasmar), 244
Spectral Sensitivity of Lead Telluride Layers (T. S. Moss), 766
Spectroscopy (Infra-Red) : Lead Telluride Cells for (O. Simpson, Dr. G. B. B. M. Sutherland and Dr. D. E. Blackwell), 281
Spectrum (Ammonia Inversion) : Collision Broadening of the, at High Pressures (Dr. B. Bleaney and J. H. N. Loubser), 522
Spectrum (Radio-Frequency) : International Aspects of the, 863
Spectrum of Active Nitrogen : Mechanism of the Emission (L. Herman and R. Herman), 1018
Spectrum of Aluminium Bromide : Band (Carl Gustav Jennergren), 315
Spectrum of ClO in Flames : Band (Dr. G. Pannetier and Dr. A. G. Gaydon), 242
Spectrum of S_2 in the Schumann Region : Absorption Band (R. Maeder and Prof. E. Miescher), 393
Spectrum of White Dwarfs (Dr. Evry Schatzman), 61
Speech : Man's Organs of (Prof. H. A. Harris), 628
    Physical Patterns of, *review* by Dr. W. G. Radley, 334
    Visible (Ralph K. Potter, George A. Kopp and Harriet C. Green), *review* by Dr. W. G. Radley, 334
Speech Therapy (College of Speech Therapists conference on), 125
Spermatogenesis of Oligospermic Men : Variations in (Prof. B. Zondek, Y. M. Bromberg and Z. Polishuk), 176
Spiders : A Book of (Dr. W. S. Bristowe), *review* by T. H. S., 706
Spin-Dependence of Magnetic Dipole Gamma Radiation and the Nuclear Level Scheme of Pb^{208} (Dr. H. O. W. Richardson), 516
Spinning Particle : The Meson Field and the Equation of Motion of a (R. C. Majumdar and Dr. S. Gupta), 410
Splitting of Ionospheric Rays : Triple (J. H. Meek), 597 ; (T. L. Eckersley), 597
Splitting of Rays Reflected from the F_2 Region : Triple Magneto Ionic (Gordon Newstead), 312
Spontaneous Waves in Discharge Tubes and in the Solar Atmosphere (Prof. V. A. Bailey), 599
Spore-forming Bacterium under Natural Conditions : A Plant Disease caused by a (Z. Volcani and Dr. W. J. Dowson), 980
Stability of Apple Juice : Effect of Ion-Exchange Treatment on the (Dr. S. W. Challinor, Margaret E. Kieser and Dr. A. Pollard), 1023
Stability of Metal Complexes : Order of (Dr. D. P. Mellor and L. Maley), 436
Staff of Life : Controlling the, *review* by A. L. Bacharach, 293
Stainless Steels : Ferromagnetic Structure of Cold-Worked Austenitic (P. T. Hobson and W. P. Osmond), 562
Standardization of Micro-film Technique (British Standard Specification 1371 : 1947), 346
Staphylococci before and after Treatment with Penicillin : Cytology of (Prof. R. Tulasne and Dr. R. Vendrely), 316
Staphylococcus aureus : Glutamine-synthesizing System of, its Inhibition by Crystal Violet and Methionine-sulphoxide (W. H. Elliott and Dr. E. F. Gale), 129
Staphylokinase, an Activator of Plasma Protease (Charles H. Lack), 559
Starch : Arsenolysis and Phosphorolysis of the Amylose and Amylopectin Fractions of (Dr. Joseph Katz, Dr. W. Z. Hassid and Dr. Michael Doudoroff), 96
    Photochemical Degradation of (Dr. S. Peat, Dr. E. J. Bourne and W. J. Whelan), 763
Starches of the Wrinkled and the Smooth Pea (Dr. S. Peat, Dr. E. J. Bourne and Mary J. Nicholls), 206
Stars (Variable) : The Story of (Leon Campbell and Luigi Jacchia), *review* by H. S. J., 460
State (Changing) : The Civil Service in the (H. R. G. Greaves), 496
Statistical Atom Theory : An Asymptotic Solution of the Fundamental Equation of the (Dr. J. I. Hórvath), 26
Statistics : Mathematics of (John F. Kenney), Part I, second edition, *review* by P. A. Moran, 544
Statistics and Agricultural and Dairy Engineering : Postgraduate Scholarships in Husbandry, Agricultural Economics, (Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland), 637
Status of the Protozoa (Dr. John R. Baker), 548, 587
Steatite Ceramic with Quaternary Ammonium Compounds for the Improvement of Electrical Insulation Resistance : Treatment of Glass and (J. S. Dryden and R. J. Meakins), 23
Steel : Determination of Silicate Inclusions in (Prof. J. Kamecki and A. Kotlinski), 402
Steels : Ferromagnetic Structure of Cold-Worked Austenitic Stainless (P. T. Hobson and W. P. Osmond), 562
Steepest Descents : Methods of—Improved Formula for X-Ray Analysis (Dr. V. Vand), 600

Stereochemistry of Trimeric Thioaldehydes (Prof. Alexander Schönberg and Mohamed Zaki Barakat), 722 ; (Dr. G. M. Bennett), 723
Sterilizing of Plant in the Food Industry : Cleaning and (Royal Sanitary Institute and the Food Group of the Society of Chemical Industry discussion on), 1025
Stilbœstrol : Stimulation of Growth in Pigs by Iodinated Casein and (Dr. R. Braude), 856
Stilbœstrol Monoglucuronide from Human Urine : Isolation of (K. S. Dodgson and Dr. R. Tecwyn Williams), 604
Stomatal Action : Studies in—Adequacy of the Porometer in the Investigation of Stomatal Aperture (Dr. O. V. S. Heath and Dr. W. T. Williams), 178 ; Control of Stomatal Movement by a Reduction in the Normal Carbon Dioxide Content of the Air (Dr. O. V. S. Heath), 179
Straggling of Short-Range Particles produced by Slow Neutron Reactions : Cloud Chamber Investigation of (Dr. J. K. Bøggild), 810
Streaming Potential : Theory of the (G. A. H. Elton), 847
Strength of Materials : Aircraft (Dr. H. D. Conway), *review*, 503
Streptococcus bovis : Serological Position of (Dr. P. M. F. Shattock), 318
Streptococcus faecalis in *E. histolytica* Infections (Dr. G. T. Stewart, W. R. Jones and M. A. T. Rogers), 936
Stress Coefficient in Solutions of Macromolecules: Normal (R. S. Rivlin), 567
Stress Corrosion (J. C. Chaston), 891
Stressed Aluminium (Prof. E. A. Owen, Y. H. Liu and D. P. Morris), 681
Stresses : Photo-elastic Investigation of Internal, in Silver Chloride caused by Plastic Deformation (J. F. Nye), 367
Stresses in Metals : Internal (W. A. Wood and N. Dewsnap), 682 ; (G. B. Greenough), 683
Stresses in Metals and Alloys : Internal (Institute of Metals, in association with the Faraday Society, the Institute of Physics, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Physical Society and the Royal Aeronautical Society symposium on), 70
Structure of an Animal Virus (Dr. I. M. Dawson and Dr. A. S. McFarlane), 464
Structure of the Bacterial Cell, as shown by the Electron Microscope : Submicroscopical (Dr. Stuart Mudd), 302
Structure of Barium Sulphate : Electrokinetic Potential and Surface (A. S. Buchanan and Prof. E. Heymann), 691
Structure of Biological Tissues as revealed by X-Ray Diffraction Analysis and Electron Microscopy (Prof. W. T. Astbury), 514
Structure of Chemical Compounds : The Theory of Valency and the (Prof. P. Ray), *review*, 460
Structure of Clay Minerals : Theory of the—Tailed X-Ray Reflexions from Random Layer Lattices (Dr. A. J. C. Wilson), 773 ; Banded X-Ray Reflexions from Clay Minerals (Dr. G. W. Brindley and J. Méring), 774
Structure of Cyclo-octatetræne (H. S. Kaufman, Dr. I. Fankuchen and Prof. H. Mark), 165
Structure of Cyclopropane (Sir Robert Robinson), 176
Structure of Jute : X-Ray Investigation of the (M. K. Sen and H. J. Woods), 768
Structure of Molecules : Reactivity and (Prof. F. A. Paneth), 901
Structure of Plasteins (Prof. Artturi I. Virtanen and Heikki K. Kerkkonen), 888
Structure of the Red Cell : Submicroscopic (Dr. M. F. Perutz), 204
Structure in the Rodent Rhinarium : An Undescribed (Dr. W. C. Osman Hill), 276
Structure of Turnip Yellow Mosaic Virus Crystals in the Electron Microscope (Dr. V. E. Cosslett and Dr. Roy Markham), 250
Structure of Urea (Dr. J. O. Harris and A. H. Robson), 98
Structure of Yeast Ribonucleic Acid (the late Prof. J. Masson Gulland and D. O. Jordan), 561
Structure Testing Machine : A 150-ton Universal (Dr. C. F. Tipper), 656
Structure and Physical Properties of Metals (X-Ray Analysis Group of the Institute of Physics discussion on), 263
Strychnine and Brucine : Relation of Vomicine to (Dr. A. S. Bailey and Sir Robert Robinson), 433
Studentship in Aeronautics : Busk, 595
Studio Acoustics (H. L. Kirke), 732
Stylasteridæ (Hydrocorals) of the John Murray Expedition to the Indian Ocean (Dr. Hjalmar Broch), 822
Sublimation in the Atmosphere over the Oceans (Dr. B. Cwilong), 62
Sublittoral Seaweed Survey—Relationship of Algal Growth and Depth (F. T. Walker), 977
Submarine Canyons of New Guinea and South Australia : Newly Discovered (Reg. C. Sprigg), 246
Submarine Gravity Survey in the English Channel, 272
Submerged Ancient Cliff near Plymouth (Dr. L. H. N. Cooper), 280
Submicroscopic Structure of the Bacterial Cell, as shown by the Electron Microscope (Dr. Stuart Mudd), 302
Submicroscopic Structure of the Red Cell (Dr. M. F. Perutz), 204
Substances Inhibitory to Acid Phosphatase in Normal Human Urine : Presence of (Dr. Alice M. Robinson and Dr. F. L. Warren), 397
Substitution in the Naphthalene Nucleus : Mechanism of (Dr. N. M. Cullinane and S. J. Chard), 690
Subtilin C, an Antibiotic Concentrate from *Bacillus subtilis* (C. H. Hassall), 317
Sugar Beet : Transmission of a Disease Resembling Virus Yellows through the 'Seed' of (Dr. Phyllis E. M. Clinch, J. B. Loughnane and R. McKay), 28
Sugar Canes (*Saccharum officinarum* L.) : Origin of Noble (Dr. N. Parthasarathy), 608
Sugars : Acetylation of (S. D. Nicholas and Dr. F. Smith), 349 ; (Dr. P. H. Plesch), 637
  Colour Reagents for the Paper Chromatography of (Dr. W. G. C. Forsyth), 239
Sulpha Compound ('6257') and its Use in Human Cholera Infection : A New (Dr. S. S. Bhatnagar, F. Fernandes, J. de Sa and P. V. Divekar), 395
Sulphanilamide : Failure of, to Inhibit Calcification of Bone (Dr. Zelma Baker Miller, Dr. Jerome Waldman and Prof. Franklin C. McLean), 273
Sulphanilamides and Sulphonic Acids : Ammonium Salts of (S. K. Munshi, B. D. Tilak and Prof. K. Venkataraman), 55
Sulphhydryl Reagents : Inhibition of Hexosediphosphatase by, and by Ascorbic Acid (Dr. E. O'F. Walsh and Mrs. G. Walsh), 976
Sulphonic Acids : Ammonium Salts of Sulphanilamides and (S. K. Munshi, B. D. Tilak and Prof. K. Venkataraman), 55
S_2 in the Schumann Region : Absorption Band Spectrum of (R. Maeder and Prof. E. Miescher), 393
Sulphuryl Chloride on Wool : Action of (A. J. Farnworth and Prof. J. B. Speakman), 850
Summer Course in Food Science, 1007
Summer School in Chemistry at Dublin, 390
Summer School in Electron Microscopy at the Cavendish Laboratory, 758
Summer School in Health Education (Central Council for Health Education), 842
Summer School on the International and Cultural Relations of Social Biology (British Social Hygiene Council), 842
Summer School in Metal Physics (Cavendish Laboratory), 637
Summer School in Micro-Chemical Techniques (Queen's University, Belfast), 125
Summer School in the Physics of Solids (University of Bristol), 233, 636
Summer School in Relaxation Methods (Imperial College of Science and Technology), 717
Summer School on the Schools and the Land (British Social Hygiene Council), 470
Summer School in X-Ray Crystallography (College of Technology, Manchester), 555
Summer School for Youth Leaders (National Association of Girls' Clubs and Mixed Clubs), 924
Sun : Annular Eclipse on May 8–9, 196, 389, 879
  Audio-Frequency Radio Waves from the (Dr. Donald H. Menzel and Winfield W. Salisbury), 91
Sunspots : Solar Radio Emissions and (I. L. Thomsen), 134 ; (M. Ryle), 136
Sunspots in Action (Dr. Harlan True Stetson), *review* by Dr. M. A. Ellison, 951
Superconductivity, *review* by Dr. H. Fröhlich, 37
  Theory of (Prof. Max Born and Kai Chia Cheng), 968, 1017
'Supermalloy', a New Magnetic Alloy (O. L. Boothby and R. M. Bozorth), 554
Supraleitung : Theorie der (M. von Laue), *review* by Dr. H. Fröhlich, 37
Surface (Specific) : Photometric Measurement of (B. A. Scott), 358
Surface Phenomenon on Flowing Water : The Floating Thread, a (I. Kuščer), *erratum*, 51
Surface Pressure and Climatic Fluctuations and Vegetation Growth in Northern Finland : Northern Hemisphere (G. W. Brier), 730
Surface Radiography with Alpha Rays (C. Jech), 314
Surface Resistance of Metal Films at a Frequency of 24,000 Mc./s. (Dr. L. Speirs), 601
Surface Structure of Barium Sulphate : Electrokinetic Potential and (A. S. Buchanan and Dr. E. Heymann), 649
Surgery : Use of High-frequency Current in (A. W. Lay), 167
Surrey (Eric Parker), *review* by W. E. S., 912
Survey of Svalbard, 232
Surveying : Research in, at University College, London, 50
Surveying for Young Engineers (S. Wright Perrott), *review*, 79
Svalbard : Survey of, 232
Swimming of Dolphins (Alfred H. Woodcock), 602 ; (Dr. L. Harrison Matthews), 731
Switzerland : Fuel Economy in, 253
Sword : The Chrysanthemum and the (Ruth Benedict), *review* by Peter Lawrence, 77
Synchroton : 30-MeV. Electron (D. W. Fry, J. W. Gallop, F. K. Goward and J. Dain), 504
Synonymy of the Nudibranch Genera *Pellibranchus* and *Okadaia* (Patricia M. Ralph), 528
Synoptic Weather Maps for the Antarctic, 709
Synthesis of Adenosine Triphosphate (J. Baddiley, A. M. Michelson and Prof. A. R. Todd), 761
Synthesis of Dehydro-β-Ionone (Dr. H. B. Henbest), 481
Synthesis of 5 : 6-Dihydroxy-Indole : The Melanin Problem—a (Dr. R. J. S. Beer, K. Clarke, H. G. Khorana and Prof. A. Robertson), 525
Synthesis of 5 : 6-Dihydroxy-Indole and its Derivatives : The Melanin Problem—a (Prof. H. Burton and J. A. Duffield), 725
Synthesis of Fluoranthene Derivatives (Dr. E. Bergmann), 889
Synthesis of Ovalene (Dr. E. Clar), 238
Synthesis of Pteridines : Reductone and the (Dr. H. S. Forrest and Dr. James Walker), 721
Synthetic Medium : Animal Tissue Culture with a (Dr. F. Jacoby and S. J. Darke), 768
Synthetic Mixtures of α-Chloroacids : Raman Spectra of some (Dr. Marcel Renard), 354
Synthetic Œstrogens : Configuration of (H. P. Koch), 309
Synthetic Pentapeptides related to Gramicidin-*S* (J. I. Harris and T. S. Work), 804
Synthetic Polyglutamic Acid (W. E. Hanby, S. G. Waley and J. Watson), 132
Synthetic Resin Chemistry (Dr. S. R. W. Martin), *review* by Dr. P. D. Ritchie, 501
Synthetic Resin Ion-Exchangers : Separation of Pyrimidine Nucleosides by (D. T. Elmore), 931

TALLENSI : The Dynamics of Clanship among the (Dr. Meyer Fortes), *review* by Dr. A. I. Richards, 111
Tanning Materials of India : Vegetable, 255
Taste Buds and Nasal Mucosa : Alkaline Phosphatase in (Dr. Geoffrey H. Bourne), 445
Taylor (George) Gold Medal of the Royal Aeronautical Society awarded to Dr. J. W. Drinkwater and W. G. Glendinning, 593
Teaching of Science in Secondary Schools (Compiled by a Joint Committee of the Incorporated Association of Assistant Masters and the Science Masters' Association), *review* by W. L. Sumner, 114
Teaching Aids : Exhibition of War Office, 164
Technical Education in Britain : Lyon Playfair and (W. H. G. Armytage), 752
Technical Literature on Silk : Bibliography of the (Dr. F. O. Howitt), *review* by Prof. J. B. Speakman, 790
Technical Publications in Sheffield : Interchange of, 305
Technique for Mechanical Vibration Problems, *review* by Prof. W. G. Bickley, 954

Technological Education in Britain : Higher, 217
  University Grants Committee Sub-Committee on, 841
Telecommunication and Radio Conferences at Atlantic City : International, 863
Telescope : Making your own (Allyn J. Thompson), *review*, 502
Telescope Objectives : The Adjustment and Testing of (H. Dennis Taylor), fourth edition, *review*, 419
Temperature : Methods of Measuring (Dr. Ezer Griffiths), third edition, *review* by S. Weintroub, 624
  Critical, and Molecular Weight of *n*-Paraffins (L. Grunberg and Dr. A. H. Nissan), 170
Temperature (Body) : Acetylcholine and (Prof. J. H. Burn and N. K. Dutta), 18
Temperature (High) : Reversal of Vernalization by (Prof. F. G. Gregory and Dr. O. N. Purvis), 859
Temperature (Room) : Luminescence Efficiency Changes in Zinc Sulphide Phosphors below (Dr. G. F. J. Garlick and A. F. Gibson), 359
Temperature in Clays : Relationships of Vapour Pressure, Capillarity and (B. Vassiliou and Dr. J. White), 487
Temperature on the Urea Denaturation of β-Lactoglobulin : Influence of (C. F. Jacobsen and L. Korsgaard Christensen), 30
Temperature Measurement, *review* by S. Weintroub, 624
Temperatures (High) : Preparation of Œstrogens from Urine by Application of (Dr. Felix Sulman), 605
Temperatures (Low) : Insulating Materials and Methods for Use at (Low Temperature Group of the Physical Society discussion on), 323
Tension, Torsion and Radial Pressure : Delayed Fracture of Glass under (C. Gurney), 729
Termites : La lutte contre les (Ch. Noriot et H. Alliot), *review* by A. D. I., 544
Terrestrial Relationships : Solar and, *review* by Dr. M. A. Ellison, 951
Test for Gold : A New Dry (R. C. Mehrotra), 321
Testis : Vascular Patterns in the, with particular reference to *Macropus* (Dr. R. G. Harrison), 399
Tetraploidy : Mathematical Theory of (Prof. R. A. Fisher), 758
Textile Fibers (Matthews), fifth edition, edited by Herbert R. Mauersberger, *review* by Dr. C. S. Whewell, 581
Textile Industries : Rheology in the (British Rheologists' Club and others conference on), 307
Textile Industry : The Organisation of the (Textile Institute conference on), 842
Textile Laboratories at Leeds, 305
Thallium : Volumetric Estimation of (B. C. Mehrotra), 242
Thallium (Trivalent) : Inner-Complex Salts of (Prof. Fr. Feigl), 436
Theoretical Aerodynamics (Prof. L. M. Milne-Thomson), *review* by Prof. W. J. Duncan, 703
Theoretical Physics : Summer School in (University of Bristol in co-operation with the Institute of Physics), 233
Theoretical Physics at the University of Liverpool, 715
Théorie des champs macroscopiques (Prof. Jean Mariani), 450
Theorie der Supraleitung (M. von Laue), *review* by Dr. H. Fröhlich, 37
Theory of Aerofoils : Potential, *review* by Prof. W. J. Duncan, 703
Theory of the Anomalous Skin Effect in Metals (G. E. H. Reuter and E. H. Sondheimer), 394
Theory of Electricity and Magnetism : Elementary, *review* by Prof. L. F. Bates, 829
Theory of Primary Calcification in Bone (Dr. Marcel L. Dallemagne), 115
Theory of Servomechanisms (edited by Prof. Hubert M. James, Nathaniel B. Nichols and Prof. Ralph S. Phillips), *review* by Prof. A. Porter, 994
Theory of Skating (Dr. A. E. Bell), 391
Theory of the Streaming Potential (G. A. H. Elton), 847
Theory of the Structure of Clay Minerals—Tailed X-Ray Reflexions from Random Layer Lattices (Dr. A. J. C. Wilson), 773 ; Banded X-Ray Reflexions from Clay Minerals (Dr. G. W. Brindley and J. Méring), 774
Theory of Superconductivity (Prof. Max Born and Kai Chia Cheng), 968, 1017
Theory of Valency and the Structure of Chemical Compounds (Prof. P. Ray), *review*, 460
Thermal Conduction in Dense Gases and Liquids : Coefficients of Viscosity and (L. M. Yang), 523
Thermal Mutual Inductance (Dr. R. C. L. Bosworth), 166
Thermionic Cathode : The, *review* by D. A. Wright, 500
Thermionic Valves working under Amplifying Conditions : Low-Frequency Noise from (Dr. E. J. Harris and P. O. Bishop), 971
Thermo-electric Power of Electronic Semi-Conductors with Vapour Pressure : Variation of (C. A. Hogarth), 60
Thermometry in the Region of Millidegrees Absolute : Magnetic Observations and (D. de Klerk, M. J. Steenland and Prof. C. J. Gorter), 678
Thermophile Fungus : A *Chaetomium*-like (C. J. La Touche), 320
Thibaud's 'Particles': Electronic Waves and (W. E. Benham), 93
Thickening in Excised Tomato Roots : Secondary (Dr. K. J. Dormer and Dr. H. E. Street), 483
Thioaldehydes (Trimeric) : Stereochemistry of (Prof. Alexander Schönberg and Mohamed Zaki Barakat), 722 ; (Dr. G. M. Bennett), 723
Thompson (Silvanus) Memorial Lecture of the British Institute of Radiology (Prof. W. T. Astbury), 514
Thread : The Floating, a Surface Phenomenon on Flowing Water (I. Kuščer), *erratum*, 51
Threshold Value of Carbon Dioxide Concentration in Photosynthesis of Foliage Leaves (Dr. E. K. Gabrielsen), 138
Thuja plicata Don. : Antibiotic Substances from the Heart Wood of (Prof. Holger Erdtman and Dr. Jarl Gripenberg), 719
Thymus (Rat) : Weight of the (L. R. C. Agnew), 205
Thyroid Deficiency on the Level of Pseudo-Cholinesterase in the Plasma of Rats : Effect of (R. D. Hawkins, Prof. B. Mendel and M. Nishikawara), 639
Thyroid Gland as a Special Factor influencing the Conditional Disposition to Infectious Diseases (Dr. S. Zimanyi), 57
Thyroxine from Derivatives of Diiodotyrosine : Formation of Derivatives of (Rosalind Pitt Rivers), 308
Tibet and Burma (borders of) : Earthquake on July 29, 657
Tidal Biology : Problems of (Prof. C. M. Yonge), 796
Tide : Severn (Brian Waters), *review* by A. T. D., 790
Timbers : How to Identify, 881
Time-Series (Oscillatory) : Contributions to the Study of (Maurice G. Kendall), *review* by David G. Kendall, 187
Time-Series with Continuous Spectra : Smoothing Periodograms from (Prof. M. S. Bartlett), 686
Time Study and Common Sense (Abraham Cohen), *review* by J. Leigh, 910
Tirol : Earthquake on December 20, 306
Tissue Cells *in vitro* : Amino-Acid Metabolism of (Dr. Albert Fischer), 1008
Tissue Cultures for Biophysical Research : Amphibian (M. M'E. Preston), 203
Tissue Extracts : Inactivation of Flavine Adenine Dinucleotide by (R. S. Comline and F. R. Whatley), 350
Tissues : Effects of Mustard Gas on Enzymes and (Dr. D. M. Needham), 225
Tissues of Inbred Strains of Mice : Ultracentrifugation and Electron Microscope Studies of (Prof. R. D. Passey, Dr. L. Dmochowski, Prof. W. T. Astbury, Dr. R. Reed and Dr. P. Johnson), 759
Toad (Male) : Pregnancy Test using the (Dr. Octavio Rodrigues Lima and Dr. Oswaldo Gelli Pereira), 676
Tobacco Necrosis Virus Crystals : Molecular Arrangement in (Roy Markham, Dr. Kenneth M. Smith and Dr. Ralph W. G. Wyckoff), 760
Tobago : Forestry in Trinidad and, 147
Tollens Naphthoresorcinol Reaction for Uronic Acids (A. H. Guerrera and Dr. R. Tecwyn Williams), 930
Tomato Roots (Excised) : Secondary Thickening in (Dr. K. J. Dormer and Dr. H. E. Street), 483
Tombs in Scotland and Ireland : Megalithic (Prof. V. Gordon Childe), 841
Tonga Islands (west of the) : Earthquake on September 2, 657
Tool in Scientific Research : Radioelements as a, *review* by Prof. F. A. Paneth, 456
Torsion and Radial Pressure : Delayed Fracture of Glass under Tension, (C. Gurney), 729
Torula-Yeast Fed with Potassium Nitrate : Formation of Oxime-Nitrogen in (Prof. Artturi I. Virtanen and Tihamér Z. Csáky), 814
Town and Country : Trees for (Brenda Colvin and Jaqueline Tyrwhitt), *review* by Sir Edward Salisbury, 497
Toxicity of Arsenicals : An Improved Method for the Assay of (W. L. M. Perry), 975
Toxicity of Azo-Compounds and other Substances to the Fruit Tree Red Spider Mite (Dr. J. K. Eaton and R. G. Davies), 644
Trace Elements and Nitrification (Dr. Howard Lees and Jane Meiklejohn), 398
Trace Elements in Plant Physiology (International Union of Biological Sciences symposium on), 364
Tracer Isotopes : The Determination of Radioactive and Stable (Physical Methods Group of the Society of Public Analysts and other Analytical Chemists symposium on), 693
Tracheids and Wood Fibres : Organisation of the Cell Walls of (A. B. Wardrop and Dr. R. D. Preston), *erratum*, 90
Trail : The End of the (Willoughby P. Lowe), *review* by Frances Pitt, 222
Trail Award and Medal for 1942 of the Linnean Society of London awarded to Dr. Honor B. Fell, 51, 882
Trail Award and Medal for 1947 of the Linnean Society of London awarded to Dr. C. D. Darlington, 51, 882
Training for Chemists (Dr. E. J. Holmyard), 31
Transfer Rates in Liquid Helium Films (K. R. Atkins), 925
Transformations : Lorentz-like (P. T. Landsberg), 208 ; (Prof. Herbert Dingle), 209
Transit Circle for the Royal Observatory, Greenwich, 271
Transition from Glow to Arc Discharge (Dr. Chas. E. R. Bruce), 521
Transmission of the Atmosphere in the 1–5 Micron Region (A. Elliott and G. G. MacNeice), 516
Transmission of Bactericidal Radiation through Glass (J. E. Stanworth), 856
Transmission of a Disease Resembling Virus Yellows through the 'Seed' of Sugar Beet (Dr. Phyllis E. M. Clinch, J. B. Loughnane and R. McKay), 28
Transmission in Nerves, *review* by Prof. J. Z. Young, 76
Transplantation of Fertilized Rabbit Ova—the Effect on Viability of Age, *in vitro* Storage Period, and Storage Temperature (Dr. Min-Chueh Chang), 978
Transport System : London's (R. H. Macmillan), 942
Treatment of Glass and Steatite Ceramic with Quaternary Ammonium Compounds for the Improvement of Electrical Insulation Resistance (J. S. Dryden and R. J. Meakins), 23
Treatment of Tuberculosis : *p*-Aminosalicylic Acid in the (D. D. Martin, Prof. F. S. Spring, Dr. T. G. Dempsey, C. L. Goodacre and D. E. Seymour), 435
Trees (Lime) : Honeydew on (C. A. Mawson), 176
Trees of the Northern States and Canada East of the Rocky Mountains : Handbook of the (Romeyn Beck Hough), *review* by Sir Edward Salisbury, 497
Trees in Prose and Picture, *review* by Sir Edward Salisbury, 497
Trees for Town and Country (Brenda Colvin and Jaqueline Tyrwhitt), *review* by Sir Edward Salisbury, 497
Trematoda of British Fishes (Dr. Ben Dawes), *review* by Dr. G. Lapage, 222
Trematode : A Rare Cœlom-Dwelling (Dr. Ben Dawes), 642
Trend of National Intelligence (Prof. Godfrey Thomson, with a Symposium by Sir Alexander Carr-Saunders, Sir Cyril Burt, Prof. Lionel Penrose and Prof. Godfrey Thomson), *review* by Dr. Julian Blackburn, 37
2 : 4 : 5-Triamino-6-hydroxy-pyrimidine with Glucose and Fructose : Condensation of (H. S. Forrest and Dr. James Walker), 308
Tribute of Industry to Science, 508
Trimeric Thioaldehydes : Stereochemistry of (Prof. Alexander Schönberg and Mohamed Zaki Barakat), 722 ; (Dr. G. M. Bennett), 723
Trinidad : The Natural Vegetation of (Prof. C. W. Wardlaw), 31 ; (Dr. J. S. Beard), 31
Trinidad and Tobago : Forestry in, 147
Triodes : Klystrons and Microwave (Prof. Donald R. Hamilton, Prof. Julian K. Knipp and J. B. Horner Kuper), *review* by Prof. J. T. Randall, 952
Triolite : Occurrence of (Dr. J. J. Frankel), 63
Triple Magneto Ionic Splitting of Rays Reflected from the F_2 Region (Gordon Newstead), 312
Triple Splitting of Ionospheric Rays (J. H. Meek), 597 ; (T. L. Eckersley), 597
Trisodium Citrate Solutions stored under Customary Laboratory Conditions : *p*H of (J. Jordan and Dr. M. Bobtelsky), 240
Trivalent Thallium : Inner-Complex Salts of (Prof. Fr. Feigl), 436
Tropical Diseases : The Role of Chemistry in combating (Sir Ian Heilbron), 956

Tropical and Sub-Tropical Areas : Memoranda on Medical Diseases in (War Office), eighth edition, *review* by Dr. N. Hamilton Fairley, 499
Trypanosoma congolense Infections : Cinnoline Derivatives as Chemotherapeutic Agents for (J. R. Keneford, Dr. E. M. Lourie, J. S. Morley, J. C. E. Simpson, J. Williamson and P. H. Wright), 603, 758
Trypanosoma heptatretae sp. n., a Blood Parasite of the Hagfish (Marshall Laird), 440
Trypanosomiasis (Cattle) : Control of (R. N. T.-W.-Fiennes), 602
Tsetse Flies and the Development of Africa (Prof. P. A. Buxton), 802
Tuberculosis : *p*-Aminosalicylic Acid in the Treatment of (D. D. Martin, Prof. F. S. Spring, Dr. T. G. Dempsey, C. L. Goodacre and D. E. Seymour), 435
d-Tubocurarine Chloride and the Dimethyl Ether of *d*-Tubocurarine Iodide : Pharmacological Activities in Different Rodent Species of (Dr. H. O. J. Collier, Sheila K. Paris and Dr. L. I. Woolf), 817
d-Tubocurarine Iodide : Pharmacological Activities in Different Rodent Species of *d*-Tubocurarine Chloride and the Dimethyl Ether of (Dr. H. O. J. Collier, Sheila K. Paris and Dr. L. I. Woolf), 817
Tubular Excretion : Specific and Non-specific Competition in (I. Sperber), 236
Tubules (Renal) : Osmotic Work performed by the (David F. Cole), 640
Tumours by Chemical Compounds : Induction of, *review* by Prof. E. Boyland, 621
Turbines : Modern Gas (Arthur W. Judge), *review* by E. G. Sterland, 910
Turnip Yellow Mosaic Virus Crystals in the Electron Microscope : Structure of (Dr. V. E. Cosslett and Dr. Roy Markham), 250
Type Cultures of Fungi, 16

UFAW Handbook on the Care and Management of Laboratory Animals (edited by Prof. Alastair N. Worden), *review* by Frances Pitt, 664
Ultra High-Frequencies : Electrical Breakdown Strength of Air at (J. A. Pim), 683
Ultracentrifugation and Electron Microscope Studies of Tissues of Inbred Strains of Mice (Prof. R. D. Passey, Dr. L. Dmochowski, Prof. W. T. Astbury, Dr. R. Reed and Dr. P. Johnson), 759
Ultrasonic Dispersion in Organic Liquids (Dr. A. Schallamach), 476
Ultrasonic Waves : Diffraction of Light by Very High Frequency (Prof. S. Bhagavantam and B. Ramachandra Rao), 927
Ultra-Violet Fluorescence in Paper Chromatography : Use of (D. M. P. Phillips), 53
Ultra-Violet and Infra-Red Radiation : Biological Applications of, *review* by H. G. Jenkins, 542
Under-Nutrition in Man : Effect of, on Hepatic Structure and Function (Sheila Sherlock and Veryan Walshe), 604
Under-Nutrition and Alterations in Diet : Effect of, on the Choline Esterase Activity of Serum (Prof. R. A. McCance, E. M. Widdowson and A. O. Hutchinson), 56
Understand the Countryside : The Right Way to (Stanley A. Manning), *review* by T. H. Hawkins, 995
Union Catalogue of German Books and Periodicals (National Central Library), 1006
United States : Corn (*Zea Mays* L.) in the (Gordon Haskell), 42
    Earthquake in south-west Montana on November 23, 306
    Medical Group Practice in the (P.E.P. Broadsheet No. 274), 841
    Mineral Resources of the (Staffs of the Bureau of Mines and Geological Survey), *review* by Dr. K. C. Dunham, 991
    Sampling Practice in the, *review* by Dr. F. Yates, 153
United States Armed Forces : Audiovisual Aids in the, *review* by Lieut.-Colonel Eric Lowe, 745
Units and Useful Range in Photo-electric Colorimetry (Dr. Walter Koch and Dr. Deborah Kaplan), 247 ; (Dr. J. R. Edisbury, R. J. Taylor and N. T. Gridgeman), 247
Universal Structure Testing Machine : A 150-ton (Dr. C. F. Tipper), 656
Universities (Colonial) : Biology in (Dr. E. B. Edney), 506
Universities (Foreign) : Scholarships for 1948–49 at (British Council), 347
Universities of the British Empire : Congress of, 430
Universities of the Empire 1947 : The Yearbook of the (Universities Bureau of the British Empire), *review*, 583
University of North Carolina Graduate School Research and Publications (edited by Prof. Edgar W. Knight and Agatha Boyd Adams), *review*, 705
University of Prague Sexcentenary Celebrations (Dr. Gerald Druce), 670
University Halls of Residence : The Planning of, 344
University Representation in the House of Commons, 259 ; (O. Peake), 468 ; (Herbert Morrison), 468 ; (Chuter Ede), 468
Unsaturated Fatty Acids in Cotton Wool Plugs (Dr. M. R. Pollock), 853
Uovo : Le Forze creatricj dell' (Prof. Pasquale Pasquini), *review* by C. H. W., 831
U^{233} : Fission Products of (Dr. W. E. Grummitt and Dr. G. Wilkinson), 520
Uranus : New Satellite of, 637
Urea : Structure of (Dr. J. O. Harris and A. H. Robson), 98
Urea Denaturation of *β*-Lactoglobulin : Influence of Temperature on the (C. F. Jacobsen and L. Korsgaard Christensen), 30
Urine : Preparation of Œstrogens from, by Application of High Temperatures (Dr. Felix Sulman), 605
Urine (Human) : Isolation of Stilbœstrol Monoglucuronide from (K. S. Dodgson and Dr. R. Tecwyn Williams), 604
Urine (Normal Human) : Presence of Substances Inhibitory to Acid Phosphatase in (Dr. Alice M. Robinson and Dr. F. L. Warren), 397
Urine of a Patient with Adrenal Cancer : Isolation of a New Androstenol-3(α)-on-17 from the (Dr. Elizabeth Dingemanse, Leonora G. Huis in 't Veld and S. Lore Jartogh-Katz), 848
Uronic Acids : The Tollens Naphthoresclnol Reaction for (A. H. Guerrera and Dr. R. Tecwyn Williams), 930
Utilization of Polysaccharide-like Substances ('Mucin') in Saliva : Bacterial Hydrolysis and (Dr. H. J. Rogers), 815
Utilization of Resources : The Conservation and (United Nations conference on), 617

VACUUM Gauge : A New Hot-Wire (H. von Ubisch), 927
Vacuum Practice : A Manual of (Dr. L. H. Martin and R. D. Hill), *review*, 665
Valency and the Structure of Chemical Compounds : The Theory of (Prof. P. Ray), *review*, 460
Validity of Amontons' Law : Rate of Wear in the Region of the (Henry James Bezer and Dr. Robert Schnurmann), 728
van den Bergh Reaction : Bilirubin-Serum Protein Complexes and the (C. H. Gray and Dr. R. A. Kekwick), 274
Vapour Pressure : Variation of Thermoelectric Power of Electronic Semi-Conductors with (C. A. Hogarth), 60
Vapour Pressure, Capillarity and Temperature in Clays: Relationships of (B. Vassiliou and Dr. J. White), 487
Variable Stars : The Story of (Leon Campbell and Luigi Jacchia), *review* by H. S. J., 460
Variation : Seasonal, in Chemical Constitution of some Common British Laminariales (Dr. W. A. P. Black), 174
Variation of the Force Constant with the Ionization Potential and the Polarizability for some Halogen Compounds (P. Torkington), 724
Variation of Geomagnetic Intensity with Depth (Prof. Sydney Chapman), 52 ; (S. K. Runcorn), 52
Variation of the Horizontal Magnetic Forte at the Magnetic Equator : Daily (J. Egedal), 443
Vascular Patterns in the Testis, with particular reference to *Macropus* (Dr. R. G. Harrison), 399
Vasodilator, Adrenolytic Substance in Aglomerular Fish Kidney : A (Dr. Benjamin Jablons), 100
Vedha : Ancient Indian Mathematics and (Prof. L. V. Gurjar), *review* by Prof. E. H. Neville, 580
Vega Medal of the Geographic Society of Sweden awarded to Admiral Richard Byrd, 430
Vegetable Cultivation : Intensive, 196
Vegetable Tanning Materials of India, 255
Vegetation after Draining (V. S. Summerhayes and Dr. W. B. Turrill), 421
Vegetation of Trinidad : The Natural (Prof. C. W. Wardlaw), 31 ; (Dr. J. S. Beard), 31
Vegetation Growth in Northern Finland : Northern Hemisphere Surface Pressure and Climatic Fluctuations and (G. W. Brier), 730
Velocity of Light : Radiation Damping and (Prof. W. Heitler), 678
Velocity of Meteors Measured by Diffraction of Radio Waves from Trails during Formation (C. D. Ellyett and J. G. Davies), 596
Vernalization by High Temperature : Reversal of (Prof. F. G. Gregory and Dr. O. N. Purvis), 859
Vertebrate Ear : Oscillographic Analysis of the Non-Acoustic Functions of the (Dr. Otto Lowenstein), 652
Veterinary Education : Grants for, 163
Vibration Problems (Mechanical) : A Technique for, *review* by Prof. W. G. Bickley, 954
Vibrations : Mechanical (Prof. J. P. Den Hartog), third edition, *review* by A. L. P., 503
Vibrations (Molecular) : Interaction Terms in (D. F. Heath and Dr. J. W. Linnett), 243
Victoria Medal for 1948 of the Royal Geographical Society awarded to Prof. Frank Debenham, 553
Victory over Pain (Dr. Victor Robinson), *review* by Dr. G. Edwards, 458
Viewing-Distance or Field-Size : Dependence of Anomaloscope Matching on (R. G. Horner and E. T. Purslow), 484
Viking Fund Award given to Dr. R. E. G. Armattoe for a field trip to West Africa, 125
Village Life in the Eighteenth Century (G. E. Fussell), *review* by Sir John Russell, 701
Virus (Animal) : Structure of an (Dr. I. M. Dawson and Dr. A. S. McFarlane), 464
Virus Crystals (Tobacco Necrosis) : Molecular Arrangement in (Roy Markham, Dr. Kenneth M. Smith and Dr. Ralph W. G. Wyckoff), 760
Virus Diseases : Plant, 945
    Viruses and (British Museum (Natural History), Exhibition of), 966
Virus Epizootic of the Manx Shearwater (*Puffinus p. puffinus*) : Puffinosis, a (J. A. R. Miles and M. G. P. Stoker), 1016
Virus Multiplication : Association of Xanthine Oxidase with (Dr. D. J. Bauer), 852
Virus Research at Cambridge : Plant (Dr. Kenneth M. Smith), 776
Virus Yellows : Transmission of a Disease resembling, through the 'Seed' of Sugar Beet (Dr. Phyllis E. M. Clinch, J. B. Loughnane and R. McKay), 28
Viruses and Bacterial Products on Human Red Cells : Enzymic Action of (C. M. Chu), 606
Viruses and Virus Diseases : Exhibition of (British Museum (Natural History)), 966
Viscosity and Thermal Conduction in Dense Gases and Liquids : Coefficients of (L. M. Yang), 523
Viscous Extension : A Coefficient of (Dr. K. H. Swainger), 650
Visible Speech (Ralph K. Potter, George A. Kopp and Harriet C. Green), *review* by Dr. W. G. Radley, 334
Vision (Colour) : Race, Pigmentation and (Dr. R. W. Pickford), 687
Vision and Seeing : Light, (Dr. Matthew Luckiesh), fourth printing, *review* by Dr. R. W. Pickford, 40
Visual Aids, Notes on some Modern Apparatus (Wilfred J. Garnett), 124
Visual Education : Material for (Betty M. B. Harris), *review* by Colonel Eric Lowe, 40
Visual Observations of the Perseid Meteor Shower of 1947 : Combined Radar, Photographic and (Dr. Peter M. Millman, Dr. D. W. R. McKinley and Miriam S. Burland), 278 ; (Dr. A. C. B. Lovell), 280
Visual Processes : Chemistry of (S. Ball, F. D. Collins, Prof. R. A. Morton and Dr. A. L. Stubbs), 424 ; (Dr. M. H. Pirenne), 724
Vitamin A : Glycerol Dichlorhydrin and (D. D. Penketh), 893
Vitamin B_T, a new Vitamin of the B-Group and its relation to the Folic Acid Group, and other Anti-Anæmia Factors (Dr. G. Fraenkel, with the assistance of M. Blewett and M. Coles), 981
Vitamin K on *M. tuberculosis* : Effect of Antibacterial Analogues of (C. N. Iland), 1010
Vitamin K Deficiency in relation to Quick's Concept of the Composition of Prothrombin : Dicumarol Poisoning and (Prof. Henrik Dam), 1010
Vitamin P (Vitamin C_2) : Influence of, upon the Amount of Ascorbic Acid in the Organs of the Guinea Pig (H. Cotereau, M. Gabe, E. Géro and Prof. J.-L. Parrot), 557

Volcanic Bomb in the Agglomeratic Slates of Kashmir : Occurrence of (Dr. R. C. Misra), 895
Volcanoes : Earthquakes and, *review* by Ernest Tillotson, 296
Volcans : Séismes et (Prof. J.-P. Rothé), *review* by Ernest Tillotson, 296
Volitional Life : An Analysis of (C. Lambek), translated from the Danish by Agnete Kortsen, *review* by Dr. Clifford Allen, 789
Voltage Distribution of a High-Voltage Multi-Stage Electron Accelerator : Effect of the Electron Beam on the (F. W. Waterton), 563
Volts at War : Men and, the Story of General Electric in World War II (John Anderson Miller), *review* by Sir Arthur Fleming, 113
Volumetric Error : Microdiffusion Analysis and (Prof. Edward J. Conway), revised edition, *review*, 583
Volumetric Estimation of Thallium (B. C. Mehrotra), 242
Vomicine to Strychnine and Brucine : Relation of (Dr. A. S. Bailey and Sir Robert Robinson), 433

WALCOTT (Charles Doolittle) Bronze Medal and Award for 1947 of the U.S. National Academy of Sciences awarded to Dr. Alexander G. Vologdin, 861
Wales : Industry and Research in (Industrial Research Committee of the Federation of British Industries and the Industrial Association of Wales and Monmouthshire joint regional conference on), 233
War : Men and Volts at, the Story of General Electric in World War II (John Anderson Miller), *review* by Sir Arthur Fleming, 113
  The Rocket as a Weapon of, in the British Forces (Sir Alwyn Crow), 329
  Science at (J. G. Crowther and R. Whiddington), *review* by S. Weintroub), 907
War Effort : Britain's Scientific, *review* by S. Weintroub, 907
War Effort of a Great Engineering Organisation, *review* by Sir Arthur Fleming, 113
War Research : German, *review*, 219
War Years : Northern Ireland Fishing Industry Developments during the, 451
  Progress in the Oil Industry during the, *review* by H. B. Milner, 703
War-time : Medical Research during (Dr. G. Lapage), 998
War-time Explorations in Manipur (F. Kingdon Ward), 636
War-time Rheological Investigations for the British Armed Services (British Rheologists' Club meeting on), 252
War-time Work of the American Academies, 304
Water : Dielectric Properties of Soils and, at a Wave-length of 3·2 cm. (Prof. A. W. Straiton and C. W. Tolbert), 73
Water (Flowing) : The Floating Thread, a Surface Phenomenon on (I. Kuščer), *erratum*, 51
Water Movements and Earth Currents—Electrical and Magnetic Effects (N. Barber and M. S. Longuet-Higgins), 192
Water Pollution : Biological Aspects of (Association of Applied Biologists symposium on), 874
Water Requirements under Desert Conditions, *review* by Dr. B. McArdle, 744
Water and Porous Materials : Interaction of (Faraday Society General Discussion on), 307, 629
Waters (British) : Occurrence of *Elminius modestus* (Darwin) in (D. J. Crisp and P. N. J. Chipperfield), 64
Waters (Inland) : Ciliate Protozoan Fauna of Soil and (Ernest Gray), 854
Wave Guides : A Survey of the Principles and Practice of (Dr. L. G. H. Huxley), *review* by Dr. R. L. Smith-Rose, 334
Wave-length of 3·2 cm. : Dielectric Properties of Soils and Water at a (Prof. A. W. Straiton and C. W. Tolbert), 73
Wave-lengths (Centimetre) : Measurement of High Permittivity Values at (J. G. Powles), 25
Waves : Electronic, and Thibaud's 'Particles' (W. E. Benham), 93
  Internal, in certain Types of Density Distribution (Dr. P. Groen), 92
Waves in Discharge Tubes and in the Solar Atmosphere : Spontaneous (Prof. V. A. Bailey), 599
Waynflete Lectures (Prof. E. D. Adrian), 498
Weapon of War in the British Forces : The Rocket as a (Sir Alwyn Crow), 329
Wear in the Region of the Validity of Amontons' Law : Rate of (Henry James Bezer and Dr. Robert Schnurmann), 728
Weather in Britain : Potato Blight and the (A. Beaumont), 429
Weather Forecast : Here is the (E. G. Bilham), *review* by M. K. Miles, 540
Weather Maps for the Antarctic : Synoptic, 709
Weather Prediction : Organisation, Meteorology and, *review* by M. K. Miles, 540
Web of Government (Prof. R. M. MacIver), 579
Weight of the Rat Thymus (L. R. C. Agnew), 205
Welfare in the West Indies : Development and (Sir John Macpherson), 181
West Indies : Development and Welfare in the (Sir John Macpherson), 181
  Social and Scientific Development of the, 181
Westlake (Mr. E.) and the Geology of the Cantal Region, Central France (G. Maynard and Aubrey T. Westlake), 485
Whale : Bile Acids of the (Dr. G. A. D. Haslewood and Veryan Wootton), 356
  Aspects of the Locomotion of (R. W. L. Gawn), 44 ; (Prof. J. Gray), 199 ; (Dr. D. A. Parry), 200
Whales : Effect of Present-day Whaling on the Stock of (J. E. Hamilton), 913
What People Are, a Study of Normal Young Men (Clark W. Heath, in collaboration with Lucien Brouha, Lewise W. Gregory, Carl C. Seltzer, Frederic L. Wells and William L. Woods), *review*, 502
Wheat : The Nature and Prevention of Cereal Rusts as Exemplified in the Leaf Rust of (Dr. K. Starr Chester), *review* by P. H. Gregory, 220
Wheat Grain from Rust-Affected Crop as Seed : Shrivelled (R. B. Ekbote and K. R. Sahasrabuddhe), 442
Wheat Straw and other Organic Materials : Production of an Antibiotic Substance on, and in the Soil (Erna Grossbard), 614
Whistles : Meteor (H. V. Griffiths, S. E. Martingell and R. W. Bayliff), 478
White Dwarfs : Spectrum of (Dr. Evry Schatzman), 61
White-eyed Mutants of Diptera (Dr. P. Tate), 641
Wild Flowers of the Chalk (John Gilmour), *review*, 188
Williams Prize for 1947 of the Iron and Steel Institute awarded to R. Fowler, 512
Wind Power : Generation of Electricity from, 162
Wings : Wonder of (Nancy Price). *review* by Frances Pitt, 460
Wireless Direction Finding (R. Keen), fourth edition, *review* by Dr. R. L. Smith-Rose, 375
Wollaston Fund of the Geological Society awarded to Dr. J. G. C. Anderson, 122
Wollaston Medal of the Geological Society awarded to Sir Edward Bailey, 122
Wonder of Wings (Nancy Price), *review* by Frances Pitt, 460
Wood (Frances) Memorial Prize for 1948 offered by the Royal Statistical Society, 390
Wood Fibres : Organisation of the Cell Walls of Tracheids and (A. B. Wardrop and Dr. R. D. Preston), *erratum*, 90
Woody Cuttings : The Use of Auxins in the Rooting of (Kenneth V. Thimann and Jane Behnke), *review* by Prof. M. Thomas, 993
Wool : Action of Sulphuryl Chloride on (A. J. Farnworth and Prof. J. B. Speakman), 850
Work (Cold) : The Disordering of β-Brass by (R. W. K. Honeycombe and Dr. W. Boas), 612
Worker (Country) : Housing the (Michael F. Tilley), *review* by R. B., 665
Worker (Young) : Education of the (University of Oxford Department of Education conference on), 801
Working Party Report on the Cutlery Industry, 448
Working Party Report on Rubber-proofed Clothing, 448
Working Party Report on Hand-blown Domestic Glassware, 449
World (Modern) : Reason in the, *review*, 664
World (Post-War) : The Intelligent Man's Guide to the (G. D. H. Cole), *review* by Maurice Bruce, 151
World Co-operation in Science (Prof. J. D. Bernal), 840
World Forestry and Forest Products (Prof. E. P. Stebbing), 710
World Magnetic Data (Comdr. Elliott B. Roberts), 677
World Problem : Afforestation as a (Prof. F. G. Champion), 902
World Resources in relation to the Family : Population and (Family Planning Association of Great Britain International Congress on), 882
World Supplies of Oils and Fats, 123
World War II : German Research in (Colonel Leslie E. Simon), *review*, 219
  Men and Volts at War, the Story of General Electric in (John Anderson Miller), *review* by Sir Arthur Fleming, 113
Wounds of the Head (*British Journal of Surgery* War Surgery Supplement No. 1), 635
Written Expression in Science (Conference at Leicester on), 533

X-RADIATION from a 20-MeV. Betatron (W. Bosley, Dr. J. D. Craggs, W. F. Nash and R. M. Payne), 1022
X- and γ-Radiations : Fluorescence of Highly Insulating Dielectrics produced by (Dr. C. W. Wilson), 520
X-Ray Analysis : Method of Steepest Descents—Improved Formulæ for (Dr. V. Vand), 600
X-Ray Crystallography : Phase-Angle Determination in (Dr. Alexander R. Stokes), 679
  Summer School in (College of Technology, Manchester), 555
X-Ray Diffraction Analysis and Electron Microscopy : The Structure of Biological Tissues as revealed by (Prof. W. T. Astbury), 514
X-Ray Diffraction Rings from Deformed Solid Metal and Metal Powders (Dr. W. A. Wood and W. A. Rachinger), 93
X-Ray Investigation of the Structure of Jute (M. K. Sen and H. J. Woods), 768
X-Ray Measurements of Retained Austenite : Comparison of Metallographic and (William J. Harris, jun.), 315
X-Ray Microspectrography : Intracellular Determination of Protein by (Dr. A. Engström and M. A. Jakus), 168
X-Ray the City ! (Dr. Ernest Fooks), *review* by R. Brightman, 297
Xanthine Oxidase with Virus Multiplication : Association of (Dr. D. J. Bauer), 852
Xanthotoxin from the Fruits of *Ammi majus* L. (Prof. Alexander Schönberg and Aly Sina), 481
3-Deoxy *D*-Xylose : Conversion of *D*-Arabinose into 2-Deoxy *D*-Ribose and (Dr. P. W. Kent, Prof. M. Stacey and Dr. L. F. P. Wiggins), 21

YALE Collections : The (Wilmarth S. Lewis), *review* by Dr. L. Harrison Matthews, 79
Yearbook of the Universities of the Empire, 1947 (Universities Bureau of the British Empire), *review*, 583
Torula-Yeast Fed with Potassium Nitrate : Formation of Oxime-Nitrogen in (Prof. Artturi I. Virtanen and Tihamér Z. Csáky), 814
Yeast Ribonucleic Acid : Structure of (the late Prof. J. Masson Gulland and D. O. Jordan), 561
Yeast Ribosenucleic Acid : Isolation and Separation of the Pyrimidine Nucleosides of (Dr. R. J. C. Harris and J. F. Thomas), 931
Yeasts : Riboflavin Enhancement of Radioactive Phosphate Exchange by (Dr. Walter J. Nickerson and Dr. Lorin J. Mullins), 939
Yeasts and Actinomycetes : Molds, (the late Dr. A. T. Henrici), second edition by Dr. Charles E. Skinner, Dr. Chester W. Emmons and Dr. Henry M. Tsuchiya), *review*, 40
Young Worker : Education of the (University of Oxford Department of Education conference on), 801
Youth Leaders : Summer School for (National Association of Girls' Clubs and Mixed Clubs), 924

ZINC Sulphide : Relation between Photo-conduction and Luminescence in (Dr. M. H. F. Wilkins and Dr. G. F. J. Garlick), 565
Zinc Sulphide Phosphors below Room Temperature : Luminescence Efficiency Changes in (Dr. G. F. J. Garlick and A. F. Gibson), 359
Zoo : Nature's Own (C. M. Beadnell), *review* by Seton Gordon, 744
Zoology : Thirteenth International Congress of, 924

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CONTENTS

Page
The Deployment of Scientific Effort in Britain 1
Exterior Ballistics of Rockets. By Dr. R. A. Rankin 3
Atomic Energy. By Prof. J. A. Crowther 4
Day by Day on Skokholm Island. By Miss F. Pitt 5
Science and Politics. By Prof. D. W. Brogan 6
Edibility of the Eggs of Birds. By Dr. Hugh B. Cott 8
Scientific Centenaries in 1948. By Eng.-Capt. Edgar C. Smith, O.B.E., R.N 11
Obituary :
  Prof. Max Planck, For.Mem.R.S. By Prof. H. T. Flint 13
News and Views 15
Letters to the Editors :
  Acetylcholine and Body Temperature.—Prof. J. H. Burn, F.R.S., and N. K. Dutta 18
  Cholinesterase Activity in Cerebro-Spinal Fluid.—Dr. M. Reiss and R. E. Hemphill 18
  Relation of Intermediary Metabolites to the Lowering of the Potency of Pancreatic Insulin in the Animal System.—Prof. M. C. Nath and H. D. Brahmachari 18
  A Modified Microbiological Assay Procedure.—Dr. Trevor I. Williams ; Stanley A. Price 19
  Primary and Secondary Responses in Biological Assay.—R. E. Blackith 20
  Conversion of *D*-Arabinose into 2-Deoxy *D*-Ribose and 3-Deoxy *D*-Xylose.—Dr. P. W. Kent, Prof. M. Stacey and Dr. L. F. Wiggins 21
  Scattering of D—D Neutrons by Deuterium.—J. F. Darby and J. B. Swan 22
  Treatment of Glass and Steatite Ceramic with Quaternary Ammonium Compounds for the Improvement of Electrical Insulation Resistance.—J. S. Dryden and R. J. Meakins 23
  ✓ Abnormalities in the *F*-Region of the Ionosphere at Calcutta.—S. S. Baral, S. N. Ghosh and M. Debray 24
  Measurement of High Permittivity Values at Centimetre Wavelengths.—J. G. Powles 25
  Photo-electric Counting of Individual Microscopic Plant and Animal Cells.—Carl Lagercrantz 25
  An Asymptotic Solution of the Fundamental Equation of the Statistical Atom Theory.—Dr. J. I. Horváth 26
  Brightness of the New Moon.—Dr. J. A. M. van Liempt 27
  Darkening of Red in Protanopes.—Dr. R. W. Pickford 27
  Effects of Calcium Deficiency on Potato Sets in Acid Soils.—Prof. T. Wallace and E. J. Hewitt 28
  Transmission of a Disease Resembling Virus Yellows through the 'Seed' of Sugar Beet.—Dr. Phyllis E. M. Clinch, J. B. Loughnane and R. McKay 28
  Possible Significance of Free-living Nematodes in Genetic Research.—Dr. Ellsworth C. Dougherty and Hermione Grant Calhoun 29
Influence of Temperature on the Urea Denaturation of β-Lactoglobulin. By C. F. Jacobsen and L. Korsgaard Christensen 30
The Natural Vegetation of Trinidad. By Prof. C. W. Wardlaw 31
Training for Chemists. By Dr. E. J. Holmyard 31
Echinoderm Fauna of Australia. By Dr. D. Dilwyn John 32
Towards an International Pharmacopœia 33

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THE DEPLOYMENT OF SCIENTIFIC EFFORT IN BRITAIN

IN his presidential address to the Royal Society on December 1, Sir Robert Robinson referred to the establishment of the Defence Research Policy Committee and the Advisory Council on Scientific Policy as the most interesting development in the relationship of science and administration during the past year, and as the fruition of insistent demands for scientific consultation at the highest levels. The Select Committee on Estimates in its Third Report for the Session 1946–47 (London : H.M. Stationery Office, 1947), on expenditure on research and development, not only made it clear that it looked to this development to secure in the future a better balance in the distribution of the nation's expenditure on research, but also to improve departmental administrative defects in the utilization and direction of research. This development has, however, been accompanied by uneasiness with regard to possible infringement of freedom of research by some form of planning or control, and to detrimental effects on the informal relations and collaboration between the Government and the Royal Society and other bodies.

This informality has been an important factor in maintaining the elasticity which has been a valuable feature of the nation's organisation for research in the past. Sir Robert Robinson has no anxiety on either of these points, and expressed his confidence that whatever gain in efficiency and co-ordination might be secured under the new arrangements, they would not lead to over-organisation or jeopardize the essential conditions of creative scientific work. On the other hand, there is a section of opinion which looks to the new developments to provide the essential framework of general control which will ensure that no important field of research of national interest is neglected,' and that the broad distribution of the nation's resources of trained man-power, equipment, materials and finance for research is in reasonable balance so far as it is possible to judge.

What is in debate at the moment, however, is the limits to which such planning and control can extend. It is not seriously suggested that there is in Great Britain any real wish that the Government would interfere with the free development of fundamental research. There is every reason for believing that the Government as a whole recognizes the vital importance of such research, and that while seeking to ensure that research is adequately endowed, its great leaders will still be able to choose and pursue their own objectives and lines of work.

That being so, there remains a large field within which the general trend of the nation's research effort may be guided or planned, at least on broad lines ; and the economic crisis, which has intensified the need for the wisest use and fullest economy of all our resources, has brought to the fore a question which was already under discussion, namely, how far the methods of attack on urgent objectives adopted during the War, and generally known as 'operational research', can be applied in the present emergency, or even as a regular feature of our peace-time system.

It has been suggested, for example, that Cabinet planning bodies such as that presided over by Sir Guy Plowden, and the Advisory Council of Scientific Policy, may be regarded as operational research sections established at a strategic level in the economic field. As the situation develops, such different bodies may find a common meeting-ground for the exposition of the major economic, scientific and administrative problems which have to be taken into consideration in a peace-time strategy.

Such a conception consorts with that of operational research as scientific management; but Prof. J. D. Bernal's contribution to the discussion at the Dundee meeting of the British Association showed that he wishes the principle to be applied at the highest level of planning authority. He proposed that the technique should be used to determine scientifically the highest priority, in accordance with Prof. Blackett's general principle, and that our effort should be concentrated on those problems which combined the greatest need with the greatest possibility of rapid achievement. The most obvious priorities are coal, steel, building and agriculture; but others, such as transport, distribution and the utilization of chemical wastes, may prove equally important, and the technique of operational research should be used, in his opinion, to find out what has to be done, to verify the success of the operation and to modify its conduct.

These are all in the nature of economic planning, but physical research is required wherever materials and techniques have to be transferred from their present use to a new one. A redistribution of the nation's research effort of the order of that proposed by the Association of Scientific Workers must inevitably pose a large number of problems in research as well as in organisation. Already, however, the redistribution outlined in the White Paper on "Capital Investment in 1948" (Cmd. 7268. London: H.M. Stationery Office, 1947. 6*d*. net) involves some repercussions on the research effort in Great Britain, and in itself raises afresh the whole question of the limits within which economic planning and control are feasible or wise.

The limitations of what is often called 'physical' control are one of the most striking lessons of the last two years, and central detailed control of complex economic relationships is now recognized as much more difficult than was at first realized. This is not to say that the attempt at economic or political planning should be wholly abandoned, although Prof. D. H. Robertson, in his presidential address to Section F (Economics and Statistics) at the Dundee meeting of the British Association, went far towards indicating this. It was not suggested that the task of planning cannot be accomplished by methods of freedom and tolerance; but it was suggested that a real effort should be made to establish, experimentally if need be, as a matter of urgency, the limits of planning. If progressive direction and political democracy are to work together, the main method must be, first to secure the maximum possible dispersion of decisions, and then to influence such decisions by indirect, persuasive measures, such as taxation and credit control.

These doubts as to the value of planning in practice, despite general agreement with it in principle, are largely the outcome of experience, often personal, of the wastefulness of physical controls in man-power. Multiplicity of forms, interminable details and a lack of common sense have in many cases led to hopeless inefficiency, frustration and exasperation. To eliminate the maximum amount of friction rather than to engender it, and to secure the maximum amount of consent and support for proposed administrative action is a primary and urgent need; this is one of the outstanding characteristics of that technique we describe as operational research, and one reason for its striking success.

It was a main purpose of Sir Hubert Henderson's Rede Lecture last May on "The Uses and Abuses of Economic Planning" to direct attention to the danger that on the strength of the misleading analogy of our war-time experience, planning may be regarded as a magic talisman by which those difficulties can be charmed away. That warning is equally valid for operational research, which, like planning, needs much hard thinking before it can be applied effectively to meet the needs either of the economic crisis or of a normal peace-time economy. Sir Hubert Henderson did not combat the view that we must have more State intervention and direction in our economic life than we had before the War; nor did he dispute the need for quantitative programmes for such purposes as the regulation of imports. He insisted, indeed, on the importance of the Government computing as precisely as possible the calls which its programmes for housing, schools, generating stations, etc., will make on man-power, materials and productive capacity; and the White Paper on capital investment indicates that to some extent the Government has accepted the view that it is desirable in the interests of economic balance to restrain within moderate limits the amount of long-term investment work that is set on foot during the next few years. But Sir Hubert Henderson does not agree that there are equally good reasons for slowing down the work of renewing and modernizing industrial plant; and although on this point the White Paper is vague, it seems clear that the shortage of steel will considerably retard the re-equipment and development of industry during the next few years.

This is the feature of the White Paper that is most disturbing. Inevitable as restrictions may be, the repercussions on industrial efficiency and even on our export programme may be very serious. Considerations advanced by Sir Hubert Henderson show the practical impossibility of any detailed planning of the restrictions so as to avoid impeding the expansion of particular branches of industry which will contribute most rapidly to industrial recovery in Britain and restoration of the balance of trade. It may be doubted whether even the most brilliant application of the methods of operational research could do much here to elucidate the uncertainties which surround new industrial development arising from scientific research even in normal times, and one great risk inherent in the new restrictions is that potential new advances may be stifled at birth for lack of laboratory and small-scale plant facilities, so that the opportunity is missed and our competitors overseas are first in the field.

Sir Hubert Henderson believes that over the greater part of our economic system quantitative programmes cannot play the part of 'directives to action' for purposes of increasing prosperity; but he does not believe that large-scale readjustments will be made smoothly or satisfactorily if they are left to the forces of supply and demand, unaided and uncontrolled. Programmes must never be an excuse for evading the crucial questions of costs and prices and competitive efficiency. What was challenged by Prof. Robertson, however, was the practicability of maintaining the distinction made by Sir Hubert Henderson between the Government sector of economic life and the private sector, or that made by Sir Oliver Franks between the strategy functions of Government and the tactical functions to be performed by industry and by labour. He questioned the feasibility of even the minimum of planning and control suggested by Sir Oliver Franks, and whether there is any real distinction between democratic and totalitarian planning.

Prof. Robertson suggested frankly that we should work towards the restoration of the price system as the only way of directing labour in a free society, and incomparably the most effective in any society; and in urging this he is in line with a marked trend of opinion in favour of using indirect persuasive measures in place of the detailed control which in practice proves so dangerous and so irksome. It is true that the great risk here is to the method of agreement stressed by Sir Oliver Franks; but although the task of devising a system for central planning and control in time of peace which does not conflict with democratic ideas and habits may be difficult and dangerous, that is no reason for not making the attempt. Sir Hubert Henderson does not challenge the correctness of Sir Oliver Franks' view that the decisions of Government must be kept general in scope and limited in number, determining merely the broad pattern of the economy and the consequent programmes to be carried out by industry and commerce; but he emphasizes the disturbing influence of external conditions and world trade generally.

Now the scientific investigator entering a new field cannot attempt to isolate all the unknown factors in a problem at the start. He must proceed from stage to stage, as he enlarges the boundaries of his knowledge. To abandon the attempt to order what is within our control because we cannot deal with what is at present beyond it would be the death-knell of scientific advance. If the technique of planning is used in economic affairs in accordance with the scientific method, there can be little fear that it will be over-strained; but its use does demand a large measure of public understanding and an attempt to clear away the false impressions which extravagant claims have created in the past. Only so can we ensure that Government decisions are criticized honestly and constructively, and that the way is prepared for the public consent which is an essential element for their success in a free society.

To the extent to which the technique of operational research contributes to this process by extending the boundaries of public discussion and understanding, its adoption is to be welcomed, at the lower levels as well as at the highest. None the less, unless the points of application are wisely chosen, there is danger that false hopes will be raised and the new method discredited before it has been fairly tried. It may be, and probably is, true, as Prof. Bernal has suggested, that thousands of scientific workers and engineers are being used in a wasteful manner or for purposes of secondary importance both in industry and in the Service research departments; but 'operational research' will not necessarily determine the best distribution. Research in the true sense may be required to assess some of the targets and to decide on which the expenditure of man-power will be most worth while; this will be one of the tasks of Sir William Stanier's panel under the new Committee on Industrial Productivity. But decisions must ultimately be matters of human judgment, in which much besides technical and scientific factors has to be pondered.

EXTERIOR BALLISTICS OF ROCKETS

Mathematical Theory of Rocket Flight

By Prof. J. Barkley Rosser, Dr. Robert R. Newton and Dr. George L. Gross. Pp. viii+276. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 22*s*. 6*d*.

THIS book is the official final report concerning the work done on the exterior ballistics of fin-stabilized rockets at the Allegany Ballistics Laboratory during 1944 and 1945. It is of importance as containing the only serious treatment of the mathematical theory of rocket flight so far published. Much of the material has been known to rocket ballisticians for a considerable time, but has, for security reasons, remained unpublished until now. The authors make generous acknowledgment of the work of their predecessors in Great Britain and the United States; but, because of official regulations, they cannot mention individual contributions. It therefore seems fair to record that in Great Britain the theory was well advanced, and in a form suitable for application, before the outbreak of war, the foundations having been laid as early as 1936 by W. R. Cook and other members of the Rocket Section of the Ballistics Department at Woolwich. Since 1939, work on rocket development has proceeded rapidly both in Great Britain and the United States, and information has been freely exchanged; to this development the authors have made important contributions.

The book contains five chapters and five appendixes. In Chapter 1 the equations of motion are formulated. As Nielsen and Synge have shown (*Quart. Rev. Appl. Maths.*, 4, 201; 1946), even in the simpler case of shell fired from guns, considerable care has to be taken if this is to be done consistently. For a rocket there are added difficulties due to the decrease in mass caused by the expulsion at high velocity of the burning gases from the nozzle. For these and other reasons the principles of the conservation of linear and angular momentum require careful enunciation, and over-simplified treatments of the problem can lead to erroneous results. The authors avoid such pitfalls by a careful examination of the equations governing the motion of systems of particles of changing mass. The equations of motion, as derived, hold for unrotated rockets only; the modifications necessary to cater for a slow axial spin are indicated briefly and are valid if the spin is sufficiently low to avoid all gyroscopic effects.

The chief objects of rocket ballistic theory are to give methods which can be used to calculate (1) the trajectory of a perfect round fired under ideal conditions, and (2) the deviations from this mean trajectory, due to various disturbing factors, of a group of rounds fired in similar circumstances. Of these two problems the second is the harder. The deviations which occur are due to asymmetries of design and functioning and, being generally of a random character, produce a dispersion about the mean trajectory which is larger than that of shell fired from guns. The greater part of this dispersion is usually attained before the propellant has ceased burning, so that deviations during the succeeding part of the trajectory are of lesser importance. In Chapter 3 the authors obtain solutions of the equations of motion which are valid during the burning period under certain simplified assumptions such as constant acceleration and absence of damping, and in Chapter 2 they examine the effects of the conditions existing at 'all-burnt', and of other factors, upon the motion throughout the remainder of the trajectory. These solutions can be used to estimate the dispersion when numerical values of the parameters describing the asymmetries are known. For the unrotated rocket the chief factor causing dispersion has generally been thought to be malalignment of the direction of the thrust. The dispersion observed in trials has usually, however, been much larger than that predicted by the theory when this malalignment is taken to be the same as that of the nozzle axis. The reasons which have been advanced to account for this discrepancy, and the other factors which contribute to the dispersion, are fully and completely discussed in an unbiased manner and are illustrated by numerical examples from actual trials. In this connexion, the reviewer has only the minor criticism to make that the term 'dispersion' is sometimes used to cover deviations which are systematic and not random.

In Chapter 4 the effect of 'tip-off' at launch from the launcher (projector) is considered, and in Chapter 5 the 'rocket functions', in terms of which the solutions of the equations are expressed, are described and fully tabulated. These functions are related to the Fresnel integrals but, being monotonic, are more suitable for interpolation. The two basic functions $\mathrm{rr}(x)$ and $\mathrm{rj}(x)$ are essentially the functions $(K \pm H)/\sqrt{\pi}$ introduced by Lash Miller and Gordon (*J. Phys. Chem.*, 35, 2785; 1931).

The book is written in a clear and lucid manner throughout, and is intended not only for the trained man of science and rocket ballistician—for whom it will be invaluable—but also "for the person with little scientific training who is interested in what makes a rocket go". The latter type of reader will no doubt wish to omit the more mathematical parts of the book, but the introductory remarks at the beginning of the sections and the many numerical examples will give him a clear picture of the principles and peculiarities of rocket flight.

R. A. Rankin

ATOMIC ENERGY

Atomic Energy in Cosmic and Human Life

Fifty Years of Radioactivity. By Assoc. Prof. George Gamow. Pp. xi + 161 + 5 plates. (Cambridge: At the University Press, 1947.) 7*s*. 6*d*. net.

It is a bitter commentary on man's failure as a social being that any mention of atomic energy arouses feelings, not of pleasurable anticipation of a boon conferred, but of dread of an approaching and scarcely to be escaped evil; and that an artist, commissioned to design a book-jacket for a treatise on the subject, should have been inspired, as John Hookham has been by the book that lies before us, to produce an allegorical picture of the fine flower of civilization already half-eclipsed by an obviously deadly and hideous growth. There is a certain bitter irony in the fact that the release of at least a small fraction of the enormous energy lying dormant in the heart of matter, which from one point of view represents the highest peak achieved by the modern scientific age, should also present the greatest single threat to its continued existence.

In spite of the pictorial warning of the dust cover, however, the reader who opens this little volume will find little either to increase or allay his fears. Prof. Gamow, in spite of the title, is much more interested in the achievement than in its possible social consequences whether for good or for evil. That atomic energy can be released explosively, and that it may ultimately be used constructively, are facts which he notes among the many other interesting properties of the atom; he even goes so far as to make some half-humorous suggestions as to how the thing can be done. In the main, however, he is concerned to give an intelligible account of the development of atomic research during the fifty years which have elapsed since the spontaneous release of atomic energy fogged a packet of photographic material in the drawer of Becquerel's desk, and J. J. Thomson discovered the electron.

It is a story well worth the telling; and we may congratulate ourselves that Prof. Gamow has undertaken the task. Prof. Gamow, as many readers of *Nature* will know, has the enviable art of making abstruse matters appear not merely intelligible but even actually entertaining. This is due, in part, to his own very obvious delight in the ideas which he is trying to convey, and in part, no doubt, to a certain naïve and rather charming humour, which bubbles up in his text in the form of little asides, quaint anecdotes and crude little sketches, inserted for no reason more obvious than that it amused the author to draw them. In the main, however, his success is due to the fact that he lives on such familiar terms with his subject that he can afford to treat it with a certain friendly disrespect, and has no hesitation in dragging it down within the comprehension of his prospective readers. This is all very refreshing. There is no reason why a scientific book should be either portentous or dull. One caveat, however, might be taken. It is not amusing to christen 'one million electron-volts' a 'crocodile'. Nothing can be less funny to an outsider than a private family joke, even when, as in this case, its retailer takes the trouble to explain it at length. When, as in the case of the 'crocodile', it is repeated on page after page of the text, it is apt to become somewhat annoying.

Prof. Gamow has divided his book into three sections. In the first, under the title of "Modern

Alchemy", he sketches the development of nuclear physics, from the early discoveries of radioactivity to the latest available publications. In this chapter he, as it were, sets the scene for the final *dénouement* and introduces us to the leading characters. The sketch is, of course, far from complete as a history of fifty years of scientific effort; but Prof. Gamow has a good eye for the main points, and it is surprising how much exact information he has succeeded in compressing into these fifty-two pages. In the second section, "How the Stars use Atomic Energy", Prof. Gamow discusses in considerable detail the cosmic aspects of atomic energy, and the processes by which the energy of the universe, assumed to have been originally all in nuclear form, is being steadily transformed into the radiant light and heat from which all our sources of terrestrial energy are ultimately derived. Much work has recently been done on this subject, and the main outlines and some of the details are now becoming sufficiently clear and certain; and this summary of the present position is very welcome. Few writers on the cosmical aspects of physics can avoid speculations, such as those which we enjoyed so much in the works of Eddington and Jeans, about the birth, progress and possible end of the universe, and Prof. Gamow is certainly not of their number. One may say that his account of the matter seems quite as convincing, and just as fascinating, as those of his predecessors in the field.

In the final section, "How can Man use Atomic Energy?", the author gives an account of the physical principles underlying the purposive release of atomic energy, whether for destructive or for constructive purposes. Prof. Gamow's mastery of the subject is evident in every page of the text, though in fact he reveals nothing which was not implicit in Dr. Smyth's official report. In these times, when a scientific author must write with one eye on his readers and the other on the police, more could not be expected. However, the official report was so informative on the purely scientific aspects of the problem that Prof. Gamow has quite enough material available for his particular purpose. If there is one portion of the book where we might have hoped for rather more guidance from the author it is in the very brief concluding paragraphs on the peaceful uses of atomic power, on which a considerable amount of information has recently been released in the United States. Possibly Prof. Gamow considers that these economic and technical matters are outside the scope of his present book.

Although the book is entertainingly written, and entirely non-mathematical in character, it is a very serious attempt to present as complete a picture as possible of the atomic energy problem in its scientific aspects, and demands and deserves the close attention of the reader. Prof. Gamow has not shirked the undoubted difficulties of the subject, though he has taken great pains to alleviate them by numerous analogies, illustrations and graphs. What that somewhat hypothetical individual—the general reader—can make of it all must be left for him to discover. He is not likely to find a pleasanter or more competent guide to the subject. Any student about to begin a course on nuclear physics should certainly read the book in order to learn what it is all about; while any student who has just completed such a course might equally profitably read it in order to discover what it has all been about. Many physicists and other scientifically minded people, who realize that during these last few strenuous years they have been unable to keep abreast of this latest efflorescence of science, will thank Prof. Gamow for providing them with this opportunity of bringing their knowledge up to date. The more widely a knowledge of the potentialities for good or evil of this latest addition to our power resources is disseminated the better.

J. A. Crowther

DAY BY DAY ON SKOKHOLM ISLAND

Letters from Skokholm

By R. M. Lockley. Pp. x+244. (London: J. M. Dent and Sons, Ltd., 1947.) 15*s*. net.

The letter form of composition has many advantages, particularly in describing the day-by-day happenings of a rural, or in this case an island, life. Mr. Lockley has written before of islands, and in particular of his own island of Skokholm off the Pembrokeshire coast of Wales; but he has by no means exhausted the interest and fascination of the subject, and we are glad he has recast the letters originally addressed to his brother-in-law, John Buxton, when a prisoner-of-war, and made them into a book.

In the first letter the author discusses why he went to live on Skokholm and the joys of simple living. He continues with various subjects, such as the history of the island and its occupation by man, beasts and birds. It was early populated by rabbits. There are documents dating back to 1324 which show how numerous they must have been. In the winter of 1387–88, 3,120 carcases were brought from the islands of "Schalmey, Schokolm and Middleholm".

Since those days rabbits have continued to flourish on the islands and all attempts to exterminate them have failed. In 1936 Mr. Lockley, having tried trapping, ferreting, snares and nets without any really marked effect, resorted to a virus disease which it was hoped would be 100 per cent effective, but it was not. It had little or no effect.

The best results were achieved with 'Cyano-gas' and the rabbits were really reduced, enabling the author's farming operations to be conducted with much more success.

One of the most interesting letters is that which tells of an old cow grey seal coming ashore on an early October day to give birth to her calf. For four days she "did not stir from beside her child, which she fed at least three times a day, probably oftener. To watch the calf suck the retractable breasts, and to see Clementina"—as the mother had been dubbed—"paw and fondle her lovingly, very humanly, was a happy sight."

Mr. Lockley says that he has found grey seal calves dropped here any time between late July and late December, whereas on the north-west of Scotland calving seems to be confined to September, October and November.

The author's letters cover a wide field, including bird migration and trapping of the migrants for identification and ringing purposes; a visit to Grassholm and its gannets; the Manx shearwaters that throng in such numbers to Skokholm; and many other things. A brief review can but hint at his topics, but reference must be made to the admirable illustrations executed by Mr. Charles Tunnicliffe, which are illustrations in fact as well as in name.

F. Pitt

SCIENCE AND POLITICS

By D. W. BROGAN

Professor of Political Science, University of Cambridge

No one could complain that the nineteenth Riddell Memorial Lectures in the University of Durham are lacking in topicality*. The terrifying efficiency of science, the terrifying inefficiency of politics, make, in combination, probably the most difficult and almost certainly the most urgent problem on the world's agenda. For much of the pressure of contemporary events, much of the strain that the whole world feels and wilts under, comes from the knowledge that the human race has set itself a problem which it may quite possibly prove to be unable to solve. We are faced, in a far truer sense than we were in 1914, with the possibility of a "war that will end war".

This problem is present in Prof. Ritchie's mind and it gives an especial urgency to the general problem that he is discussing, but his theme is not just the "control of the atom bomb". It is the wider theme of the role of science (which, of course, means of men of science) in the modern world and their relationship with the modern State.

It is also the theme of the meaning of the word 'science' in political discussion. Prof. Ritchie is right in linking the two problems, for the discussion of the first is clouded and often made pointless by ambiguity about the second. Faced with the immense power for good and for mischief that modern science puts into the hands of the modern State, the man-in-the-street (including the man-in-the-street who spends his working days in a laboratory) is bewildered and indignant. If he is a scientist man-in-the-street, he is alarmed at his own moral responsibility and tempted to think that the evil comes from letting the control of the scientific resources of the world, or of his own country, fall into wrong, that is, unscientific hands. So he dallies with the dream of a political society in which power and responsibility are united in the same hands. Since the world can be destroyed by men of science, why should not the power to save the world be put into their hands? Sometimes, this hankering after a society 'scientifically' controlled is merely a revival of the old dreams of Platonic guardians or H. G. Wells' "Samurai". More commonly, to-day, it is based on a belief that immense possibilities for good are being thwarted and immense possibilities for evil being created by rulers who, neither by training, nor by interest, understand the world that science has so thoroughly upset.

As Prof. Ritchie suggests, this dream is often given a local habitation and a name in the U.S.S.R.; and, as Prof. Ritchie also suggests, this dream is only a dream. In the Soviet Union, men of science *are* privileged people—like ballet dancers. They are not rulers and, so far as we know anything of the distribution of power in Russia, there is no Russian equivalent of Sir Stafford Cripps, no political ruler who has had a first-class scientific education. It is perhaps worth noting that this dream of a land where science is taken seriously is not new, and the country to which British men of science looked enviously, a generation ago, was Germany; the proof of the superior regard of an enlightened State for science was the Kaiser Wilhelm Institute in Berlin. There is, that is to say, no necessary relationship between a 'right' political organisation and a low regard for science. The Prussian army was once described by an optimistic admirer as "science in a Pickelhaube". Nor is there any necessary connexion between the man of science and a given attitude to politics. If most British, French and, probably, American men of science are 'left', that is due to social and historical conditions in their countries, not to any inherent bias due to a scientific training. Political credulity is quite compatible with a very high degree of scientific accomplishment, as the case of Germany shows. When we say, to-day, that a world so largely remade by science calls for 'scientific government', and by that mean a government by scientists, we are begging a great many questions. We are assuming that there is a unified class of 'scientists' and that this class has an identifiable and uniformly admirable attitude to politics. These things are to be proved, not assumed.

Prof. Ritchie raises, too, the question of the fitness of the man of science as such for political life. It is a question that might be further developed with great profit. It is often confused with the question of the desirability of having a great number of people in politics who have had a scientific education. The concealed assumption in arguments on these topics is that the man of science of the first order has something especially valuable to contribute to politics, and that the way to contribute it is for him to become a politician. The first proposition is, I think, indisputable. But it does not mean more than that in the fields in which the man of science is an expert he should be able to make his opinion heard, that there should be no danger of only one group or individual being heard, that the highest level of relevant public opinion in the scientific field concerned should be given all facilities for influencing general public opinion (including the public opinion of politicians).

It is also desirable that projects calling for a high degree of scientific expertize be planned by people who know how science does, in fact, progress. Prof. Ritchie points out that there is no agreement on how science *does* progress, though he has no doubt that the real principle is that "the wind bloweth where it listeth". In the case of technology, Prof. Ritchie both accepts and welcomes far more general control of experiment, far more general imposition of ends than we have been accustomed to. He accepts these limitations less, one might guess, because he thinks that this is bound to promote technical progress, than because he sees the dangers of uncontrolled 'progress', of technical advances made without its being anybody's business to question or define the 'good' of such progress.

But Prof. Ritchie sees another danger in the credulous and indeed superstitious acceptance of the magical claims of science. That what the man-in-the-street often means by science is an unintelligible magical power is suggested by the way the popular Press treats any real or alleged scientific achievement, by the low standard of critical reporting in this field and by the fine, general confusion of very different kinds of scientific technique which is the attitude of millions who yet smile pityingly at the superstitions of their ancestors. What is admired or worshipped is not scientific methods but a mysterious power. "In short, to be scientific is to be powerful; to possess the 'mana' or power of the witch doctor so much admired and feared by primitive man." There is good reason to fear that a popular decision to put power into the hands of 'scientists' would be far from making for general progress or even safety. Scientific demagogues, scientific revivalists, are quite serious possibilities. Indeed, there is a danger that if real or fictitious scientific attainments were a way to political power, the last state of science (and politics) might be worse than the first. For both science and politics are very jealous taskmasters. It is almost certain that no man of science of the first order could keep his scientific rank and live a full political life at the same time. Indeed, all the pressures of both ways of life are against such a combination. It is not only that science changes rapidly, but that politics is more and more a full-time job. It is not a matter of a few interventions in debate, of a few deputations to ministers, of service on an occasional royal commission. With the great modern extension of the powers of the State, the duties of an active politician have more and more become incompatible with the successful pursuit of any other career. It is a problem that affects more people than men of science. It is, for example, doubtful if even a university constituency to-day would put up with a member doing so little direct political work as Edinburgh agreed to tolerate in the case of Macaulay. If it be said that this is only true of democratic countries (in the Western sense), it can be replied that it does not matter how a great man of science fritters away his time, whether in democratic or dictatorial politics; the price of power is the same—eternal vigilance and a consequent neglect of his primary claim to power, his scientific excellence.

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* "Science and Politics", by Prof. A. D. Ritchie. (University of Durham, Riddell Memorial Lectures.) (London: Oxford University Press, 1947.) 2s. 6d. net.

It is quite another matter to suggest ways in which the highest scientific opinion should be given opportunities of access to an effective sounding board. Perhaps there should be more university Members of Parliament, more men of science promoted to the House of Lords, more weight given to the considered judgment of organised bodies like the Royal Society; but this is far from the rule of the State by men of science. It is a truth, possibly a sad truth, that the rulers of a State are always politicians, and if they have been men of science, the decision as to whether they have done well or ill by leaving science for politics depends on the degree to which their transfer of allegiance has been a loss to science or a gain to politics; and that in every case is an individual judgment.

Carefully and ingeniously distinguishing between various kinds of scientific technique, Prof. Ritchie takes up the claims of the so-called 'social sciences'. It is true that this ambiguous term is often used merely to placate contemporary taste, to give the impression that the economist or historian or anthropologist or statistician is doing *real* work comparable in importance and in method to work on the atom bomb or on bacteriological warfare or on new applications of nylon or penicillin. But this confidence trick does neither the physical nor the social sciences much good. It is, perhaps, in a natural reaction against this trick that Prof. Ritchie scales down the claims of the social sciences. "The rules already formulated are generally only assertions of what happens for the most part, not of what happens always; they resemble the looser rules of biology, not the stricter ones of physics." This is true, but the application to social problems even of "the looser rules of biology" is highly desirable. Prof. Ritchie thinks that "if there is to be social science which produces control of human beings, legitimate yet in some ways comparable to that control of physical objects which is the fruit of physical science, should it not be a science of persuasion ?". It should, but one drawback of a society largely governed by persuasion is that persuasion becomes an end in itself; winning over the jury, the House of Commons, the electorate is all that matters. Such a society overvalues the arts of persuasion, and the skilled persuader is often genuinely angered when exterior forces refuse to be persuaded as a mass meeting can be, or when a popular vote repealing arithmetic or abolishing rain on holidays proves ineffective. It is in breeding a habit of respect for established truths that a scientific education, or any rigorous education, is useful to the State and to the would-be statesman. 'Social science' is doubly useful in that it can or should breed respect for the awkward fact and that it brings to the notice of the ruler the existence of the awkward fact. Prof. Ritchie goes too far, surely, when he writes "there is one genuine improvement to be recorded of the last 150 years that can definitely count as scientific: i.e. the collection and use of social statistics". That the growth and improvement of statistical methods is one of the most valuable conquests of the social sciences is undoubted. But statistics as such may be mere information; a statistician may have no very helpful ideas about what questions to ask or any clear idea of what to do with his own answers. Social scientists must continually ask themselves, as Prof. Lynd recommends them to do, "knowledge for what ?". Statistical questions and answers are often about categories which must, so far as is humanly possible, be defined before the statistical question can be usefully put. Mere knowledge of numbers of Hindus and Moslems in India is barren unless we have some idea of what we mean by Hindus and Moslems. Surely another great gain of the past 150 years has been an extension of sympathetic curiosity about human society, so that we do not now think of China or India or even of savage societies exclusively in our own terms ? We do know a great deal more about the mechanisms of other societies and indeed about the mechanisms of our own society than was known 150 years ago—or much later. Anthropology and sociology have not been merely efforts in cataloguing (though many books in these fields have been that and nothing more).

Primitive as it is, social science is not as primitive as it was. In its methodology it is not like physics or even the biological sciences, and its results are less certain, less general, less permanent. But into the study of human affairs something of the spirit of the exact sciences has been imported, and one fairly well established result has been the understanding of the great differences which there must be between the exact sciences and the would-be sciences of social organisation and human behaviour. The acceptance of as much of the spirit of the exact sciences as human frailty and the character of the materials permits, the acceptance of the idea that an exact, infallible, quasi-mathematical science of society is impossible, these results are not everything, but they are something. If Prof. Ritchie's lectures devote more space to eradicating error and exposing false analogies than to laying down the lines of a scientific politics, his time and his readers' time has not been wasted, since the weeds tend to grow up again, and since the new Riddell Lectures with great skill bring home the nature of the problem, both to the reader who thinks that the creation of a social science is easy and to the reader who thinks that it is superfluous.

EDIBILITY OF THE EGGS OF BIRDS

By Dr. HUGH B. COTT
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IN a previous communication[1], a preliminary account was given of observations and experiments on the relative edibility of the flesh of birds. Full details of this research have now been published elsewhere[2]. During the past two years, this work has been extended to an investigation of the relative edibility of birds' eggs. Final results of the inquiry, which is still in progress, will not be available for some time; but since, with the exception of a paper by C. F. M. Swynnerton published in 1916[3], the subject appears hitherto to have remained almost unexplored, it would now seem appropriate to summarize the new observations and to indicate certain conclusions to be drawn from them.

The bulk production and purchase of various foodstuffs (including eggs) during the War led to a widespread use of tasting panels (together with other methods for the assessment of quality) for the purposes of standardization and grading. At the Low Temperature Research Station, Cambridge, a tasting panel was already in existence in 1936[4]; and I take this opportunity of expressing my indebtedness to the three members of this panel—Dr. J. Brooks, Mr. H. P. Hale and Dr. J. R. Hawthorne—whose skill and experience have made possible the reliable assessments of palatability which form the basis of the present inquiry. Sincere thanks are also due to the Superintendent of the Station for allowing me storage and many other facilities in his Department.

The method of assessment was similar to that used in routine examination of fowls' eggs. Each sample was tested in the form of a scramble, prepared over steam, a numerical score being awarded on a scale ranging from 10·0 (excellent flavour) to 2·0 (inedible). In general, seven or eight species were tested at one session. Members of the panel were in all cases unaware of the identity of the samples to be examined (except in the case of a fowl's egg used as a control); and they recorded their results independently. The majority of species listed below were examined on two occasions by each taster, so that in general the mean edibility rating for a species is based upon six independent assessments. Eggs of eighty-one species, belonging to eleven orders and thirty-five families, have now been examined. In the following list these are arranged in order of palatability.

GROUP A (RELATIVELY PALATABLE)

Domestic fowl	8·8
Coot (*Fulica a. atra* Linn.)	8·3
Moorhen (*Gallinula c. chloropus* (Linn.))	8·3
Lesser black-backed gull (*Larus fuscus grællsii* Brehm)	8·3
Kittiwake (*Rissa t. tridactyla* (Linn.))	8·2
Herring-gull (*Larus a. argentatus* Pont.)	7·9
Common tern (*Sterna h. hirundo* Linn.)	7·8
Fulmar petrel (*Fulmarus g. glacialis* (Linn.))	7·7
Greater black-backed gull (*Larus marinus* Linn.)	7·7
Guinea-fowl (*Numida m. meleagris* (Linn.)	7·6
Razorbill (*Alca torda britannica* Ticehurst)	7·6
White-naped crane (*Grus vipio* Pall.)	7·5
Chaffinch (*Fringilla cœlebs gengleri* Kleinschmidt)	7·5
Hedge-sparrow (*Prunella modularis occidentalis* (Hart.))	7·5
Partridge (*Perdix p. perdix* Linn.)	7·3
Lapwing (*Vanellus vanellus* (Linn.))	7·3
Spur-winged plover (*Lobivanellus lobatus* Lath.)	7·3
Stock-dove (*Columba œnas* Linn.)	7·3
Jackdaw (*Corvus monedula spermologus* Vieill.)	7·3
Spotted flycatcher (*Muscicapa s. striata* (Pall.))	7·3
Domestic turkey	7·2
Red-legged partridge (*Alectoris r. rufa* (Linn.))	7·2
Bullfinch (*Pyrrhula p. nesa* Math. and Ired.)	7·2
Southern guillemot (*Uria aalge albionis* With.)	7·1
Great skua (*Stercorarius s. skua* (Brünn))	7·1
Rock-dove (*Columba l. livia* Gmel.)	7·1
House-sparrow (*Passer d. domesticus* (Linn.))	7·1
Common gull (*Larus c. canus* Linn.)	7·0
Dipper (*Cinclus c. gularis* (Lath.))	7·0

GROUP B (INTERMEDIATE)

Hobby (*Falco s. subbuteo* Linn.)	6·9
Cirl bunting (*Emberiza c. cirlus* Linn.)	6·9
Black-headed gull (*Larus r. ridibundus* Linn.)	6·8
Wood-pigeon (*Columba p. palumbus* Linn.)	6·8
Little owl (*Athene noctua vidalii* Brehm)	6·8
Kestrel (*Falco t. tinnunculus* Linn.)	6·7
White-fronted goose (*Anser a. albifrons* Scop.)	6·7
Carrion-crow (*Corvus c. corone* Linn.)	6·7
Magpie (*Pica p. pica* (Linn.))	6·7
Pheasant (*Phasianus colchicus* Linn.)	6·6
Domestic duck	6·6
Robin (*Erithacus rubecula melophilus* Hart.)	6·5
Rook (*Corvus f. frugilegus* Linn.)	6·3
Skylark (*Alauda a. arvensis* Linn.)	6·3
Catbird (*Dumetella carolinensis* (Linn.))	6·3
Sparrow-hawk (*Accipiter n. nisus* (Linn.))	6·2
Little tern (*Sterna a. albifrons* Pall.)	6·1
Eider (*Somateria n. mollissima* (Linn.))	6·0
Red-backed shrike (*Lanius c. collurio* Linn.)	6·0
Swallow (*Hirundo r. rustica* Linn.)	6·0
British jay (*Garrulus glandarius rufitergum* Hart.)	5·8
Long-tailed tit (*Aegithalos caudatus rosaceus* Mathews)	5·8
Blackbird (*Turdus m. merula* Linn.)	5·8
Greenfinch (*Chloris c. chloris* (Linn.))	5·7
Chiffchaff (*Phylloscopus c. collybita* (Vieill.))	5·7
Meadow-pipit (*Anthus pratensis* (Linn.))	5·7
Sand-martin (*Riparia r. riparia* (Linn.))	5·7
Capercaillie (*Tetrao u. urogallus* Linn.)	5·5
Song-thrush (*Turdus e. ericetorum* Turton)	5·5
Cowbird (*Molothrus a. ater* (Bodd.))	5·4
Tree-sparrow (*Passer m. montanus* (Linn.))	5·3
Yellow bunting (*Emberiza c. citrinella* Linn.)	5·3
Gannet (*Sula bassana* (Linn.))	5·3
Oyster-catcher (*Hæmatopus ostralegus occidentalis* Neum.)	5·2
Bar-headed goose (*Eulabeia indica* (Lath.))	5·2
Dabchick (*Podiceps r. ruficollis* (Pall.))	5·0
Turtle-dove (*Streptopelia t. turtur* (Linn.))	5·0

GROUP C (RELATIVELY UNPALATABLE)

Puffin (*Fratercula arctica grabæ* (Brehm))	4·8
Sedge-warbler (*Acrocephalus schœnobænus* (Linn.))	4·7
Blackcap (*Sylvia a. atricapilla* (Linn.))	4·7
Lesser whitethroat (*Sylvia c. curruca* (Linn.))	4·5
Shag (*Phalacrocorax a. aristotelis* (Linn.))	4·4
Sandwich tern (*Sterna s. sandvicensis* Lath.)	4·3
Little crake (*Porzana parva* (Scop.))	4·0
Linnet (*Carduelis c. cannabina* (Linn.))	3·9
Ringed plover (*Charadrius h. hiaticula* Linn.)	3·8
Whitethroat (*Sylvia c. communis* Lath.)	3·8
Great tit (*Parus major newtoni* Prazak)	3·5
Reed-warbler (*Acrocephalus s. scirpaceus* (Herm.))	3·4
Blue tit (*Parus cœruleus obscurus* Prazak)	3·3
Eastern house-wren (*Troglodytes a. ædon* (Vieill.))	3·2
Wren (*Troglodytes t. troglodytes* (Linn.))	2·0

An extensive series of experiments has also been carried out to test the preferences of small egg-eating mammals such as the ferret, rat and hedgehog. In each test, the experimental animal was offered a choice as between two egg-samples. On the basis of 454 experiments with rats, it has been possible to arrange the eggs of thirty-five species in their approximate order of palatability for these animals. With hedgehogs, 230 tests have provided a basis for assessing eighteen egg-species. Only 17 tests have as yet been made with a ferret, on eleven egg-species.

From this work it is clear that the eggs of various birds differ very widely in palatability to egg-eating mammals, as they do to man—all these animals showing unmistakable preferences or aversions for particular eggs. It appears also that the assessments by experimental animals are in fair agreement with the human palatability rating. This general agreement is very close for the ferret, and tolerably so for the hedgehog. Rats show wider differences, especially in their rating of various species considered as palatable or intermediate by man. For example, rats appear to class chaffinch, spotted flycatcher and hedge-sparrow as relatively unpalatable, while the bar-headed goose, magpie, dabchick and eider are given a high place in the series.

Similar *pairs* of egg-species offered to the various experimental animals afford a means of comparison, and show the following agreement or disagreement with the human edibility rating :

Experimental animal	Number of paired samples		
	Agreement	Doubtful	Disagreement
Rat	55	19	30
Hedgehog	23	7	10
Ferret	9	3	0

It is perhaps significant that agreement is closest for eggs of low-grade edibility. Thus, among eleven species below 4·9 (Grade C), no fewer than eight, namely, great tit, sedge-warbler, lesser whitethroat, linnet, eastern house-wren, blue tit, whitethroat and blackcap, appear (in the order given) at the bottom of the sequence for rats. Similarly, three of the four Grade C eggs offered to hedgehogs, namely, sedge-warbler, linnet and whitethroat, appear to be the least edible of eighteen species offered to these animals : puffin, on the other hand, is given a high place.

We may here note that Swynnerton's experiments[3], with a mongoose as taster, though not carried far enough to yield a graded sequence of egg-species, tend also to show some coincidence with the present ratings by man—where similar species are available for comparison. Thus, the eggs most acceptable to the mongoose included those of house-sparrow, bullfinch, greenfinch and moorhen ; and those most repugnant, lesser whitethroat, great tit and wren. The above evidence on the preferences of four mammals therefore suggests that the sequence of palatability in terms of human preference may afford a provisional basis for the consideration of ecological and other aspects of the subject.

Eggs belonging to the few orders in which a considerable number of species has been examined show a very wide range of palatability. For example, Charadriiformes grade from 8·3 (lesser black-backed gull) to 3·8 (ringed plover) ; Passeriformes, from 7·5 (chaffinch) to 2·0 (wren). This wide intra-ordinal range appears to indicate that edibility in eggs may be largely independent of systematic status. A comparison of the various orders in this respect should be based upon a more extensive series than has at present been examined. Nevertheless, the following figures may give some indication of relative edibility within various groups :

Order	No. of species	Edibility range	Mean edibility
Procellariiformes	1	—	7·7
Galliformes	7	8·3 — 5·5	7·2
Gruiformes	4	8·3 — 4·0	7·0
Strigiformes	1	—	6·8
Charadriiformes	17	8·3 — 3·8	6·7
Columbiformes	4	7·3 — 5·0	6·6
Falconiformes	3	6·9 — 6·2	6·6
Anseriformes	4	6·7 — 5·2	6·1
Passeriformes	37	7·5 — 2·0	5·6
Colymbiformes	1	—	5·0
Pelecaniformes	2	5·3 — 4·4	4·9

It might be expected, in the absence of contrary evidence, that the palatability of an egg would show some relation to that of the bird which laid it, and that an acceptable or repugnant flavour in the former might be a reflexion of palatable or distasteful properties of the parent. Indeed, it is true that some birds with high-grade flesh lay palatable eggs—as is notably the case with Galliformes, and with some Charadriiformes and Columbiformes. Similarly, in the oyster-catcher both eggs and flesh are unpalatable. Nevertheless, in general there is a wide discrepancy between the quality of the flesh and eggs of various species. Thus, the relatively distasteful common tern, jackdaw, and bullfinch lay palatable eggs. Conversely, many of the species the eggs of which are bitter and repugnant, including turtle-dove, little crake, ringed plover, yellow bunting, tree-sparrow, sedge-warbler and reed-warbler, are themselves good or excellent as food. Such divergences no doubt follow from the fact that while there is a general correlation between coloration and palatability, both for eggs (see below) and for birds[3], the coloration of the egg itself has no relation to that of the parent bird.

We have also to note that there is no close or obvious relationship between the food-habits of a bird and the flavour of its egg. For example, the eggs of many maritime or shore-feeding species such as kittiwake, common gull, herring-gull, lesser and greater black-backed gulls, common tern, great skua, razorbill, guillemot and fulmar petrel, are good in flavour and free from 'fishiness'. The same is true of others outside the series examined. Thus, as I am informed by Mr. G. A. Gibson-Hill and Dr. L. Harrison Matthews, the eggs of king (*Aptenodytes p. patagonica*), gentoo (*Pygoscelis p. papua*), jackass (*Spheniscus demersus*), macaroni (*Eudyptes chrysolophus*) and rockhopper penguins (*E. c. crestatus*) are quite palatable and without any unpleasant or fishy flavour. The last-named is described by Earle (in Murphy[5]) as "particularly fine and delicate in flavour". Similarly, Gibson-Hill and Matthews considered the eggs of black-browed (*Diomedia melanophrys*) and wandering albatross (*D. exulans*) very good eating and nearly as palatable as those of domestic fowl. Conversely, the eggs of some species (see below) which do not eat fish or feed along the shore yet have a more or less pronounced and unpleasant fishy flavour. This apparent lack of correlation between edibility status of the egg and feeding-habits of the parent is again illustrated by insectivorous species, which may have high-grade (spotted fly-catcher, dipper), intermediate (sand-martin), or low-grade eggs (sedge-warbler, reed-warbler, wren). Similarly, the eggs of mixed (seed and insect) feeders may vary widely : thus we have the palatable chaffinch and hedge-sparrow ; the intermediate greenfinch and yellow bunting ; and the unpalatable linnet and blue tit. It appears, therefore, that no simple explanation of distastefulness, in terms of food-derived deterrents, is admissible.

There appears to be a broad relationship between relative edibility and egg-size. The shell-length of the species so far examined ranges from 104·0 mm. (white-naped crane) to 14·0 mm. (eastern house-wren). The five most distasteful eggs, those of the wren, eastern house-wren, blue tit, great tit and reed-warbler, are all among the smallest tested, and range from 14·0 to 18·3 mm. Conversely, the twelve species heading the list as most palatable are mostly large eggs, ranging from 41·0 (common tern) to 104·0 mm.—seven of these species laying an egg larger than the domestic fowl's. This general correlation is apparent from the accompanying graph (Fig. 1), which shows the mean shell-length for species within various palatability-groups.

The relationship appears to hold even within the limits of several orders and families. Thus the gannet is rated at 5·3 as compared with the shag at 4·4 (the respective egg-lengths being 78·1 and 62·9 mm.) ; among Rallidæ, coot (8·3, 52·6 mm.) and moorhen (8·3, 44·4 mm.) are rated above the little crake (4·0, 30·4 mm.) ; among Ploceidæ, the house-sparrow (7·1, 22·5 mm.) is preferred to the tree-sparrow (5·4,

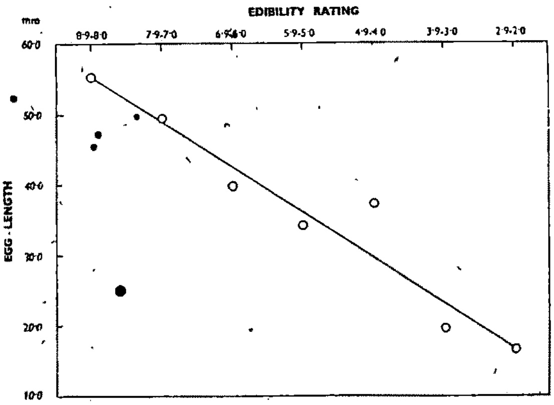

Fig. 1. MEAN SHELL-LENGTH WITHIN GRADED EDIBILITY GROUPS

19·3 mm.); among Hirundinidæ, the swallow (6·0, 19·9 mm.) to the sand-martin (5·7, 18·0 mm.). In several other cases, where the correlation throughout the group is less clear, it is found that the smallest egg is also the least palatable within its systematic group. For example, among three auks tested, guillemot (7·1, 81·5 mm.) and razorbill (7·6, 73·1 mm.) are more palatable than the puffin (4·8, 61·0 mm.); among three plovers, spur-winged plover (7·3, 50·0 mm.) and lapwing (7·3, 47·1 mm.) are both considerably larger and more palatable than the ringed plover (3·8, 35·7 mm.); among six species of gulls, the black-headed gull (6·8, 52·0 mm.) is both the smallest in size and lowest in edibility; among four Columbidæ, the turtle dove (5·0, 30·7 mm.) is again lowest for its group in both respects; while the same is true for six species of Corvidæ and six Fringillidæ, the jay (5·8, 31·7 mm.) in the former and linnet (3·9, 18·0 mm.) in the latter each showing the lowest figure for size and edibility within their respective families. In other groups, notably the terns and game birds, no such correlation is apparent; and on looking at the series as a whole, many outstanding exceptions are to be seen, both among the smaller and larger eggs. Thus, chaffinch, hedge-sparrow, spotted flycatcher, bullfinch and house-sparrow all lay small but palatable eggs graded between 7·5 and 7·1. Similarly, several relatively large eggs are outstanding as exceptions: the status of some of these, such as sandwich tern and bar-headed goose, is still subject to confirmation, since the freshness of the material available may have been in question. The remaining large unpalatable eggs are typically those of shore-living or maritime species such as puffin, shag, oyster-catcher and eider, in which the flavour of the egg is possibly tainted by the bird's diet.

There also appears to be a general correlation between the degree of conspicuousness of the egg and its palatability. Among nineteen species laying cryptic eggs in open situations, twelve occur in the palatable group (A) and five in the intermediate group (B), only two being recorded as unpalatable (C). Moreover, within Group A, cryptic eggs predominate at the head of the list, the first six species (omitting domestic fowl) all falling into this category. Twelve other species, in which non-cryptic eggs are covered by a cryptic parent on open nests, are also distributed (with one exception) in Groups A and B. Of the remaining fifty species, in which the eggs are more or less conspicuously coloured, and are not incubated by a cryptic parent, twelve are unpalatable, representing no less than 80 per cent of all species in Group C. The distribution of cryptic and non-cryptic eggs within graded palatability groups is shown in Fig. 2.

The various species rated as least palatable owe their distastefulness to a variety of unpleasant or foreign flavours: such terms as acid, rancid, soapy, sour, oily, salty, fishy, and bitter occurring in the reports of the panel. Eggs of the oyster-catcher (*Hæmatopus ostralegus occidentalis*) (5·2) are markedly different from those of all other eggs tested, being remarkable both for their strong aromatic odour and flavour, and for their wide individual variation: thus of three samples examined, the first was rated by the three observers at 4·0, 4·0, 5·0, each member of the panel recording a strong smell and taste of onions; the second, at 8·5, 7·5, 7·0, with normal or nutty flavour; the third, at 4·0, 4·0, 3·0, inedible, with a strong odour and flavour of hemp. Species rated as 'fishy' were numerous, those with a markedly rank and fishy smell and taste being shag (4·4), bar-headed goose (5·2), eider (6·0), sparrow-hawk (6·2), ringed plover (3·8), sandwich tern (4·3) and blue tit (3·3). It will be noted that some of these, such as the sparrow-hawk and blue tit, are not themselves fish-eaters.

But by far the most widespread and important distasteful quality is bitterness. This is a frequent attribute of eggs in the lowest palatability grades. In nineteen species this flavour was more or less pronounced (being noted in at least 50 per cent of tests on the species concerned). Fifteen of these bitter-tasting eggs were those of passerine birds: greenfinch, linnet, yellow bunting, tree-sparrow, meadow-pipit, long-tailed tit, red-backed shrike, sedge-warbler, reed-warbler, chiffchaff, common and lesser whitethroats, eastern house-wren, swallow and sand-martin. It will be noted that all these are small species, laying eggs between 23·0 and 14·0 mm. long. Moreover, the remaining four species recognized as markedly bitter, namely, ringed plover, little tern, little crake and turtle-dove, are in each case the smallest eggs examined within their respective orders or families. To this we may add that the two smallest eggs of Corvidæ (jay and magpie) were both recorded (in two observations out of six for each species) as bitter; the same being true of the puffin—the smallest of three auks examined.

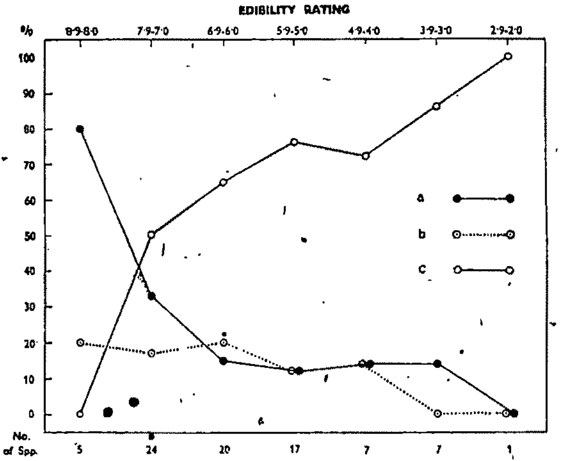

Fig. 2. PERCENTAGES, IN GRADED EDIBILITY GROUPS, OF SPECIES IN WHICH (*a*) THE EGGS ARE CRYPTIC, (*b*) NON-CRYPTIC EGGS ARE COVERED BY A CRYPTIC PARENT, (*c*) NEITHER EGGS NOR PARENTS ARE CRYPTIC

This incidence of bitterness among the smaller eggs laid by members of four different orders, Passeriformes, Charadriiformes, Gruiformes and Columbiformes, raises an interesting ecological question, and suggests that this quality may have been developed as a deterrent to attack by potential egg-eating predators. Obviously, the point requires further investigation, especially in the light of field observations, but the suggestion appears to be supported by three types of evidence.

In the first place, while distasteful properties of the egg appear to be neither directly related to the feeding-habits nor to the palatability of the parent bird, they are, on the other hand, often associated with small size and with conspicuousness. Size is an important factor in the vulnerability of a species in Nature. In the absence of compensating adaptations, smaller birds are liable to attack by a wider range of predators, and are less able to protect themselves and their eggs during the incubation period than larger species. Consequently any deterrent property such as relative distastefulness in the eggs of such birds is likely to be of selective value in the interspecific struggle for existence—especially if it is associated with conspicuous coloration easily recognized and remembered by potential predators.

Secondly, Rensch[6] has shown, in his work on the sensitivity of birds to various tastes, that the lower limit of (externally ascertainable) taste perception is not markedly different from that of man; and that while relative insensitivity to bitterness is characteristic of birds feeding on seeds or insects which often have a sharp or bitter flavour, other species, and in particular birds of prey, such as the goshawk (*Accipiter gentilis*) and tawny owl (*Strix aluco*), are especially sensitive to bitterness.

A third approach to the question is through feeding experiments with egg-eating predators. We have already noted that there is a fair agreement between the palatability ratings of man and the apparent preferences of the ferret, rat, hedgehog and mongoose, and that this agreement is closest for the eggs rated as least edible by man. The series of thirty-five egg-species used in the rat tests includes eleven species rated as bitter, and all these occur in the lower half of the palatability sequence. Among eighteen species used in the hedgehog experiments, the three which appear at the end of the list as least palatable to these animals are the only three markedly bitter eggs offered.

In conclusion, it may be noted that previous work on the relative edibility of the flesh of birds affords a series of facts parallel in many respects to those here considered. Thus cryptic coloration, whether of plumage or egg-shell, appears to be correlated with palatability; and conspicuousness, in otherwise vulnerable species, often to be associated with a distasteful or deterrent property. I hope to continue the present investigation next season, and should be glad to hear from anyone (*a*) who has tasted eggs of tropical or other species not usually eaten by man, or (*b*) who might be willing to submit newly laid eggs (of species not included in the above series) for examination.

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SCIENTIFIC CENTENARIES IN 1948

By Eng.-Capt. EDGAR C. SMITH, O.B.E., R.N.

THE past year has seen the commemoration of the centenaries of many men and institutions, and thus homage has been paid, memories recalled, interest aroused and history enriched. Notable among commemorations in the realm of science and technology were those associated with the Chemical Society, the Institution of Mechanical Engineers, the Royal Netherlands Institution of Engineers, King's College Engineering Society, and with Edison, Graham Bell and Denis Papin. Papin's work (see *Nature*, Sept. 27, 1947, p. 422) belonged mainly to the seventeenth century, which saw the foundation of the Royal Society in 1660 and of the Paris Academy of Sciences in 1666. Both these bodies sprang from earlier meetings of men with scientific leanings, and the meetings in France are recalled by the tercentenary of the death of Marin Mersenne, who carried on a large correspondence with men of science and joined with Mydorge, Roberval, Pascal and others in friendly discussions. Born at Souitière (Sarthe) on September 8, 1588, he was educated at La Flèche, where for a time Descartes was his school-fellow, studied at the Sorbonne and entered the priesthood. He became the superior of a convent of his order in Paris, and he died there on September 1, 1648. An amiable and conciliatory man, he was given to experimenting, translated Galileo's mechanics, contributed to mathematics and was much devoted to music.

Turning back to the later part of the Renaissance, the year 1548 saw the birth of Simon Stevin, the Dutch mathematician, a friend of Prince Maurice of Orange, by whom he was made quartermaster-general of the Dutch Army. His best work was done in fortification and military engineering; but he is remembered for his invention of decimal fractions and as one of the first to revive the study of statics. Cajori wrote of him as "a man remarkable for attainments in science, independence of thought and extreme lack of respect for authority". His statue was erected at Bruges in 1847.

It was such men as Stevin and Mersenne, whose lives overlapped those of Kepler, Galileo and Newton, who helped to pave the way for the great discoveries and advances made in the eighteenth century, so rich in the names of famous men, of whom the first to be mentioned is John Bernoulli, who died at Basle on January 1, 1748. No fewer than eight members of the Bernoulli family achieved fame as mathematicians, John being the eldest. His equally distinguished brother James died in 1705 at the early age of fifty, but John lived to be eighty years of age, leaving two sons, Daniel and John, and a grandson, another John, to maintain the family traditions. Especially remembered for his work on the calculus, John the first had a temperament in marked contrast to that of the priestly Mersenne; but, said Ball, "he was, however, the most successful teacher of his age and had the faculty of inspiring his pupils with almost as passionate a zeal for mathematics as he felt himself". Born at Basle on August 7, 1667, from 1695 to 1705 he held a chair of mathematics at Groningen and then returned home to fill the chair left vacant by his brother's death. For twenty years he corresponded with Leibniz. He was a foreign associate for forty years of the Paris Academy of Sciences, and D'Alembert declared that whatever he knew of mathematics he owed to the works of this great mathematician.

Bernoulli's fame was earned by work steadily pursued over half a century; the name of his contemporary, the German physicist and ecclesiastic, Ewald Georg von Kleist (1700–48), is remembered for a single electrical experiment made in 1745 with a phial, a nail and an electrical machine. Much the same experiment was made a year later by Musschenbroek at Leyden, giving rise to the so-called Leyden jar, a piece of apparatus which became popular with itinerant showmen. Kleist, who was dean of the cathedral at Cammin, in Pomerania, made his experiment in his house, and a tablet thereon, erected in 1898, recalls the episode.

If John Bernoulli be regarded as the outstanding man of science who died in 1748, the most eminent born that year was undoubtedly the French chemist Claude-Louis, Comte Berthollet, one of that distinguished group who made Paris the scientific centre of the world in the days of Napoleon. Though born at Talloires near Annecy, in the Savoy, then an Italian possession, and educated partly at Turin, Berthollet passed the greater part of his life in the French capital, near which he died in 1822. As the discoverer of the composition of ammonia, the supporter of the views of Lavoisier, the director of the Government dye-works, a reorganiser of the Academies and the companion of Napoleon, he enjoyed a great reputation. Sir David Brewster, who was in Paris in 1814, related how he was taken by Laplace, Biot and Poisson to see Berthollet at his house at Arceuil, and how Berthollet and his wife met them: "A more homely pair you never saw, and though very rich, they were dressed little better than a decent Scotch farmer and his wife". It was at Berthollet's house that the English chemist and experimentalist Sir Charles Blagden (1748–1820) died suddenly. An army surgeon, Blagden was a legatee of Cavendish, a friend of Sir Joseph Banks, and during 1784–97 was secretary of the Royal Society. Before his election, there had been dissensions among the fellows of the Society, but on his assumption of office, records Weld, "The ordinary meetings resumed their former scientific appearances, and if harmony was not entirely restored, at least there was no longer any violent attempts to interrupt the regular business of the Society".

Two other distinguished French men of science were born in the same year as Berthollet, one being the botanist Antoine-Laurent Jussieu (1748–1836), long connected with the Jardin des Plantes, the other Jacques-Dominique Comte de Cassini (1748–1845), the last of the four Cassinis who directed the Paris Observatory. The Bernoullis, the Jussieus, and the Cassinis are all examples of science appealing to several members of the same family, and another such family is recalled by Johann Friedrich Gmelin (1748–1804), who held chairs at Tübingen and Göttingen. He and his relations were known as physicians, chemists and botanists. The year 1748 also saw the birth of Scipione Breislak (died 1826), an Italian geologist and a friend of Cuvier, of Pierre Louis Guinaud (died 1824), the watchmaker of Les Brenets near Le Locle in the Swiss Jura, who made important advances in the manufacture of optical glass, and of John Playfair (died 1819) of Edinburgh. It is perhaps difficult now to realize the great admiration and esteem felt in Scotland for Playfair. One of the most cultivated men of his time, he started his career as a minister, successively held the chairs of mathematics and natural philosophy in the University of Edinburgh, was a founder of the Royal Society of Edinburgh, and the centre of an interesting circle of literary and scientific men. Among his greatest friends was James Hutton. Five years after Hutton's death in 1797, Playfair published the classic "Illustrations of the Huttonian Theory of the Earth", a book Geikie advised every young student of geology to read (see *Nature*, Nov. 22, 1947, p. 694). "How different," wrote Geikie in 1897, "would geological literature be to-day if men had tried to think and write like Playfair." Finally, mention must be made of the tragic figure, Phillippe-Frédéric, Baron de Dietrich (1748–93), who like Lavoisier, Bailly and Bochart de Saron fell beneath the guillotine. A mineralogist of note, a member of the Academy of Sciences, a royal commissioner of mines and a magistrate of Strasbourg, during the Revolution he fled to Switzerland, but returning to France voluntarily he was tried once and acquitted, only to be condemned by the revolutionary tribunal. He was executed on December 28, 1793. By one account, it was at Dietrich's house at Strasbourg that Rouget de Lisle composed the "Marseillaise".

Moving forward another hundred years to the middle of last century, as might be expected inventors and engineers take their places besides the devotees of science, and no one will question the greatness of George Stephenson, universally honoured as the 'father of railways', who died at his home, Tapton House, near Chesterfield, on August 12, 1848, at the age of sixty-seven. Of scarcely less stature was Jons Jakob, Baron Berzelius, the Swedish chemist, who passed away at Stockholm five days earlier, at the age of sixty-eight. In the gardens at Stockholm "not far from the statues of kings, amidst trees, with a fountain playing before it, is the bronze figure of Berzelius, the great chemist. He is enveloped in a thick heavy mantel, the stoic fur of the philosopher, and the face and the whole pose indicate the union of perseverance and intelligence which belong to such conquerors in the field of science." Sir William Ramsay once said of Berzelius that "he believed that since the time of Boyle none had done more for the advancement of chemistry". To the same period belong the labours of the German engineer Johann Albert Eytelwein (1764–1848), and the French engineer Baptiste-Alexis Legrand (1791–1848), for sixteen years head of the Corps des Ponts et Chausseés, and also the Alsatian mechanician Joshua Heilmann (1796–1848), who secured for himself a place among the improvers of textile machinery. On January 8, 1848, Caroline Herschel, long the assistant of her brother Sir William Herschel, died in Hanover when nearly ninety-eight. Twenty years before, the Royal Astronomical Society had awarded her its Gold Medal, and seven years before her death had placed her name among its honorary members, the first woman to be so honoured. Another astronomer who worked in the early part of the nineteenth century was the Jesuit father, Francesco de Vico (1805–48), who six times won the gold medal offered by the King of Denmark for the discovery of telescopic comets. De Vico's work was done in Rome; but the political disturbances of 1848 led him to join Georgetown College in the United States. Travelling to England on business, he contracted typhus and died in London on November 15, 1848. To these names may be added those of Sir George Steuart Mackenzie (1780–1848), who discovered the identity of diamonds and carbon; Wilhelm Albrecht (1786–

1848), who introduced scientific methods into agriculture in western Germany and directed the Normal Agricultural Institute at Geisberg; George Augustus Goldfuss (1782–1848), professor of zoology and mineralogy at Bonn; Josiah Christopher Gamble (1776–1848), one of the founders of the British chemical industry, and Sir John Barrow (1764–1848), who from being a timekeeper in a Liverpool iron foundry rose to be the Secretary of the Admiralty and became the virtual founder of the Royal Geographical Society. The cottage at Ulverston in which Barrow was born now bears a memorial tablet, while on the summit on the hill behind is the tower erected in his memory.

In an age which has seen the spread of education, the founding of many colleges, universities, laboratories and scientific societies, a remarkable increase in inventions and the harnessing of science to industry, the centenaries of men of science born a century ago, who as investigators, teachers, writers or administrators have left their mark, fall fast and thick. Each year, indeed, brings a longer and longer list. Taken in chronological order, the year 1848 saw the birth in February of Josiah Richard Perrett (died 1918), who from a dockyard apprentice rose to be the chief naval architect at Elswick, where he built many fine warships. In March occurred the birth of Shelford Bidwell (died 1909), known for his work in electricity and magnetism, who served as president of the Physical Society during 1897–99; of the Austrian scientist Josef Maria Pernter (died 1908), for many years a leader of meteorology in his country; of the German pioneer of flight, Otto Lilienthal, who was accidentally killed while gliding in 1896, and whose monument is to be seen at East Lichterfelde, Berlin; and of Henry Marion Howe (died 1922), the leading American metallurgist of his day.

The Rev. Frederick John Jervis-Smith (died 1911), of Trinity College, Oxford, who represented his University at the tercentenary of Torricelli at Faenza in 1908, was born in April 1848; and Vero Charles Driffield (died 1915), the eminent manufacturing chemist and collaborator with Hurter, was also born in the same month. In July of that year the physicist Baron Roland von Eötvös (died 1919) was born at Budapest. A pupil of Helmholtz, Kirchhoff and Bunsen, he founded the Hungarian Mathematical and Physical Society and for many years was president of the Hungarian Academy of Science. In the following month Paul Henri (died 1905), brother of Matthieu-Prosper Henri (1849–1903), was born at Nancy. Their outstanding work at the Paris Observatory gained for them both the associateship of the Royal Astronomical Society. Seldom, if ever, have two brothers been such close collaborators. The famous German chemist, Victor Meyer (died 1897), was born in Berlin on September 8, 1848, and became Bunsen's successor at Heidelberg, where Sir Edward Thorpe first knew him. Thirty years later, Thorpe delivered the memorial lecture on Meyer to the Chemical Society, giving a fascinating picture of one whom he first remembered as a "bright-eyed youth, quick of movement and action, ready and fluent of speech and full of zeal". In many of his characteristics, Meyer, said Thorpe, was not unlike Davy.

The list of physicists born in 1848 includes also Sir Arthur Rücker (died 1915), Henry Augustus Rowland (died 1901), and Sigmund von Wroblewski (died 1888). Rücker was born on October 23 and Rowland on November 27. A Royal Medallist and secretary of the Royal Society, Rücker was professor of physics for fifteen years at the Royal College of Science, London, and then principal of the University of London. Rowland held the chair of physics in the Johns Hopkins University, Baltimore, from its foundation in 1876, a post for which he was recommended by Maxwell. Wroblewski, like many of his compatriots, suffered for taking part in the Polish insurrection in 1863, and spent six years in exile in Siberia. Afterwards he was able to work under Helmholtz; in 1874 he went from Berlin to Strasbourg, and in 1882 became professor of experimental physics in the University of Cracow; where, working with Karl Olszewski, he liquefied in considerable quantities the three gases oxygen, nitrogen and hydrogen. He met his death on April 16, 1888, at the early age of forty, through the accidental overturning of a lamp.

Finally, it may be recalled that on May 12, 1748, Thomas Lowndes died at the age of fifty-five, leaving his property in Cheshire to found a chair of astronomy at Cambridge, the first occupant of which was Dr. Roger Long (1680–1770), vice-chancellor of the University from 1733 until 1769. The reason for Lowndes' bequest is obscure, for his activities had been concerned with the colonization of South Carolina, the manufacture of potash, the decay of England's wool industry and the supply of salt to the Navy.

OBITUARIES

Prof. Max Planck, For.Mem.R.S.

PROF. MAX PLANCK died on October 4 in Göttingen at the age of eighty-nine. The burial service was held in the crowded church of St. Alban, where addresses of appreciation were given by the officiating minister and by Profs. O. Hahn and M. von Laue. It is hoped to hold a larger memorial service in the spring of next year, probably on the ninetieth anniversary of Planck's birthday.

Planck was born in Kiel on April 23, 1858. His father was professor of constitutional law in the University of Kiel and later in Göttingen. He took the degree of doctor of philosophy at Munich at the age of twenty-two, the subject of his thesis being the second law of the mechanical theory of heat. In 1885 he was appointed professor *extraordinarius* in Kiel. His association with the University of Berlin began in 1889 and lasted for fifty years: he was appointed professor *ordinarius* in 1892. In 1920 he was awarded the Nobel Prize for Physics and in 1926 was elected a foreign member of the Royal Society. He was granted the title of professor emeritus in 1926; but this was not to usher him to a period of retirement, for shortly afterwards he became president of the Kaiser Wilhelm Institute for the Promotion of Science, an appointment which he held until 1937. Planck's original and critical writings extended from about 1879 until shortly before his death. He was, indeed, engaged in writing down some of his latest views during his visit to Great Britain last year.

In his early twenties, Planck attended lectures given by Kirchhoff in Berlin. He had a great admiration for Kirchhoff's work, and it may be supposed that this was one of the influences which directed him to the study of thermodynamics and the theory of radiant heat.

A very early paper, written at the age of twenty-two, was on the theory of the law of saturation. The statement of this law he expresses in the form: in the case of each isothermal the straight line, parallel to the axis of abscissæ, which represents the pressure of the saturated vapour, lies so that the areas between it and the isothermal are equal. This work appeared almost simultaneously with a paper by Clausius, who reached the same conclusion.

There is a feature of this early paper which is characteristic of his outlook. He was always ready to apply himself to concrete examples and to put his conclusions to the test of experiment. In this case he calculated the pressure of saturated carbon dioxide and made a comparison with the results of Andrews' experiments.

During the following decade, he published a number of papers on thermo-electricity and on the theory of dilute solutions. Between 1890 and 1900 he appears to have concentrated particularly upon thermodynamics and the process of radiation. The first edition of his treatise on thermodynamics appeared in 1897, and this work alone places him in the front rank as a clear and critical thinker. It is perhaps the greatest work on this subject, and it is certainly a classic. At the same time he was writing upon the processes of radiation. He showed that these were to be considered as electromagnetic, the phenomena being confined to the oscillation of certain entities analogous to Hertzian oscillators connected in some way with the atoms of matter. The phenomenon of absorption of radiant heat was not to be regarded as a consequence of ohmic resistance or friction of any kind, but simply as a phenomenon of resonance; the oscillators were regarded not merely as emitters of waves, but also as capable of excitation by incident waves.

These studies of thermodynamics and of electromagnetic vibrations brought Planck naturally to the problem of the distribution of energy in the spectrum of full radiation. His famous formula was first given in the latter half of the year 1900. He had come to the conclusion that the law of energy distribution could be completely solved if the entropy of an irradiated monochromatic resonator could be expressed as a function of its energy U. The essential part of his work was the discovery of this expression. In an earlier attempt he had deduced Wien's law and expected it to have general validity. This law fails as a general law on experimental grounds, so Planck found it necessary to consider more closely the concept of entropy.

By applying Boltzmann's equation from the theory of gases, relating entropy and probability, to a set of resonators the energy of which must necessarily occur in discrete multiples of an amount ε, he was able to show that the entropy was a function of U/ε. At the same time, by means of Wien's displacement law, he realized that, ν being the frequency of the radiation emitted, the entropy was a function of U/ν. He was thus led to his famous relation between the elements of energy and the frequency and to the introduction of the constant h, named universally after him.

This was the climax of Planck's work. It was also a climax in the history of physics, for there had been nothing of greater importance since the time of Newton. But in 1900 there was no suggestion of a climax. Planck's work continued and his contemporaries were unconvinced or sceptical. In the same volume in the *Annalen der Physik* as that in which Planck's work was published appears a paper by Rubens and Kurlbaum on the experimental proof of the law of radiation, in which it is stated that the two formulæ best fitted to express the law are those suggested by Lummer and Pringsheim and by Planck, though Planck's has the advantage of its greater simplicity.

It is also of interest to recall that Jeans' contributions to this question were made between 1900 and 1910, and in this latter year Planck, in a summary of the situation, describes this work of Jeans as faultless and as the most satisfactory from the point of view of the accepted theories of physics, but as a failure from the point of view of experiment. It may be that the unwillingness to accept Planck's theory at this time was partly due to his clear statement of the assumptions made. These may have caused his contemporaries to hope that they might ultimately be set aside, leaving the old doctrines sufficient.

When asked many years later what he had felt in this period, he replied: "I knew I could wait", and on another occasion: "I am glad I led no one astray". The gradual accumulation of data from the domain of atomic physics, from Einstein's theory of the photo-electric effect and from the work of Rutherford and Bohr, are familiar to all students of physics. But it took a quarter of a century of theoretical and experimental work to build up a self-contained quantum theory. This is the measure of the quality of Planck's insight and inspiration.

But he appears always to have hoped for the establishment of a theory harmonizing the classical and quantum points of view. This was evident in his interest, even his delight, in Schroedinger's theory of wave mechanics which, by the title of his first paper, "Quantization as a Problem of Characteristic Values", raised hopes which have not been realized.

On wave mechanics Planck published papers in 1940 and 1941. He does not appear to have followed modern developments beyond this stage.

Planck remained mentally clear and active to the end; but during the last two years he was physically weak and easily became tired during conversation and in his efforts at writing.

There is no doubt about Planck's place in science. His name will be remembered with those of Newton and Einstein for generations. For the shorter period of the lives of those who knew him, he will be remembered, with a rare affection. Among his colleagues and, indeed, among his countrymen, he inspired a deep respect akin to reverence. This was due not merely to the importance and originality of his scientific discoveries, but also to his great personal qualities, to his sympathy, modesty and patience.

His friends and students will delight to recall his piano accompaniments with Einstein playing the violin. Even in Great Britain there are some who have enjoyed his gift as a pianist. He has said that at one time he considered music as a career.

He was twice married and suffered heavy blows in the loss of two sons and twin daughters. These sorrows saddened but did not embitter him, and he was always ready to give sympathy in matters which, compared to his own sufferings, must have seemed trivialities. His second wife and one son survive him. The end of the War had involved him in disaster. His house in Berlin was destroyed and his source of income vanished. In the last days of the War he was homeless and took shelter in a wood until he was recognized by members of the American Army. He ultimately found shelter in very limited quarters in the house of his grand-niece in Göttingen.

Planck was unpopular with the former German Government on account of his refusal to be associated with the movement for 'German physics' and on account of his admiration for the work of Einstein. Moreover, he appealed personally at the highest level for a relaxation of the persecution of Jewish men of science. A very gifted son, a Secretary of State to an earlier German Government, was executed for alleged complicity in the plot to overthrow the Nazi regime in the last stage of the War.

These experiences had greatly enfeebled Planck, when he was invited by the Royal Society to take part in the Newton celebrations last year. In spite of the anxiety of his relatives he insisted on undertaking the journey in order, as he said, to reopen the bridge which united the physicists of both countries. His old friends were pained to see his enfeeblement, but they will all be glad to know that he returned home refreshed in mind and body by the renewal of old friendships and by the hospitality so readily offered. Of the latter aspect of his visit his own words were: "Ich lebe wie im Schlaraffenland".

One of the last letters he wrote was to friends in Britain on the anniversary of his visit, recalling happy memories of it. Before the letter could be posted he had a bad fall and sustained bruises and a slight fracture from which he did not recover.

H. T. Flint

We regret to announce the following deaths:

Prof. J. N. Brönsted, professor of chemistry in the University of Copenhagen, on December 17.

Prof. A. N. Whitehead, O.M., F.R.S., professor of philosophy in Harvard University during 1924–37, on December 30, aged eighty-six.

Erratum.—In *Nature* of December 13, p. 821, the death was announced of Mr. S. A. Courtauld. This was incorrect; the reference should have been to Mr. S. Courtauld, a trustee of the National Gallery, who died on December 1 at the age of seventy-one.

NEWS and VIEWS

Social Studies in Manchester: Appointment of Prof. M. Polanyi, F.R.S.

Prof. Michael Polanyi has been appointed professor of social studies in the University of Manchester in lieu of his present position as professor of physical chemistry. The change of duties will become effective after Easter of this year. Prof. Polanyi graduated in medicine in the University of Budapest. Later he was appointed professor of chemistry in the Technical High School, Berlin, and taught in the Kaiser Wilhelm Institute, publishing much original work. In 1933 he accepted an invitation to become professor of physical chemistry in the University of Manchester, where he has conducted distinguished teaching and research, and has directed a stream of research workers in that subject. Prof. Polanyi's wide experience and range of interests have brought him closely into contact with investigators and teachers in social studies and in economics, and in recent years he has produced a number of papers on aspects of those subjects. These include volumes entitled "The Contempt of Freedom" and "Full Employment and Free Trade", together with a substantial number of essays in this field published in economic and other journals. In 1946 he accepted an invitation to deliver the Riddell Lectures in the University of Durham, his subject being "Science, Faith and Society". He has recently accepted an invitation to give the Gifford Lectures for 1949–50 in the University of Aberdeen.

University College, Exeter, and the Norman Lockyer Observatory

Arrangements have now been completed by which the astronomical observatory on Salcombe Hill, Devon, will become "The Norman Lockyer Observatory of the University College of the South West of England, Exeter". The Observatory occupies a commanding site of about 44 acres above Sidmouth, at an altitude of 565 ft.; and since its foundation in 1912 it has been maintained through funds provided by a few generous donors as a non-profit making corporation with articles of association approved by the Board of Trade. By the will of Lady Lockyer, who died in September 1943, some additional land, with her house and also her residuary estate, were bequeathed to the Corporation. These gifts brought the capital funds of the Observatory up to about £33,000 in March 1947, with an income therefrom of nearly £1,400 a year. The whole property is now being incorporated in the University College of the South West, with the buildings, telescopes and other equipment for astronomical research, under a scheme adopted by the Councils of the College and of the Observatory Corporation. The director (Mr. D. L. Edwards) and chief assistant will thus become attached to the staff of the College, and the registrar of the College will become secretary of the Observatory Corporation. Under the revised articles of association, the future Council of the Observatory Corporation will consist of not more than twenty persons nominated by the Council of the College and not more than five nominated by the Corporation. By this provision, leading British astronomers will still be able to ensure the promotion of the educational and research sides of astronomy, in which, because of lack of financial support, Great Britain has lagged behind other countries in many of the new developments.

The work of the Norman Lockyer Observatory hitherto has mainly dealt with stellar spectroscopy; but the erection of the Mond astrographic instrument has enabled a somewhat wider field of astrophysical research to be included. In all, sixty-one papers from the Observatory have been accepted by the Royal Astronomical Society, in addition to a number of contributions published elsewhere. At present the principal routine programmes of work deal with colour temperatures of stars, bright-line stars, spectrum variables and galactic clusters. Work on the last is at the moment in abeyance, owing to shortage of staff, and progress in the other programmes is retarded for the same reason. Minor programmes are also kept in reserve for use when conditions are not suitable for the main routine work.

Jubilee of the Discovery of the Electron

IN *Nature* of December 6, p. 776, an account was given of celebrations in London arranged by the Institute of Physics, the Physical Society, and the Institution of Electrical Engineers to mark the jubilee of the discovery of the electron by Sir J. J. Thomson in 1897. It is of interest to learn that the event was also remembered on the Continent. The Bernische Naturforschende Gesellschaft held a commemorative meeting in June 1947, with Dr. A. Kurz in the chair. An address was delivered by Prof. André Mercier; as a professor of theoretical physics, he insisted especially on the great influence that the discovery of the electron has had since 1897 on physical theories, particularly under the impulse given by H. A. Lorentz, W. Pauli and P. A. M. Dirac.

Institute of Metals: Elections

THE Council of the Institute of Metals has made the following elections: *Fellows* (members who have rendered eminent service to the Institute), Dr. C. H. Desch, formerly superintendent of the Metallurgy Division, National Physical Laboratory; Sir John Greenly, chairman of the British Non-Ferrous Metals Research Association and a past-president of the Institute of Metals. *Honorary Members* (in recognition of their distinguished services to the science or practice of non-ferrous metallurgy), Prof. P. A. J. Chevenard, member of the Institut de France, known for his work on special steels; Sir Geoffrey Taylor, Yarrow research professor of the Royal Society; Dr. J. F. Thompson, executive vice-president of the International Nickel Company of Canada, Ltd., known for his studies of the science and practice of non-ferrous metallurgy.

Ministries of Food and Health: Lasker Group Award

A LASKER GROUP AWARD for 1947 has been presented by the American Public Health Association to the British Ministries of Food and Health "for the unprecedented programme of food distribution in Great Britain" during the War, "with resulting improvement in the health of the people". The Lasker Award, which takes the form of a statuette of the "Winged Victory of Samothrace", was provided through the generosity of the Albert and Mary Lasker Foundation, and is made either to individuals for their achievement in the field of medical research and public health administration or to groups for outstanding work or research. This is the first occasion on which the award has been given outside the United States.

Nuffield (Penicillin) Research Fellowships

LORD NUFFIELD has given £50,000 to Lincoln College, Oxford, of which Sir Howard Florey is a fellow, to establish three research fellowships in science and allied medicine. The gift is to commemorate the discovery, in the Sir William Dunn School of Pathology, of which Sir Howard Florey is head, of the chemotherapeutic properties of penicillin. The fellowships are to be known as Nuffield (Penicillin) Research Fellowships.

University of Glasgow

THE following appointments in the University of Glasgow have been announced: Prof. Thomas Alty, Cargill professor of natural philosophy, deputy principal; Dr. Basil C. King, lecturer in geology; Messrs. Daniel Martin and Walter Brown, lecturers in mathematics; Messrs. John B. Birks (formerly an I.C.I. Fellow) and G. M. Lewis (from University College, Hull), lecturers in natural philosophy; and (from April 1, 1948) Dr. William C. Hutchison, lecturer in physiology in the University of Edinburgh, and Mr. George Leaf (from the National Institute for Medical Research), lecturers in physiological chemistry.

For the 1947–48 session, 350 students have been admitted to the various first-year classes covered by the Faculty of Science—280 in pure science and 70 in applied. These numbers represent a slight reduction compared with the 1946–47 session. Of the 250 fresh admissions, about 45 per cent are ex-Servicemen. Of the graduate research students who have been registered, or re-registered, about sixty are at the University and forty at the Royal Technical College, Glasgow.

University of Leeds: Appointments

THE following appointments in the University of Leeds have been announced: Dr. W. Bradley (at present research director at the British Drug Houses, Ltd.), professor of colour chemistry and dyeing, in succession to the late Prof. F. M. Rowe; Mr. A. H. Hanson, lecturer in the Departments of Social Studies and Extra-Mural Studies; Mr. H. D. Ursell, lecturer in mathematics, to succeed Mr. R. M. Gabriel as reader in mathematical analysis.

University of Sheffield: Appointments

THE following appointments in the University of Sheffield have been announced: Dr. S. R. Elsden, senior lecturer in microbiology in the Department of Bacteriology; R. O'Rahilly, lecturer in anatomy; T. F. Bamber (at present research assistant), assistant lecturer in the Department of Mining; Dr. J. L. Emery, honorary lecturer in pathology.

Agricultural Research Council: Postgraduate Scholarships

THE Agricultural Research Council announces the following awards of postgraduate scholarships in agricultural science and in animal health, to be held at the university or college mentioned from the beginning of the academic year 1947: P. Aitkenhead (Durham), a two-year research scholarship in entomology; N. Bateman (London), a three-year research scholarship in animal genetics; J. R. Butler (Cambridge), a three-year research scholarship in soil mineralogy; J. W. B. King (Cambridge), a three-year research scholarship in animal genetics; D. Lewis (Wales), a three-year scholarship in biochemistry; A. M. McCallum (Glasgow Veterinary College), a one-year research scholarship in animal health; I. A. Nicholson (Durham), a three-year research scholarship in plant breeding; H. Platt (Liverpool), a one-year research scholarship in animal pathology; Miss P. E. Stokes (London), a three-year research scholarship in plant physiology; K. F. Thompson (Cambridge), a three-year research scholarship in plant genetics; G. M. Urquhart (Glasgow Veterinary College), a one-year research scholarship in animal parasitology; D. P. Webley (Durham), a one-year research scholarship in entomology; Miss J. N. Winfield (Leeds), research scholarship in plant pathology renewed for one further year from October 1, 1947.

Type Cultures of Fungi

FROM January 1, the National Collection of Type Cultures preserved by the Lister Institute has ceased to maintain and distribute cultures of fungi and yeasts; it is now confining its activities to bacteria and viruses. Most of the fungi, except yeasts and fungi of medical interest, from the National Collection of Type Cultures, have been transferred to the Imperial Mycological Institute, which proposes to maintain cultures of phytopathogenic, taxonomic and economic interest, provided expected financial support is forthcoming. Applications for cultures should be addressed to the Director of the Institute at Ferry Lane, Kew, Surrey. Timber-rotting fungi can be obtained, as before, from the Director, Forest Products Research Laboratory, Princes Risborough, Bucks.

Conference on Films in Agriculture

The Scientific Film Association is organising a one-day conference to be held on January 17 at the Caxton Hall, London, at which the present state and the future development of the use of films in agriculture and their place in the drive for increasing production will be discussed. The chair will be taken by Prof. J. A. Scott Watson, chief scientific and agricultural adviser to the Ministry of Agriculture and Fisheries. Mr. G. Goodman (Ministry of Agriculture) will speak on the scope, and Mr. A. Vesselo (Central Film Library) on the sources and distribution of agricultural films. Dr. W. K. Slater (senior education and advisory officer of the Ministry of Agriculture) will discuss the use of the instructional film in agriculture; Mr. R. Kenney, lecturer in agriculture, University of Reading, will deal with its use in university training and research; and Mr. E. Anstey (Film Centre) with the making of agricultural teaching films. In the evening a show of selected British and foreign agricultural films will be given. Further information and tickets (£1 1*s*. each, including buffet lunch and tea) can be obtained from the Conference Secretary, Scientific Film Association, 34 Soho Square, London, W.1.

Geographical Distribution of Deaths from Cancer

The General Register Office has initiated a series of occasional publications under the title of "Studies on Medical and Population Subjects". The purpose of the series is to present a more detailed treatment of certain important subjects than is possible in the Registrar General's Annual Statistical Review. The first publication is by Dr. Percy Stocks, and studies geographical variations in mortality from cancer of various sites (Regional and Local Differences in Cancer Death Rates. London: H.M. Stationery Office. 1*s*. net). One of the underlying difficulties in such a study is the uncertainty as to the accuracy of the certified cause of death, particularly in relation to inaccessible sites. It is, however, impossible to dismiss all the local differences demonstrated by Dr. Stocks as due to such variations in certification practice, and this study investigates other possible explanations. Correlations with social indices show a marked relationship with stomach cancer, but none with lung cancer. However, lung cancer mortality is closely associated with annual hours of sunshine in twenty large towns, and this suggests that a beneficial effect of sunshine or a deleterious effect of smoke may operate. A grouping of London boroughs according to their water supply is reminiscent of Farr and cholera, but is not so revealing. Dr. Stocks has brought together a great deal of information and has put forward many suggestions for more intensive research.

Comet 1947*n*

This comet was discovered in the southern hemisphere on December 8, and was described as diffuse with stellar condensation and a tail longer than 1°. Its magnitude was − 5, and it was moving northward. Dr. Cunningham computed an orbit from observations supplied; but as these may not have been very accurate, the orbit must be regarded as merely provisional. The elements of the orbit and an ephemeris are given below:

$$\begin{array}{ll} T & 1947 \text{ December } 2{\cdot}710 \text{ U.T.} \\ \Omega & 341^\circ\ 05' \\ \omega & 197\ \ 00 \\ i & 133\ \ 54 \\ q & 0{\cdot}0999 \end{array} \left.\begin{array}{l} \\ \\ \\ \\ \\ \end{array}\right\} 1947{\cdot}0$$

1948	α	δ	r	ρ
Jan. 2·0	21h. 30·5m.	− 24° 18′	0·979	1·552
6·0	21 43·2	22 36	1·069	1·680
10·0	21 54·0	21 05	1·155	1·805
14·0	22 03·5	19 44	1·241	1·928

The Night Sky in January

New moon occurs on Jan. 11d. 07h. 44m., U.T., and full moon on Jan. 26d. 07h. 11m. The following conjunctions with the moon take place: Jan. 8d. 14h., Jupiter 3° N.; Jan. 14d. 04h., Venus 4° N.; Jan. 27d. 05h., Saturn 4° S.; Jan. 28d. 06h., Mars 0·6° S. Mercury, in superior conjunction on Jan. 3, becomes an evening star later and sets at 16h. 52m., and 18h. 15m., at the middle and end of the month, respectively, but the planet lies too low for good visibility. Venus, an evening star of stellar magnitude −3·4, sets at 18h. 23m., 19h. 08m. and 20h., at the beginning, middle and end of the month, respectively, and is a conspicuous object, about 80 per cent of the illuminated disk being visible. Mars, in the constellation of Leo, is visible throughout the greater portion of the night, rising at 21h., 20h. 04m. and 18h. 41m., on Jan. 1, 15 and 31, respectively. Jupiter is not visible until the late morning hours, its time of rising on Jan. 1 being 6h. 20m., and 4h. 50m. on Jan. 31. As the planet does not attain an altitude of 17° in the latitude of Greenwich, it is not very suitably placed for observation. Saturn, in the constellation of Leo, is visible throughout most of the night, rising at 19h. 46m. and 17h. 30m., at the beginning and end of the month, respectively. Occultations of stars brighter than magnitude 6 are as follows: Jan 3d. 05h. 35·1m., γ Virg. m. (*D*); Jan. 3d. 06h. 48·5m., γ Virg. (*R*); Jan. 17d. 19h. 45·7m., 14 Ceti (*D*); Jan. 23d. 20h. 51·9m., 139 Taur. (*D*). *D* and *R* refer to disappearance and reappearance, respectively, and the latitude and longitude of Greenwich are assumed. In addition to these occultations of stars, Mars is occulted on Jan. 28d. 06h. 09·9m., reappearing at 6h. 26·3m. The earth is in perihelion on Jan. 2.

Announcements

Viscount Falmouth has been elected by the governors of the Imperial College of Science and Technology to be their chairman in succession to Lord Rayleigh, whose period of office terminated on May 31, 1947.

The Council of the British Welding Research Association has accepted an offer from Messrs. British Oxygen Company, Ltd., to provide a prize fund of £100 a year for three years. A single prize of £100 is offered in 1948 for the best paper on a research into welding or its application. Papers must be submitted on or before September 30, 1948.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Acetylcholine and Body Temperature

Glaubach and Pick[1] were the first to find that procaine causes a fall of body temperature. The fall has recently been shown by Peczenik[2] to be greatly increased after adrenalectomy. The work of Dawes[3] in this laboratory on quinidine substitutes led him to point out that quinine, quinidine and procaine antagonize the effect of acetylcholine on many types of tissue. They reduce its effect on the heart and on the intestine, and they reduce its effect on skeletal muscle also (Harvey[4]). Thus procaine, in addition to being a local anæsthetic, reduces the action of acetylcholine in all forms of muscle. Recently, de Elio[5] has shown in this laboratory that procaine shares these properties, not only with quinidine, but also with atropine and with the analgesic 'Pethidine' (demerol), while Dews and Graham[6] have shown that the antihistamine substance 'Neoantergan' shares them too.

We have now tested atropine, benadryl, 'Pethidine' and quinidine to see if they affect the body temperature of mice as does procaine. We have discovered that they do, and that the fall they produce is augmented by adrenalectomy. Since the common property of these substances is that they depress the action of acetylcholine, it becomes probable that the maintenance of body temperature depends on a mechanism in which acetylcholine plays a part, and that the adrenal glands support such a mechanism against the depressant action of substances like procaine.

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N. K. Dutta

Department of Pharmacology,
University, Oxford.
Nov. 19.

[1] Glaubach, S., and Pick, E. P., *Arch. Exp. Path. Pharmak.*, **162**, 551 (1931).

[2] Peczenik, O., *Proc. Roy. Soc.*, B, **134**, 218 (1947).

[3] Dawes, G. S., *Brit. J. Pharmacol.*, **1**, 90 (1946).

[4] Harvey, A. M., *J. Physiol.*, **95**, 45 (1939).

[5] de Elio, F. J., *Brit. J. Pharmacol.* (in the press).

[6] Dews, P. B., and Graham, J. D. P., *Brit. J. Pharmacol.*, **1**, 278 (1946).

Cholinesterase Activity in Cerebro-Spinal Fluid

The published finding of Stedman and Stedman[1], that cholinesterase cannot be detected in cerebrospinal fluid, appears to be generally accepted, for recent literature contains no account of further investigations in cholinesterase activity.

We have found that the cholinesterase activity of the cerebro-spinal fluid of forty-two human subjects was in each case considerably above the range of the spontaneous hydrolysis of the cholinesters.

The cholinesterase activity was determined manometrically by Warburg's method at 37·5° C., and the result expressed in cubic millimetres of carbon dioxide produced by 1 ml. cerebro-spinal fluid in a period of thirty minutes. 1·6–2 ml. cerebro-spinal fluid, with 0·2 ml. 2 per cent bicarbonate, were put in the main vessel of the ordinary conical containers, and in the side arm 0·2 ml. of the substrate solutions, which consisted of 0·3 *M* acetylcholine, or 0·3 *M* acetylmethylcholine ('Mecholyl'), or 0·06 *M* benzoylcholine, respectively. This procedure was adopted in the light of the recent investigations of Mendel and Rudney and Mendel and Mundell[2].

The cerebro-spinal fluid was obtained from psychotic patients suffering from organic (general paralysis of the insane) and non-organic (mania, schizophrenia) psychoses. The cholinesterase activity of individual specimens varied considerably: substrate acetylcholine, between 6·6 and 28·4; substrate acetylmethylcholine, between 5·4 and 23·6; substrate benzoylcholine, between 2·3 and 6·2.

The relation between cholinesterase activity of cerebro-spinal fluid and blood serum was: with acetylcholine as substrate, 1/90–1/150; with 'Mecholyl' as substrate, 1/8–1/40; with benzoylcholine as substrate, 1/125–1/300.

Specimens of cerebro-spinal fluid from a number of patients were mixed; the cholinesterase activity, using the different substrates, is shown in the accompanying table.

For preparatory reasons, we tried to absorb the cholinesterase by different absorbents: 'Permutit' ('Decalso'), kieselguhr and alumina. The result was negative; no activity was lost by treatment with any of the substances (see table).

	Hydrolysis (mm.^{3} CO_2 evolved by 1 ml. cerebro-spinal fluid in 30 min.) of			Nitrogen content (mgm./ml.)
	Acetylcholine 0·03 *M*	Acetylmethylcholine 0·03 *M*	Benzoylcholine 0·006 *M*	
Cerebro-spinal fluid mixture (16 patients)	23·6	12·4	4·6	1·18
After treatment with kieselguhr	25·1	11·8	5·2	1·19
After treatment with alumina	22·8	10·3	4·9	1·13
Cerebro-spinal fluid mixture (29 patients)	21·4	10·4	4·3	
After filtering through 'Decalso' column	21·5	9·6	4·6	
After boiling for four minutes	13·7	6·7	2·5	

It seems reasonable to suppose that the so-called true cholinesterase of Mendel and Rudney is the predominant enzyme system present in cerebro-spinal fluid.

We are now investigating possible relationships between the level of cerebro-spinal fluid cholinesterase and various disturbances of brain and mental function.

M. Reiss
R. E. Hemphill

Biochemical and Endocrinological Research
Department,
Bristol Mental Hospitals. Sept. 1.

[1] Stedman, E., and Stedman, E., *Biochem. J.*, **29**, 2107 (1935).

[2] Mendel, B., and Rudney, H., *Biochem. J.*, **37**, 59 (1943). Mendel, B., and Mundell, D. B., *Biochem. J.*, **37**, 64 (1943). Mendel, B., Mundell, D. B., and Rudney, H., *Biochem. J.*, **37**, 473 (1943).

Relation of Intermediary Metabolites to the Lowering of the Potency of Pancreatic Insulin in the Animal System

It has long been felt by several workers that adiposity is connected with the onset of diabetes mellitus. It has previously been reported by us[1] that the intermediary fat metabolites such as β-hydroxy butyric acid, aceto-acetic acid and pyruvic acid, when injected into normal rabbits in the form of their sodium salts, give rise to the condition of hyperglycæmia characterized by decreased sugar tolerance in those animals. It has also been observed by us[2] that these substances can reduce the potency of external insulin while allowed to combine with them both *in vitro* as well as *in vivo*.

In order to obtain confirmatory evidence on this point, these metabolites were injected into normal guinea pigs beginning with 100 mgm. each animal per day, which was increased by 15 mgm. per animal per week.

The animals were depancreatized at intervals (15–30 days), and the insulin content of their pancreases was assayed on rabbits according to the usual method of Marks[3].

During the first stage of the experiments (that is, up to 15–25 days) there was observed much higher potency of the pancreatic insulin isolated from the animals injected with those metabolites ; the activity being about 50 per cent higher than that of normal animals. But this stage of hyperactivity was soon followed by the gradual reduction of potency as measured by the percentage reduction of blood sugar in normal rabbits ; this was found to be as low as 50 per cent of the normal values after seventy days.

These observations show that accumulation of intermediary fat metabolites is responsible for either lowering insulin secretion, or for decreasing the insulin potency in the system, and that these keto-bodies can be held responsible for the onset in the long run of diabetes mellitus.

Though hyperglycæmia thus caused may not be directly associated with the pancreatic damage, still it may be considered that the strain on the insulin-producing mechanism resulting from early hypertrophy and increased insulin production might ultimately lead to atrophy of the pancreatic islet cells, with consequent decrease in the insulin production.

Further investigations in this connexion as well as on the histological picture of the pancreas of the experimental animals are in progress.

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H. D. Brahmachari

Department of Biochemistry,
University, Nagpur. Sept. 6.

[1] Nath, M. C., and Brahmachari, H. D., *Nature*, 154, 487 (1944).

[2] Nath, M. C., and Brahmachari, H. D., *Nature*, 157, 336 (1946).

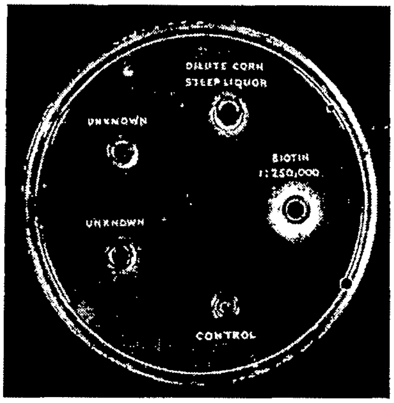
[3] Marks, C. H., *Quart. Bull. Health Organ. League of Nations, Geneva*, Spec. No. (Nov. 1936).

A Modified Microbiological Assay Procedure

Mr. A. L. Bacharach's letter[1] on the use of the plate-and-cylinder method in reverse for assaying certain growth-factors suggests that it may be of interest to record some very similar experiments which I carried out during 1944–45.

There was at that time a need for a simple and rapid method of approximately determining the biotin content of certain solutions. As the plate-and-cylinder method was then in daily use in the laboratory in connexion with research on antibiotics, the possibility of applying the method for assaying substances which promoted instead of inhibited growth was investigated.

Sterile agar containing glucose and mineral salts was poured into Petri dishes and the surface was seeded with the test organism, a strain of *Saccharomyces cerevisiæ*. The method of seeding was the same as that used for seeding plates with *S. aureus* for the assay of penicillin[2]. Cylinders for containing the liquids to be assayed were placed on the surface of the agar in the usual way.



The cylinders were filled with the solutions to be tested, using a 1 : 250,000 solution of pure biotin as a standard and saline as a control, and the plates were incubated at 37° C. Although growth proceeded slowly over the whole surface of the agar, it was very much more prolific around the cylinders containing the standard solution of biotin or other liquids in which biotin was known to be present. This effect is clearly shown in the accompanying photograph.

It was found that results were fairly reproducible and that it was possible to plot a graph relating ring-size to biotin concentration which gave consistent results over a considerable range when used to determine the strength of other solutions. Alternatively, solutions could be assayed by comparing them on the same plate with known dilutions of a standard biotin solution.

There seems to be no reason why this method of assay should not be generally applied and give results comparable with those obtained in the assay of antibacterial substances by the normal plate-and-cylinder method. Experience suggests that the main difficulties which may be encountered are as follows :

(1) Unless the micro-organism chosen is one the response of which to the various known growth-factors has been closely studied, there may be doubt as to whether the observed promotion of growth is, in fact, specifically due to the growth-factor under investigation. Certain derivatives of biotin, for example, possess the same kind of physiological activity as biotin itself. This danger is, of course, most serious when highly complex substances of largely unknown composition are being assayed.

(2) The edges of the 'rings of exhibition' are not always sharply defined. Among the factors which, by experience and by analogy with the assay of antibacterial substances, would be expected to influence this are the nature of the test organism, the thickness with which the agar is seeded, and the concentration of the substance being assayed.

(3) It may sometimes be difficult to prepare a culture medium which requires only the addition of a single growth-promoting substance to determine whether growth is negligible or prolific.

This work was done while I was a Nuffield Research Student at the Sir William Dunn School of Pathology, Oxford.

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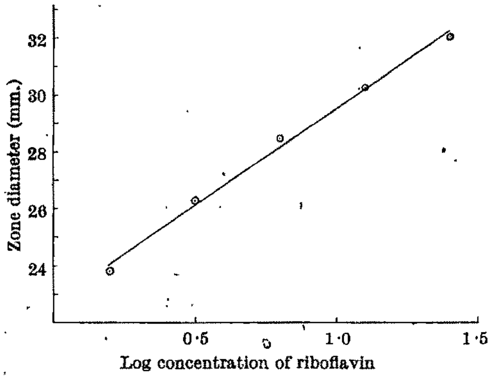
Royal Institution, Albemarle Street,
London, W.1.

[1] Bacharach, A. L., *Nature*, 160, 640 (1947).

[2] Chain, E., Florey, H. W., Gardner, A. D., Heatley, N. G., Jennings, M. A., Orr-Ewing, J., and Sanders, A. G., *Lancet*, ii, 226 (1940).

THE Petri dish technique for the microbiological assay of vitamins described by Mr. Bacharach[1] has been used in these laboratories for demonstration purposes since September 1946, and the disadvantage to which he refers, namely, the lack of sensitivity, can be fully confirmed.

The general technique we have employed follows closely that used for the cup-plate assay of penicillin. The suspension for inoculum is prepared exactly as for a riboflavin assay by the usual method, except that the cells are suspended in the original volume of saline and used without further dilution. To 12·5 ml. of the melted medium at 45° C., 1 ml. of this strong suspension is added, and the flasks are held at 45° C. for 10 min. before pouring the plates. If a weaker inoculum is used, or the heating at 45° C. is omitted, the zones are less sharp and, in consequence, more difficult to read. Five cups are cut in each plate, and previously sterilized solutions of riboflavin containing 25, 12·5, 6·25, 3·125 and 1·56 μgm./ml. are distributed into the cups in approximately 0·05 ml. amounts. We can confirm Mr. Bacharach's observation that the zone diameter is proportional to the logarithm of the dose, as exemplified on the accompanying graph.



If further research makes it possible so to increase the sensitivity that the technique is suitable for the routine assay of riboflavin in foodstuffs, it will be interesting to examine the influence, on the sizes of the zones, of non-specific growth stimulants which are a source of difficulty with the assay of riboflavin as at present carried out. Since, in the Petri dish assay, the *diffusion* of the vitamin is a factor determining the magnitude of the response, it may be that stimulants of higher molecular weights than the vitamin under test will be without effect on an assay of this type.

Nevertheless the method is even now not without practical applications, as, for example, in demonstrating the qualitative and to some extent the quantitative differences between organisms with regard to their abilities to synthesize a given growth-factor. Instead of cutting cups in the bulk-inoculated, solidified riboflavin-free medium, the surface may be seeded in three or four places with suspensions of bacteria or mould-spores. Those organisms capable of synthesizing the vitamin may then be readily detected by the appearance of circular 'zones of exhibition', the diameter of the latter serving as an index of the amount synthesized. It is suggested that this might be an expeditious way of conducting a survey of organisms in order to differentiate them in this respect.

An obvious point of difficulty is the possibility of widely different requirements of the 'indicating' bacterium and the organisms under test, not only nutritionally but also with regard to pH and temperature. We have so far used only the usual basal media developed for microbiological assay (solidified with 1·5 per cent agar) and *Lactobacillus helveticus* and *Lactobacillus arabinosus* for the detection of riboflavin and nicotinic acid respectively. Such media permit growth of, and vitamin synthesis by, many moulds at 37° C., although they are scarcely likely to be optimal for this purpose. The ideal to be aimed at would be a medium and conditions of growth as nearly as possible optimal for both the indicating and the test organisms.

Pontecorvo[2] has described a technique, in some respects similar, for the identification of the nutritional requirements of a mutant, based on the addition of crystals of nutrilites to plates of 'minimal' medium inoculated with the mutant strain. The procedure outlined above, however, serves a different purpose, namely, the investigation of the synthesizing abilities of a range of organisms with respect to a given nutrilite.

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[1] *Nature*, **160**, 640 (1947).

[2] *Proc. Nut. Soc.*, **5**, 182 (1947).

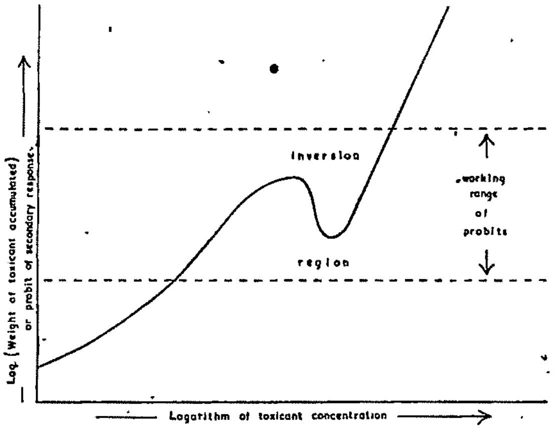
Primary and Secondary Responses in Biological Assay

IT has already been shown that the irritant and paralysing effects of the pyrethrins are of material influence in determining the dose of insecticides accumulated by flying insects in pyrethrum-bearing sprays[1].

The influence of such primary responses on the dose of toxicant accumulated, and thus on the resulting secondary response (usually estimated as proportionate mortality), is now widely accepted as of importance in this system, and the purpose of this communication is to suggest that similar factors may be of more common occurrence in biological assay systems than is generally appreciated, and in particular to indicate their probable influence in fungicidal assay.

Dimond *et al.*[2] reported that tetramethyl thiuram disulphide tested as a fungicide against *Macrosporium sarcinæforme* yields a dosage-response curve exhibiting a maximum and a minimum. They offered an explanation, based on the spontaneous dissociation of the fungicide, which Finney[3] has shown could not account for the observed action without the additional hypothesis of drug antagonism between the two states of the molecule. Montgomery and Shaw[4] also criticized the dissociation hypothesis on physico-chemical grounds, and found similar effects, which they termed 'inversion', in the dosage-response curves for five thiuram and five dithiocarbamate derivatives tested against *Venturia inæqualis.* Parker-Rhodes[5], applying the theory of variability to both types of fungicide, demonstrated that absorption is necessarily preceded by reaction with the spore secretion.

The spray pick-up/toxicant concentration curves, previously published for the flying insect system[1] may be converted into log (toxicant pick-up)/log (toxicant concentration) curves of the type shown



THEORETICAL FORM OF DOSAGE RESPONSE CURVE IN SYSTEMS WHERE PRIMARY RESPONSES INFLUENCE THE DOSE ACCUMULATED BY THE RESPONDING POPULATION

in the diagram. It has been pointed out to me by A. Stringer that such curves are quite general in that they can be derived empirically for systems where the toxicant pick-up, and hence the probit secondary response, is not a monotonic function of the applied dosage because of the influence of primary responses.

The probit response and log (toxicant pick-up) are interchangeable as ordinates, using an arbitrary scale ratio, when the probit of an observed response is proportional to the log (effective dose) expected to produce that response.

Since the working range of secondary response probits covers the region of the probit response/applied dosage curve most influenced by the primary responses, the relevant portion of the curve shown here is analogous to that obtained by Dimond *et al.*, whose data are fitted as well by a curve of this form as by that of the authors.

Wain and Wilkinson[6] observed that suspensions of spores dissolve about twice as much copper from Bordeaux mixture as filtrates from the same number of spores, and that the free secretion present in the former does not increase materially on standing in the absence of the fungicide. These facts indicate that further secretion takes place as a primary response to the fungicide, and the application of this general hypothesis to the observations of Parker-Rhodes completes the analogy outlined above.

While this interpretation does not necessarily conflict with the general construction for this system by Finney[3], it does suggest that the postulate of linearity for the regression lines outside the inversion region, made on statistical grounds, may be misleading. No reasonable transformation will consistently reduce the lower dosage end to linearity, and the high-dosage end is linear because the rate of inactivation of the test organism tends to become independent of the applied toxicant concentration. Interpretation of the curve in terms of tolerance distribution is therefore meaningless.

The statistical treatment of data from such systems is being developed; but it may be noted here that probit analysis assumes the linearity of the transformed response with respect to some monotonic function of the toxicant concentration. Such methods, applied to the systems under discussion, will give rise to estimates of relative potency and heterogeneity which are invalid and will frequently be misleading.

I am indebted to Dr. A. B. P. Page for his interest in and discussion of this note.

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London, S.W.7.
Sept. 20.

[1] Page, A. B. P., Stringer, A., and Blackith, R. E., *Nature*, 157, 80 (1946).

[2] Dimond, A. E., Horsfall, J. G., Heuberger, J. W., and Stoddard, E. M., Bull. Conn. Agric. Expt. Sta. No. 451 (1941).

[3] Finney, D. J., "Probit Analysis" (Camb. Univ. Press, 1947).

[4] Montgomery, H. B. S., and Shaw, H., *Nature*, 151, 333 (1943).

[5] Parker-Rhodes, A. F., *Ann. Appl. Biol.*, 30, 170 (1943).

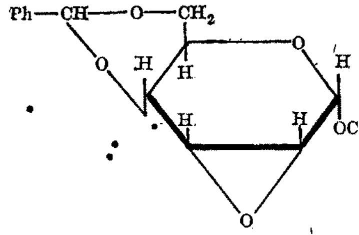
[6] Wain, R. L., and Wilkinson, E. H., *Ann. Appl. Biol.*, 30, 379 (1943).

R290

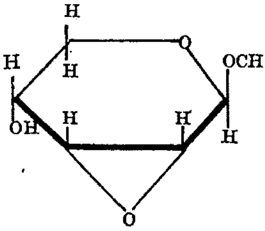
Conversion of *D*-Arabinose into 2-Deoxy *D*-Ribose and 3-Deoxy *D*-Xylose

2-DEOXY *D*-ribose is of considerable importance since it is the carbohydrate constituent of the deoxyribonucleic acid of cell nucleal material, and we have been interested in its preparation for structural and synthetic studies. Although we have made some improvements in the standard method of its synthesis from *D*-arabinal, we are exploring alternative routes. A possible method resulted from the work of Newth, Overend and Wiggins[1] on the ring scission of 2 : 3-anhydro 4 : 6-benzylidene α-methyl alloside (I) with halogen acids, because hydrobromic acid in aqueous acetone solution effected scission of the anhydro ring in this substance to give 2-bromo α-methyl altroside (one part) and 3-bromo α-methyl glucoside (4 parts). On this finding it was clear that a similar ring scission of 2 : 3-anhydro β-methyl *D*-riboside (II) would give rise to 2-bromo β-methyl *D*-arabinoside (III) and 3-bromo β-methyl *D*-xyloside (IV), although it is our experience[2] that, as yet, it would be inexpedient to predict the relative proportions of the isomers that could be produced in this reaction. The halogen sugars (III) and (IV) on reductive dehalogenation would afford 2-deoxy β-methyl *D*-riboside (arabinoside) and 3-deoxy β-methyl *D*-riboside (xyloside). Thus if 2-bromo β-methyl *D*-arabinoside (III) was the main product of the ring-opening of 2 : 3-anhydro β-methyl *D*-riboside, this procedure would furnish a new method of preparation of 2-deoxy β-methyl *D*-riboside and of 2-deoxy *D*-ribose itself. We have found, however, that (III) was only the minor constituent of the ring-scission products, 3-bromo β-methyl *D*-xyloside being the main product. We have, however, obtained 2-deoxy β-methyl *D*-riboside and 2-deoxy *D*-ribose by this procedure, although the method clearly has no preparative value.

2-Tosyl 3 : 4-monoacetone β-methyl *D*-arabinoside (since described by Honeyman[3]) was converted into 2-tosyl β-methyl *D*-arabinoside, which gave on mild alkaline hydrolysis crystalline 2 : 3 anhydro β-methyl *D*-riboside (II), m.p. 45° $[\alpha]_D^{22} - 35{\cdot}8$ in chloroform (*c.* 0·6) (cf. ref. 3). Treatment of the anhydro derivative (II) with hydrobromic acid in aqueous acetone gave two halogenated sugar derivatives ; a crystalline substance, 3-bromo β-methyl *D*-xyloside (nine parts) (IV), m.p. 95° $[\alpha]_D^{18} - 16{\cdot}4$ in methyl alcohol (*c.* 0·36) and a liquid which was mainly 2-bromo β-methyl *D*-arabinoside (III) (one part). The latter substance on hydrogenation in the presence of Raney nickel and calcium hydroxide was converted into 2-deoxy β-methyl *D*-riboside, which gave a strongly positive Dische diphenylamine test[4] for 2-deoxy ribose. The glycoside, on hydrolysis with *N*/100 acetic acid, was



I



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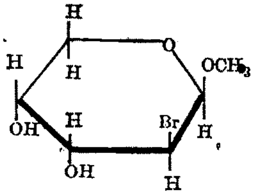
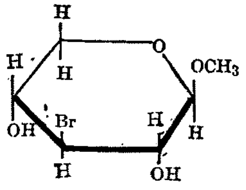


III



IV

converted into the free sugar 2-deoxy *D*-ribose, which was isolated in the form of the crystalline anilide. This was identical with a specimen obtained from authentic 2-deoxy *D*-ribose[5].

The designation of (IV) as 3-bromo β-methyl *D*-xyloside rests only on theoretical considerations. Some additional evidence comes, however, from the fact that on hydrogenation IV gave a deoxy β-methyl pentoside (3-deoxy β-methyl *D*-xyloside), b.p. 100/0·2 mm. (characterized as the crystalline bis 3 : 5-dinitrobenzoate, m.p. 157°), which gives a completely negative Dische test, a test which on the basis of the work of Deriaz, Stacey, Teece and Wiggins[5] is given only by 2-deoxy pentoses or readily hydrolysable derivatives thereof.

This work and further structural studies will be published in detail elsewhere.

Note. After the completion of this investigation it came to our notice that the synthesis of 3-deoxy *L*-xylose from 2 : 3 anhydro β-methyl *L*-riboside has been achieved in Prof. A. R. Todd's laboratory by different methods[6].

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Sept. 4.

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Scattering of D—D Neutrons by Deuterium

Massey and Buckingham[1,5] have pointed out that a study of the collisions of neutrons with deuterons can be expected to throw light on the nature of the nucleon forces even when the neutron energy is comparatively low. In a recent survey[1] of experimental data, they conclude that the evidence is in favour of exchange forces. It seems worth while, therefore, to report some experiments which give support to ordinary, rather than exchange, forces.

The tracks of 1,500 recoils from D—D neutrons of 2·53 MeV. energy have been photographed in a cloud chamber filled with heavy methane to an (expanded) pressure of 1·1 atmosphere, and those tracks were measured which started from points from which no track could pass out of the illuminated region.

Selection of tracks for a statistical count of number *vs.* angle was made by the method of Dee and Gilbert[2], in which only those tracks are counted the length and angle of projection of which are close to satisfying the theoretical range – angle relation. In this work the allowed spread in range was greater, because neutrons could enter the chamber during, as well as after, the expansion, though the observed results indicate that most entered after.

The numbers of tracks in equal intervals of cos 2φ, where φ is the angle of projection of the deuteron in room co-ordinates, were counted and plotted against the corresponding values of $(180 - 2\varphi) = \theta$ to give the number of neutrons scattered per unit solid angle in the direction θ, measured in centre-of-gravity co-ordinates (see table). A few long tracks attributed to recoil protons were observed and a correction was made at the larger recoil angles where allowed bands for protons and deuterons would overlap. The mean number of long tracks in the first three intervals was taken as the number to be expected in each interval, and the correction was obtained by multiplying this number, 10, by the ratio of the overlap area to the allowed deuteron area in each interval. A random track correction, for tracks produced by neutrons not coming directly from the source but yet lying within the allowed length – angle band, was made by subtracting a number proportional to the number of tracks observed just outside that band. The results are shown in the accompanying table.

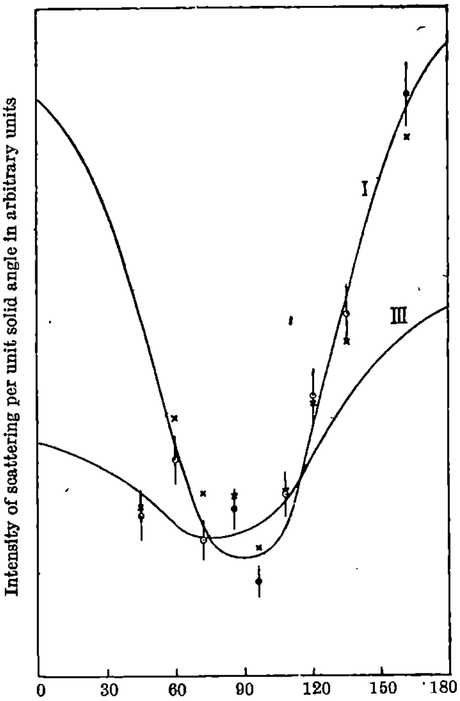
Interval	Cos 2φ	No. of tracks	Proton correction	Random correction	Corrected number	'Standard deviation'
1	1 –0·8	217	0	26	191	11·7
2	0·8–0·6	134	0	15	119	10·0
3	0·6–0·4	109	0	17	92	9·0
4	0·4–0·2	74	1	13	60	7·4
5	0·2–0·0	51	2	18	31	5·5
6	0·0– −0·2	72	3	14	55	7·1
7	−0·2– −0·4	74	5	24	45	6·5
8	−0·4– −0·6	103	5	27	71	8
9	−0·6– −0·8	68	6	9	53	7

The 'standard deviation' of the corrected numbers given in the table was calculated from the formula $\sigma = Npq$, where N is the total number of tracks, p is the probability that a track will lie in a particular angle interval and q is $1 - p$, for a uniform binomial distribution. In this case p is different for each interval, and the best estimate of p was taken to be the ratio of the number of tracks observed in an interval to the total number, so that the formula became

$$\sigma_i = n^{1/2}\left(1 - \frac{n_i}{N}\right)^{1/2} \qquad i = 1, 2 \ldots 9.$$

The random track correction is rather large and makes so great a difference to the distribution obtained—ratio of interval 1 to interval 5 is about 4 : 1 before correction and about 6 : 1 after—that the precision of the determination must be considered to be low. The track-lengths in interval 9 were less than 5 mm. and some could have been missed. The value given may be taken as a lower limit.

The distribution found shows qualitative agreement with that found by Kruger, Shoupp, Watson and Stallmann[3] and Coon and Barschall[4], but indicates a greater change between $\theta = 180°$ and $\theta = 90°$ than either, and a less sharp maximum in the forward direction than found by Coon and Barschall.



THEORETICAL DISTRIBUTION CURVES I (ORDINARY FORCES) AND III (EXCHANGE FORCES) CALCULATED BY BUCKINGHAM AND MASSEY

—×—, observed uncorrected points, adjusted to agree with curve I near 120°.

—⊙—, observed points after corrections have been applied, adjusted to agree with curve I near 120°, and showing twice 'standard deviation'.

The distributions to be expected on the assumptions of ordinary and exchange forces have been calculated by Buckingham and Massey[5] and are reproduced in the accompanying graph. Our data—ignoring point 9—fit the curve for ordinary forces very closely. Experiments are being continued with lower gas pressures in the attempt to study the distribution at small angles with greater precision.

We wish to thank Prof. L. H. Martin for continual advice and encouragement. The work was made possible by a grant from the Council for Scientific and Industrial Research.

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[1] Massey and Buckingham, *Phys. Rev.*, 71 (April 15, 1947).

[2] Dee and Gilbert, *Proc. Roy. Soc.*, A, 163, 265 (1937).

[3] Kruger, Shoupp, Watson and Stallmann, *Phys. Rev.*, 53, 1014 (1938).

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Treatment of Glass and Steatite Ceramic with Quaternary Ammonium Compounds for the Improvement of Electrical Insulation Resistance

THE adsorption and condensation of water on the surface of insulators was responsible for the failure of much electrical equipment under service conditions in the tropics. From the literature of flotation[1], it was known that the adsorption of a unimolecular film of an amphipathic (polar – non-polar) compound gives to solid surfaces a paraffin-like character, rendering them less readily wetted by water. Some typical flotation reagents were therefore applied to glass and steatite ceramic surfaces in an endeavour to improve their electrical insulation resistances under moist conditions. As might be anticipated from the work of Wark[2], the quaternary ammonium compounds were effective. The accompanying table shows the results obtained with various substituent radicals for glass microscope slides and steatite terminal bushings. These were cleaned with chromic acid, immersed for about one second in an aqueous solution of the quaternary ammonium salt, and then washed thoroughly in distilled water.

Quaternary ammonium salt (10^{-4} *M* solutions used for treatment except where otherwise indicated)	Insulation resistance (megohms) measured *in situ* after 2 days at 98–100 per cent relative humidity and 30° C.		Contact angle with water for the treated glass
	Glass microscope slides (double contacts 1 in. in length, 1 in. apart)	Steatite terminal bushings (min. leakage path, 0·3 in.)	
Control samples (cleaned with chromic acid)	5×10^2	7×10^2	0°
Decyl-trimethylammonium bromide	4×10^2	4×10^3	0°
Dodecyl- ,, ,,	4×10^2	1×10^4	0°
Tetradecyl- ,, ,,	7×10^2	3×10^4	40°
Cetyl- ,, ,,	5×10^4	7×10^4	55°
Octadecyl- ,, ,,	2×10^5	1×10^5	54°
Ceryl- ,, ,,	1×10^5	4×10^4	55°
Cholestanyl- ,, ,, (10^{-5} *M*)	4×10^5	4×10^5	60°

The surface of glass in contact with an aqueous medium is negatively charged[3] and therefore attracts cations present in the medium. If amphipathic cations are present, they become oriented so that the polar groups are turned towards the glass surface[4,5]. Whereas hydrogen ions and metal ions at the surface are continuously exchanged with cations in the bulk of the solution, the diffusion of amphipathic cations from the surface back into the solution is hindered as a result of the cohesion of the non-polar groups. If this cohesion is sufficiently great, it leads to the formation of a stable monolayer of quaternary ammonium ions in which the outward orientation of the non-polar groups reduces the attraction of the surface for water. The results given in the table indicate that, for the treatment of glass with alkyl-trimethylammonium bromides under the conditions described, alkyl substituents of chain-lengths greater than fourteen carbon atoms give sufficient cohesion for the formation of stable adsorbed layers.

The replacement of the alkyl substituent by a cholestanyl group gives slightly better results, probably because the minimum area subtended by the latter at a glass surface is more nearly equal to that of the trimethylammonium head-group.

A more complete report on these experiments will be given elsewhere.

We are indebted to Dr. I. W. Wark, chief of the Division of Industrial Chemistry, and to Mr. K. L. Sutherland, Division of Industrial Chemistry, for the original suggestion regarding the use of cationic surface-active substances for the treatment of glass and steatite, and for subsequent helpful suggestions. Thanks are also due to Dr. D. M. Myers, chief of the Division of Electrotechnology, for his continued interest in, and encouragement of, this work.

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Oct. 16.

[1] See, for example, Wark, "Principles of Flotation" (Australasian Inst. Min. and Met. Eng., Melbourne, 1938).

[2] Wark, I. W., *J. Phys. Chem.*, 40, 661 (1936).

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Abnormalities in the *F*-Region of the Ionosphere at Calcutta

IONOSPHERIC observations carried out for more than two decades have clearly established the existence of correlation between the variation of electron contents of the different ionospheric layers and solar activity. It has been found that there is a general increase in the ionization density during the period of maximum sunspot numbers. This general increase, as expected, has also been noticed during the present phase of maximum solar activity in the routine ionospheric observations made at the Wireless Laboratory of the University College of Science, Calcutta. Besides this general increase, however, certain peculiar features of the diurnal variation of the ionization density have also been observed.

Figs. 1–3 depict the monthly mean diurnal variation of Region *F* ionization for the months of January 1946 and January 1947 for Madras (lat. 13° N., long. 80° 13′ E.), Calcutta (lat. 22° 33′ N., long. 88° 21′ E.), and Delhi (lat. 28° 35′ N., long. 77° 5′ E.) respectively. (For Calcutta the curve for 1945 is also given. The curves for Delhi and Madras are drawn from data kindly supplied by All India Radio.) It is at once noticed that there is a general increase of ionization at all the stations. The stations Calcutta and Madras, however, show another peculiar feature which is not noticeable at Delhi or at Slough (Fig. 4). A comparison of Figs. 3 and 4 shows that the general trend of diurnal variation for January 1947 at the two stations is the same, and is similar to that for the previous year at Delhi. The trend of variation for the same month for Calcutta and Madras is, however, markedly different. The ionization begins to rise sharply at daybreak and attains nearly the maximum value at about 11 a.m. In the case of normal solar activity, this value is maintained during the whole day and the decrease in ionization begins nearly at sunset. But for the month under consideration (January 1947, phase of maximum solar activity) the peak value is maintained more or less constant not only during the whole day but even up to the evening hours, 9–10 p.m. It is remarkable that there should be such marked difference in the character of ionization variation for two stations, Calcutta and Delhi, situated at not very different geographic latitudes. The difference in the magnetic dip values at the two stations is, however, comparatively larger, and one is tempted to associate the characteristic difference in ionization variation of the two stations as due to some geomagnetic control of the ionosphere[1], to the existence of which attention was first directed by Appleton[2].

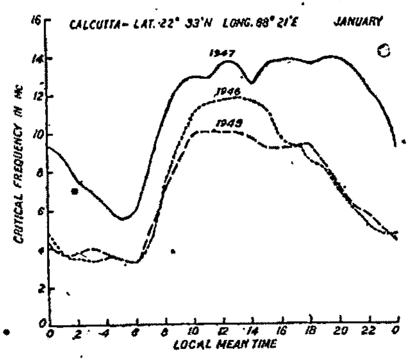

Fig. 1

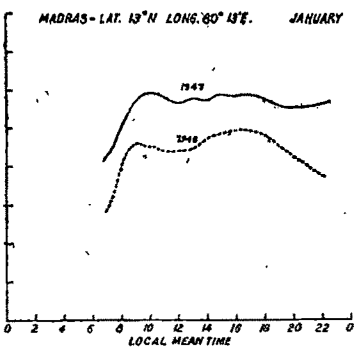

Fig. 2

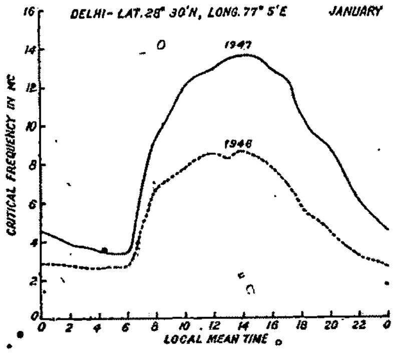

Fig. 3

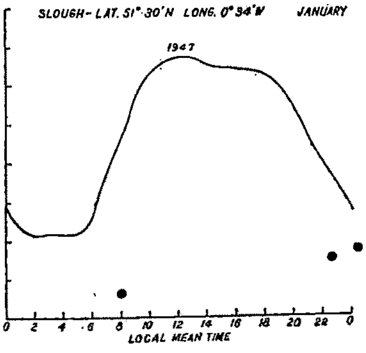

Fig. 4

The investigations described above form part of a programme of research of the Radio Research Committee of the Council of Scientific and Industrial Research, India. We thank the Director of Scientific and Industrial Research for permission to publish the note.

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Measurement of High Permittivity Values at Centimetre Wave-lengths

CERAMIC materials with permittivity values up to several thousand are now available. The measurement of permittivities of this order provides little difficulty at normal radio frequencies, but measurements have not been made, so far as I am aware, at frequencies of the order of 10^{10} c./s. ($\lambda = 3$ cm.)[1], in which frequency region the materials are likely to find increasing application. For this purpose the experimental technique illustrated in Fig. 1 has been developed. A specimen of the material is placed in a coaxial line or wave-guide (completely filling the dielectric space) and is followed by a non-reflecting termination. The energy transmitted through the specimen is measured at *A*, for constant incident energy, as the wave-length of the energy source is varied.

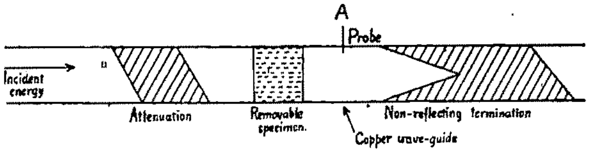

Fig. 1

Two sets of experimental results obtained in an H_{01} wave-guide system over the frequency range $8\cdot1 \times 10^9 - 10^{10}$ c./s. ($\lambda = 3\cdot7 - 3\cdot0$ cm.) are shown by the points in Fig. 2. The results marked ● and O relate to specimens of permittivity, as measured at $1\cdot5 \times 10^6$ c./s. of 25·8 (zinc orthotitanate) and 91·2 (rutile), and of thicknesses 1·810 and 2·140 cm., respectively. The curves (*a*) and (*b*) show the variations of transmitted energy determined theoretically for assumed permittivity values of 26·0 and 91·0. It will be seen that the peaks become sharper and move closer together, for a given length of specimen, as the permittivity increases, and that in both cases they are sufficiently sharp to afford an accurate permittivity evaluation from the experimental results. The peaks, in fact, disappear in the limiting case of infinite permittivity, since it may be shown that

$$\frac{\text{width of peak}}{\text{peak separation}} \sim \frac{1}{\sqrt{\varepsilon}} \quad \text{for large } \varepsilon.$$

The occurrence of peaks necessitates great accuracy in the preparation of the faces of the specimens, and causes considerable experimental difficulty in the usual methods of permittivity measurement.

Dielectric loss in the specimen causes a reduction in height of the peaks, but this effect is apparently not significant in the results shown.

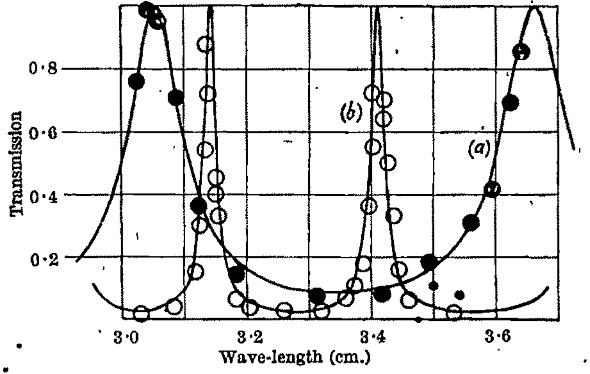

Fig. 2. EFFECT OF PERMITTIVITY ON SHARPNESS OF PEAKS
Curve *a*: $\varepsilon = 26\cdot0$; $b = 1\cdot81$. Curve *b*: $\varepsilon = 91\cdot0$; $b = 2\cdot14$

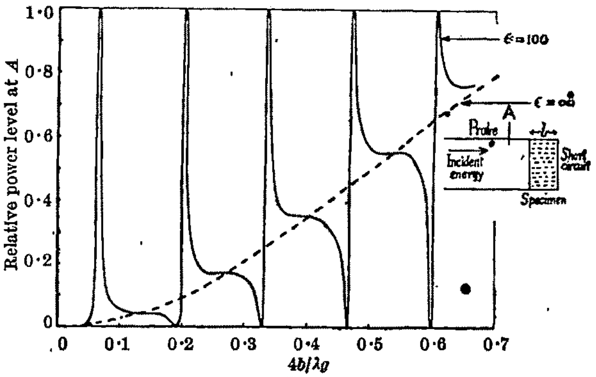

Fig. 3

The behaviour approaches that of a perfect metal as ε increases. This is demonstrated more clearly in the variation of the power-level at a fixed point in front of a specimen, when backed by a short circuit, as the length of the specimen, *b*, or the wave-length of the incident energy is varied. The calculated effect with this arrangement and a specimen of permittivity 100 is shown in Fig. 3 as a function of $4b/\lambda_g$, where λ_g is the wave-length in the air-filled guide. The dotted curve shows the behaviour for a metal specimen (that is, the limiting case as $\varepsilon \to \infty$).

The curves of Fig. 2 are reminiscent of the Fabry-Perot interference fringes, and, in fact, both are due to the presence of a pair of parallel, highly reflecting surfaces. The analogy between the effect with light and that described here with centimetre waves is very close.

The arrangement could be used as a highly selective filter, the response being of normal *Q* curve form with the '*Q* value' proportional to the permittivity.

Experiments are in progress on materials with much higher permittivities than those referred to in Fig. 2, and the work will be reported fully when these are completed.

I am indebted to Dr. D. F. Rushman, of the Mullard Radio Valve Co., for providing suitable ceramic materials.

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[1] A hint is given of measurements at 3×10^9 c./s. in a paper by von Hippel, *Ind. Eng. Chem.* (Nov. 1946).

Photo-electric Counting of Individual Microscopic Plant and Animal Cells

A PHOTO-ELECTRIC apparatus for counting individual microscopic cells in fluid suspension has been constructed in this laboratory. A sufficiently large signal-to-noise ratio from a single cell or a part of it has been obtained by the use of a specially designed dark-field system and an *RCA 931-A* multiplier phototube. The phototube is followed by an amplifier which operates a mechanical counter. As it was not possible to arrange the cells in one line in a capillary space, a scanning method using an ordinary counting chamber was evolved.

The optical arrangements are shown in Fig. 1. A circular aperture, *A*, is projected by a reversed microscope objective, O_D, in such a way that the diminished image, which has about the same size as a cell, is

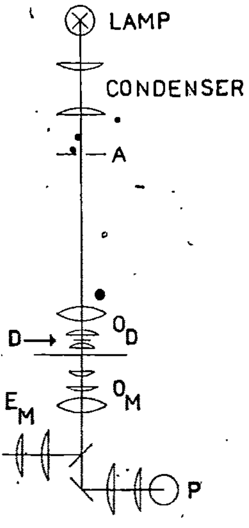

Fig. 1

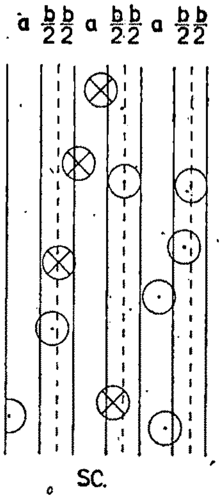

Fig. 2

focused on the plane where the cells are situated. By means of an opaque circular diaphragm, *D*, placed behind the front lens and covering the central part of the lens surface, the objective, O_D, also acts as a dark-field condenser. By these means the projected image of the circular aperture, *A*, is invisible and latent so long as the field is optically homogeneous. When a cell or part of it is inside the effective area of the latent spot, the light is reflected and refracted so that light from the latent spot reaches the objective of the microscope, O . The light emerging from this objective is divided by means of a double ocular into two parts, one part falling into the phototube, *P*, and the other falling into the ocular, E_M, through which the object plane may be observed.

When the counting chamber with the cells is moved, the latent spot meets successively cells or parts of them which now become luminous and are recorded by the phototube-amplifier-counter system. The width of the scanning area, which must be known in order to calculate the scanned volume, is derived in the following manner. Fig. 2 shows schematically the cells of an arbitrary field in the counting chamber. *a* is the effective diameter of the latent spot and *b* the median value of the cell diameter. The area of the counting chamber is divided by lines parallel to the scanning direction, so that the distance between two adjacent dotted lines is $\frac{1}{2}b + a + \frac{1}{2}b$. This distance is the scanning width. Those cells are counted (crossed in Fig. 2) the centres of which are inside the scanning width (actual scanning track marked *SC*). When the centre of a cell is situated just inside the scanning width, this cell is not counted if the diameter is so much smaller than the median value of the cell diameter which determines the position of the dotted line that the edge of the cell does not reach the effective area of the latent spot. In the same way, a cell which is situated just outside the scanning width is counted if the diameter is so much larger than the median value of the cell diameter that the edge of the cell reaches the effective area of the latent spot. However, the effects of these two groups of cells cancel each other if a large number of cells are counted, because there are as many cells of a diameter greater than the median value as there are cells of a diameter smaller than that value, according to the definition of the median value.

In order to get correct results, it is necessary to have the cells uniformly distributed and the cell suspension free from contamination with foreign particles that can be recorded by the electronic system. These two conditions will decide whether a certain kind of cell can be satisfactorily counted or not by the method described. The method has been applied to the counting of human erythrocytes and yeast cells. The results have been compared with those of the ordinary counting chamber method, and the two methods have been found to agree rather well.

A full account of this work will be published in *Upsala Läkareförenings Förhandlingar*.

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An Asymptotic Solution of the Fundamental Equation of the Statistical Atom Theory

THE problem of atoms and ions with spherical symmetry as well as the problem of metals and ionic crystals seems to be dealt with quite satisfactorily by the Thomas–Fermi's statistical method[1], with its modifications due to Dirac[2], Jensen[3] and Gombás[4] respectively. But the fundamental equation of the modified theory having no solution in closed form, that is, in terms of elementary functions, one must apply for its solution, in each particular case, rather lengthy numerical methods. To avoid these difficulties, we propose an asymptotic method of solution which may be applied successfully in many cases.

The fundamental equation may be written in the following form[4]:

$$y'' = x\{(y/x)^{1/2} + \beta\}^3, \tag{1}$$

and is to be solved under the conditions

$$y(0) = 1 \text{ and } y(x_0) - x_0.y(x_0) = (Z-N)/Z, \tag{2}$$

where Z, N and x_0 denote respectively the atomic number, the number of the electrons and the atomic radius; β depends also on Z.

In the particular case $\beta = 0$, (1) reduces to the original equation of Fermi, which has been solved by Fermi[1], Sommerfeld[5] and Miranda[6].

In a previous paper we have attempted to solve (1) by the method of perturbations. By considering β as a perturbation parameter, we have sought the solution in the form of a power series

$$y = y_0 + \beta y_1 + \beta_0 y_2 + \ldots,$$

where y_0 is the solution of the Fermi equation. For $y_1, y_2, \ldots$ we have obtained a recursive system of linear differential equation, which may be solved quite easily. The only difficulty which arises is that the resulting series does not converge very rapidly, and one has to calculate, therefore, several terms.

We can avoid this difficulty by making use of the following method. In case $\beta = 0$, (1) has the particular solution

$$y = 144/x^3. \tag{3}$$

In case $\beta \neq 0$ we may seek, therefore, the solution in the form

$$y = 144/x^3.v(x). \tag{4}$$

For $v(x)$ we obtain the equation

$$\frac{1}{12}\,x^2v'' - \frac{1}{2}\,xv' + v = \left\{v^{1/2} + \frac{\beta}{12}\,x^2\right\}^3.$$

For $v(x) = w(x^2) = w(t)$ we have then

$$\frac{1}{3}\,t^2w'' - \frac{5}{6}\,tw' + w = \left\{w^{1/3} + \frac{\beta}{12}\,t\right\}^3. \tag{5}$$

Putting $w(t) = 1 + c_1t + c_2t^2 + \ldots$ we obtain, by comparing coefficients :

$$c_1 = -\frac{3}{16}\beta,\ c_2 = \frac{79}{9216}\beta^2,\ c_3 = \frac{1584}{63700992}\beta^3,\ \ldots$$

Thus we have the solution

$$y = \frac{144}{x}\,(1 + c_1x^2 + c_2x^4 + c_3x^6 + \ldots), \tag{6}$$

and the series converges rapidly, for it is majorized by the geometrical series with the quotient 10^{-3}. We may stop, for example, at the third term.

The shape of our curve is the same as that calculated by Jensen's numerical method. Our solution does not satisfy the condition $y(0) = 1$. We can avoid the difficulty by using an idea of Sommerfeld[5], namely, we put

$$y \sim \frac{144}{\{1 + (x/a)^2\}^{3/2}\,a^3}\,\{1 + c_1a^2\,\{1 + (x/a)^2\} + \ldots + c_3a^6\,\{1 + (x/a)^2\}^3\}. \tag{7}$$

This function is asymptotically equal to (6), and the parameter a may be chosen such that the condition $y(0) = 1$ be satisfied.

This asymptotic solution, as well as Sommerfeld's, yields a very good approximation, especially in the exterior parts of the atoms.

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Brightness of the New Moon

I HAVE been unable to find in the literature any data for the brightness of the new moon. This can be calculated in two independent ways.

(1) The earth receives from the sun at noon about 10^5 lux[1]. The albedo value of the earth is about 45 per cent[2]. The brightness of the earth, as seen from a great distance, is therefore $4 \cdot 5 \times 10^4$ apostilb (equivalent metre candles) or $1 \cdot 43 \times 10^4$ c./m.^{2}. The cross-section of the earth is $1 \cdot 27 \times 10^8$ km.^{2}, or $1 \cdot 27 \times 10^{14}$ m.^{2}. The candle-power of 'full earth' is therefore $1 \cdot 82 \times 10^{18}$ c. The distance earth to moon being $3 \cdot 84 \times 10^8$ m., the latter receives from the earth 12·3 lux. The illumination on the earth at full moon being only 0·2 lux[1], the illumination-level on the moon at 'full earth' is consequently about sixty times better.

The albedo value of the moon is about 7·3 per cent[3] ; therefore, the brightness of the new moon is 0·86 apostilb or $2 \cdot 7 \times 10^{-5}$ stilb (candle per sq. cm.).

(2) The earth receives at full moon 0·2 lux. The surface of the earth is 15·1 times that of the moon. The earth reflects 6·2 times as well as the moon. Because the sun sheds the same number of lux on the earth as on the surface of the moon, the moon receives at full earth $15 \cdot 1 \times 6 \cdot 2 \times 0 \cdot 2$ lux or 18·7 lux. The moon reflects 7·3 per cent. The brightness of the new moon is thus 1·37 apostilb or $3 \cdot 6 \times 10^{-5}$ stilb.

Both methods lead thus to a value of about 3×10^{-5} stilb or about 1 apostilb. The brightness of full moon is about 0·3 stilb or 10,000 times higher.

With the aid of a formula given by P. J. Bouma[3] the brightness of the new moon can be converted into magnitudes and is equal to − 2·4, whereas for the full moon the magnitude is − 12·5.

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Darkening of Red in Protanopes

THE degree of darkening of the Ilford Spectrum Red colour-filter was measured for twelve protanopes and compared with its brightness for eighteen deuteranopes and several hundred normal subjects. The light transmitted by the red filter from a daylight source was mixed with light transmitted by the Ilford Spectrum Green filter and matched for brightness against light transmitted by the Ilford Spectrum Yellow filter by varying the intensity of the yellow. The mean brightness-level for the eighteen deuteranopes was the same as for normal subjects for all red-green mixtures. For the twelve protanopes the red light was only 15·5 per cent as bright on the average as for normal subjects; but the brightness-level steadily increased as green was added, until it reached the normal level at the pure green end.

At the extreme red end of the scale, the scatter of brightness measurements for the twelve protanopes did not overlap the scatter for the eighteen deuteranopes. No calculations are necessary to show that we are dealing with two groups of subjects which are statistically distinct.

This experiment confirmed the view put forward previously[1] that the Ishihara Test for colour blindness fails to distinguish clearly between protanopes and deuteranopes. Of the eighteen deuteranopes who did the present experiment, fourteen also did the Ishihara Test, which failed to distinguish five of them clearly from protanopes. Similarly, nine of the twelve protanopes also did the Ishihara Test, and it failed to distinguish eight of them unequivocally from deuteranopes, although the evidence for this distinction based on actual measurements of the darkening of the red is very clear indeed. It is interesting that Geddes[2], assuming the validity of the Ishihara Test, makes a separate class ('incompletely red-green blind') for those subjects not decisively placed as protanopes or deuteranopes (that is, scoterythrous or photerythrous) by that test.

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Effects of Calcium Deficiency on Potato Sets in Acid Soils

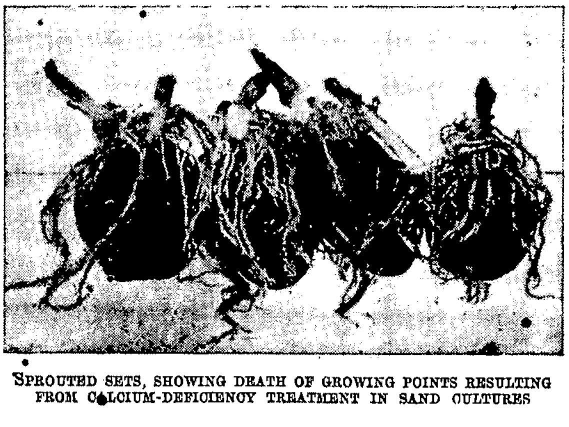
DURING the War, when many poor upland areas and commons in Britain were ploughed up for crop production, potatoes were commonly planted as a first crop in view of their tolerance to acid soil conditions. Many failures, however, were experienced where the soils were very strongly acid, with *p*H values of the order of 4·0, and it was shown that liming was necessary to correct the unfavourable conditions. Plants which survived on these acid soils usually showed pronounced symptoms of calcium deficiency in the haulms, and it was clear that the supply of this element was an important factor in determining success or failure of the crops.

A second point which was noted where the shoots failed to emerge, and which has so far remained unexplained, was that the planted tubers remained firm and apparently failed to make any shoot growth. This phenomenon appeared unusual, since tubers will sprout and soften normally in the absence of any soil, and seemed to suggest an inhibiting effect on shoot-growth, such as might result from toxic substances in the soil, as, for example, excess of hydrogen ions, manganese, aluminium or ammonium.

In the course of sand-culture experiments carried out at Long Ashton, in which the effects of possible soil-acidity factors have been examined on a number of crop plants[1,2], observations have been made on potatoes which indicate that the effect is a direct result of calcium deficiency and is not due to the toxic action of elements present in excess.

Sprouted potato sets, variety Majestic, were grown in sand, with and without calcium, both pots and sand being specially treated to ensure very acute conditions of calcium deficiency where the element was omitted from the nutrient solutions. Differential nitrogen treatments, including nitrate, ammonia and urea, were given, and some cultures also received concentrations of manganese and aluminium sufficiently high to produce severe toxic effects. Two series of parallel nutrient solutions, with *p*H values of 3·5 and 5·5, were used.

In the cultures from which calcium was omitted, the plants failed completely and the shoots did not emerge above the level of the sand. On examining the tubers of these plants, it was found that the sprouts had broken down immediately behind the growing points, after which they died off. The roots, in contrast, appeared fairly normal and the tubers remained as firm as when they were planted (see accompanying illustration).



SPROUTED SETS, SHOWING DEATH OF GROWING POINTS RESULTING FROM CALCIUM-DEFICIENCY TREATMENT IN SAND CULTURES

The affected tubers were afterwards thoroughly washed; then they again sprouted normally in boxes without sand or soil.

In all cultures to which calcium was given the shoots emerged normally, and it was not until a later stage of growth that signs of the other unfavourable treatments were developed.

It thus seems that the hard-tuber condition which occurs in failure-plants on acid soils results from the dying back of the young shoots prior to emergence above the soil, and that this is caused by deficiency of calcium and is not due to the effects of toxic concentrations of elements such as manganese and aluminium.

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University of Bristol. Sept. 13.

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Transmission of a Disease Resembling Virus Yellows through the 'Seed' of Sugar Beet

IN the course of breeding experiments, Mr. B. Cronbie of the Irish Sugar Co. observed in 1946 that three separate field crops of a new family of sugar beet showed in each case approximately 25 per cent of 'yellowed' plants two to three weeks after singling. He stated that the disease resembled typical virus yellows but did not appear to spread to neighbouring beet crops. The parent plants of the family (No. 41) had been selected from good commercial beet crops in a relatively virus-free district, but no information was available as to their freedom or otherwise from yellows. The cross had been made in 1945 in a pollen-proof cage.

On September 7, 1946, the Sugar Co. transmitted to this laboratory field-plants of family 41 showing yellows, together with a small quantity of the residual 'seed' of this family. (The term 'seed' is used in the popular sense and refers to the fruit clusters.) A portion of the latter was sown in 1946, and the remainder in March 1947, in an insect-proof glasshouse, the seedlings being transplanted to 7-in. pots when of appropriate size. No abnormality was noted until the plants were about 10 in. in height, with ten to twelve foliage leaves, when the tips of the two basal leaves of certain plants became tough, then changed from the normal colour to light green and, gradually, through yellow to orange. As a general rule, the yellowing afterwards spread downwards through the leaves, only the areas around the veins remaining green. Similar symptoms meanwhile developed in the next leaves above, the advance of the disease being thus acropetal. No vein-clearing or other abnormality was detected in the young developing foliage. In some of the affected leaves the yellowing remained confined to the tips with, occasionally, an island of affected tissue midway on the lamina; in others it spread irregularly down one side. Frequently a yellow area was clearly demarcated from a green one by a main vein, this being more noticeable as the plants became older. Eventually the chlorotic areas withered and turned brown and the margins of the leaves curled upwards. Of the 143 plants which were raised from seed, 47·5 per cent showed the foregoing symptoms, which, in general, resemble those of virus yellows as described by Watson[1].

In view of repeated statements that beet yellows virus is not transmissible through the seed, and having regard to the proportion of plants affected in the 1946 field crops of family 41, it had been tentatively assumed that the yellowing might be due to a genetical abnormality rather than to virus infection. However, it has now been established that the disease is transmissible from family 41 to healthy plants of sugar beet and spinach (*Spinacia oleracea* L.) by means of the aphis *Myzus persicæ* (Sulz.). Confining the expression of results to those obtained with plants of family 41 raised from seed in the glasshouse, and thus protected from accidental infection, transmission has now been secured in three separate experiments involving sixty-eight sugar beet and thirty-four spinach seedlings as experimental hosts. Of these, 85 per cent and 76 per cent, respectively, developed yellows, the initial symptoms appearing in the lower leaves three to four weeks after inoculation by the insect vector. In parallel experiments, using as sources of infection field plants of commercial beet and mangold varieties showing typical yellows, a disease was obtained which appeared identical with that occurring in family 41. It is reasonable to assume, therefore, that an ordinary yellows virus was present in at least one of the parent plants of family 41, and that it penetrated the seed resulting from the cross. This new family is possibly unique in being thus susceptible to seed infection; but it is important to know that such a type can arise from the crossing of popular commercial sorts.

Incidentally, there appear to be two types of yellows disease occurring in commercial beet crops, for certain plants selected from the latter yielded a virus (or virus mixture) which invariably produced in the experimental hosts a clearing or superficial necrosis of the veins of the young leaves, this initial symptom being followed by acropetal yellowing as already described.

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Possible Significance of Free-living Nematodes in Genetic Research

THE free-living nematodes of the sub-order Rhabditina are widespread in the soil[1] and relatively easily cultivable[2-4] on nutrient agar in the presence of bacteria and have short life-cycles (3–7 days from hatching to sexual maturity), with adult sizes up to 3 mm. in length. They offer, in our estimation, certain very interesting possibilities for the study of basic genetic phenomena—morphological, cytogenetic and physiological.

The particular morphological significance of these forms is related to the phenomenon of cellular constancy, or eutely, which the phylum Nematoda (along with the other aschelminth phyla) exhibits for some or all somatic cells. Therefore, the free-living nematodes, containing at most a few hundred somatic nuclei in cells and syncytia, offer material in which mutations affecting structural components may well be interpretable in terms of cellular morphology, rather than only in terms of organ morphology and gross structure.

The cytology of the sex cells of various species of the genus *Rhabditis* Dujardin (1844) has been studied by a few workers[5-11], and has revealed some very interesting sex-patterns. Diploid numbers of 10–24 chromosomes are known for the females and hermaphrodites of different species; the males, where known, are the heterogametic sex with an *XO* sex-chromosome pattern. Some species are diœcious, usually with approximately equal numbers of males and females; others are composed of hermaphrodites of female form and much rarer males, or no males at all; and a few consist only of thelytokous females. Certain diœcious and many hermaphroditic species use their sperm only to initiate development; the sperm confers its centrosome, but not its nucleus, on the ovum[5,7,8]. In some of these species pairing and reduction of chromosomes nevertheless occurs in meiosis; the diploid number is reconstituted with the failure of a second meiotic division to occur. Sex-determination is apparently effected by an unusual regulation of *X*-chromosome behaviour in meiosis. With simple chromosome numbers these forms should be good cytogenetic material; and with their unusual sex-patterns a considerable versatility in the detection and manipulation of mutations should be possible.

Another important consideration is the possibility of studying physiological mutants. As a result of the work of Kidder and Dewey[12] it is now possible to grow at least one organism of animal nutrition (the ciliate *Tetrahymena geleii*) on an almost completely chemically defined medium (consisting of inorganic salts, glucose, vitamins, amino-acids, purines and pyrimidines, and one unknown growth factor). It seems certain that the near future will see a completely known synthetic medium for this form. Through the use of a chemically defined medium the possibility arises that the new concepts of physiological genetics developed by Beadle[13] may be tested on a differentiating organism. Kidder and Dewey's work suggests a valuable lead for the development of a chemically defined medium for species of *Rhabditis*.

We feel that, with eutely, good cytological features, and convenient sex patterns, together with promising cultural and nutritional aspects, the soil-dwelling nematodes offer attractive possibilities for a correlation and precise interpretation of the morphological and physiological genetics of a simple, differentiating organism. Such a simultaneous approach is being attempted in this laboratory. We are presenting the foregoing discussion in the hope of stimulating others to work on the same problem.

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Aug. 18.

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INFLUENCE OF TEMPERATURE ON THE UREA DENATURATION OF β-LACTOGLOBULIN

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THE kinetics of urea denaturation of globular proteins has been little investigated. This is surprising in view of the interesting results obtained by Hopkins[1], who showed that the temperature coefficient of urea denaturation of egg-albumin (60 per cent urea) is negative.

Since unusual features of a chemical process often help in the elucidation of the reaction mechanism, it was thought that a closer investigation of the urea denaturation might be valuable. Unfortunately, a negative temperature coefficient of the egg-albumin denaturation by urea is only found at very high urea concentrations (Clark[2]), which means that the reacting system must be built up from egg-albumin solution and solid urea. Because of the very high initial rate of the reaction, the numerically large temperature coefficient and the large heat consumption due to the dissolution of the urea, an accurate investigation of the denaturation of egg-albumin in high urea concentration seems to be difficult. It was, however, found that the β-lactoglobulin denaturation by urea has a negative temperature coefficient at an appreciably lower urea concentration, namely, 38 per cent. Some results of experiments with this protein are given in the following.

Solutions of iso-electric β-lactoglobulin in 0·1 *N* sodium chloride (*p*H 5·15) and freshly dissolved urea (*p*H 6·95) were mixed in such proportions that the reaction mixture contained 38 per cent urea and 2 per cent β-lactoglobulin. The *p*H of the reaction mixture was 5·17 (hydrogen electrode): The aliquots withdrawn were mixed with 10 volumes of a solution containing 0·8 mol. acetic acid, 0·4 mol. sodium acetate and 0·5 mol. magnesium sulphate. Extensive comparative experiments by Mr. G. Johansen in this Laboratory have shown that of all buffer-salt mixtures tried, this solution gives the highest yield of precipitated (denatured) protein, without precipitating undenatured protein. The precipitate was filtered and washed ten times with the salt-buffer mixture and analysed for nitrogen.

The accompanying curves are based on independent double determinations.

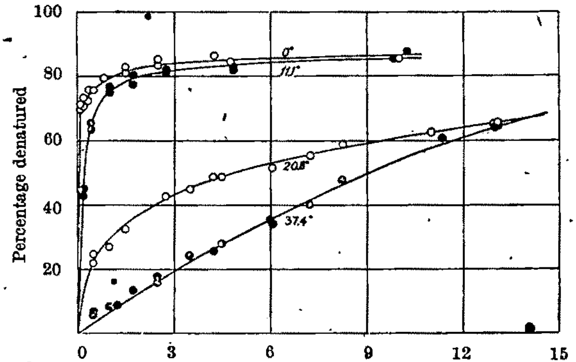

Fig. 1

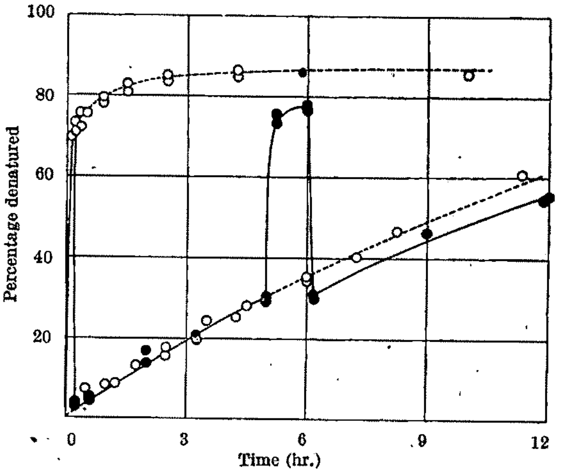

Fig. 2

The temperature dependence of β-lactoglobulin denaturation by urea is shown by Fig. 1, which shows the very large negative temperature coefficient for the initial stages of the denaturation. For the later part of the denaturation process the temperature coefficient is positive.

The denaturation at 0° C. is rapidly and nearly completely reversed if the temperature is increased. Fig. 2 shows the denaturation time-curves for experiments in which the temperature is changed. The dotted curves show the denaturation process at constant temperature, while the full-line curve shows the denaturation process in the following circumstances. The urea and protein solutions were mixed at 0° C.; after 6 min. the mixture was heated to 37·4° C. and was kept at this temperature for five hours, whereupon it was cooled to 0° C., kept at this temperature for one hour and again heated to 37·4° C.

The high denaturation-rate at 0° C. is already known from Fig. 1; the reversion of the denaturation upon heating is amazingly rapid. In this connexion it is interesting to note that heat denaturation of β-lactoglobulin can be reversed by cooling[3].

The shape of the curves of Fig. 1 seems to indicate that the denaturation process is composed of simultaneous or consecutive reactions, while Fig. 2 shows that at least one of the denaturing reactions goes to a temperature-dependent equilibrium between denatured and native protein. In these circumstances the mutual positions of the curves may be accounted for by assuming positive temperature coefficients for the partial reactions. The choice between the several possibilities for the paths of reactions must, however, wait until more experimental material is at hand.

The reversion of denaturation seems to be complete, since the reverted protein is crystallizable. This was shown in the following manner. The denaturation was allowed to proceed for 6 min. at 0° C. (70 per cent denatured), whereupon the solution was heated to 37·4° C. and kept at this temperature for 10 min. After addition of one volume of water, about 3 per cent of the protein was insoluble in the buffer-salt mixture. Slow addition of saturated ammonium sulphate solution to two-thirds saturation caused crystallization of practically all the protein (addition of trichloroacetic acid to the filtrate caused only a slight opalescence). The crystals were indistinguishable from those produced by the method of Sørensen and Sørensen[4].

It seems likely that the crystallized protein is identical with the starting material; a final identification cannot, however, be established without careful examination of other properties than the crystalline habit.

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THE NATURAL VEGETATION OF TRINIDAD

IN a work bearing this title*, Dr. J. S. Beard has given a comprehensive and interesting account of the vegetation of the untouched forest regions of the island of Trinidad, B.W.I. In general, this work follows the earlier survey of R. C. Marshall and brings to the notice of the reader literature which has contributed to a knowledge of the ecology of this region. The underlying practical reason for this study, namely, the correct utilization and conservation of the remaining areas of unalienated Crown land, follows a long period of *laisser-faire* during which there was no effective official policy and, when, as in many other tropical regions, the harmful utilization of virgin areas was all too common.

The present survey is both thorough and readable. It gives a clear account of the uniquely interesting position of Trinidad—an outlier of the South American continent, rather than the southernmost member of the Antilles—and of the factors which enter into the ecological situation. It might almost be said that if what you want is an adequate introduction to the vegetation of tropical America, you should begin with Trinidad. The advantages are numerous. The island, roughly about the size of an English county, has a rich flora (upwards of 2,200 angiosperms), many being representative of the mainland. On the whole this flora is now sufficiently well known, and herbaria are available for consultation. The data of considerable soil surveys are also available: no less than twenty-three types have been enumerated, which for ecological purposes can be classed into three groups in terms of drainage—a conception of which much use has been made in Beard's studies. Other relevant data, topographical, geological and meteorological, are also at hand and are summarized in the present work.

The total of endemic species in the entire flora is estimated at 7 per cent—a low figure for an island flora. The evident close affinity of the Trinidad flora is with the rich adjacent South American region; affinities of a more remote kind with the flora of West Africa can also be traced.

The present work is chiefly concerned with the tree flora. Although a considerable part of the original forested area has been cleared for cultivation, much still remains in its native state, the influence of man being entirely local in nature. A check list of trees is followed by a classification of the plant communities. The six formations which are recognized, seasonal, dry evergreen, montane, intermediate, swamp and marsh formations, are based on climatic and edaphic factors. Each is treated in detail and illustrated by diagrams and some good photographs. Space does not permit of any account being given of this considerable section of the memoir: the overall result is, however, excellent, and the reader, and still more the visiting botanist, will be able, in a short space of time, to gain a real insight into the components of this rich and varied region.

In the concluding section the author analyses and discusses the relationships observed and the ecological conceptions which emerge. In particular, he is concerned with the correct application of certain terms—the names of the several floristic groups—and with concepts such as the nature of the climax. Of the climatic climax he writes as follows:

"In the tropics, studies have shown repeatedly that it is the moisture-supplying ability of the soil which is the most important consideration and this is not necessarily at all closely concerned with climate. The writer's classification of the formations into six series is based entirely on moisture relations which result from the interplay of the three factors of climate, topography, and soil. The ecosystem, in fact, is one and indivisible. Climate, however, is the only component factor of the ecosystem which for any given area is constant (or presumably more or less constant). Land-form and soil, and with them the vegetation, pass through young, mature, and senile stages of development. Within any climatic region or zone, therefore, at some point in the cycle of development a formation will appear which can be interpreted as the highest type of vegetation which can develop under the given climate, other environmental factors (land-form, soil) having at the same time developed the most favourable moisture conditions possible to them in the cycle. The writer believes this to be a more workable definition of the climatic climax.

"As so defined, the climatic climax will not necessarily be the highest type which can exist in the given climate, for such a type would only appear in the presence of ideally favourable conditions of soil and topography. This definition permits of the existence of more than one equivalent climatic climax within a given climate, according to differences in the land-form/soil complex."

A final section is devoted to a reconstruction of the palæo-ecology of the island. The author is to be congratulated on a valuable piece of work in which the reader's interest is sustained throughout.

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* Oxford Forestry Memoirs, No. 20, 1945. Pp. 152, with coloured map and 46 illustrations. (Oxford: Clarendon Press, 1946.)

TRAINING FOR CHEMISTS

THE Education Committee of the British Association of Chemists has recently published its suggestions on the education of chemists*, and though the report does not contain any strikingly novel proposals, it is full of sound sense and should be carefully studied in both academic and industrial chemical circles. The Committee points out that practically the whole of the industry of Britain is dependent on scientific control: a platitude, no doubt, to men of science, but a fact that still has to be emphasized, and emphasized repeatedly, for a general public to whom science is even yet an arcanum. To implement this control a steady and increasing flow of scientific men, and particularly chemists, is essential, and the Committee considers

* Education in Chemistry: the Teaching of Chemistry in Schools and the Training of Chemists and Chemical Technicians for Industry. (London: British Association of Chemists.) 2*s*. net.

the education of chemists under the headings of chemistry in schools, chemistry at the university and the technical college, the training of chemists and chemical technicians engaged in industry, and the recruitment and training of teachers of chemistry.

The report has little to say about the inherent value of science as part of a liberal education, confining itself to the bare assertion that the study of science is of direct cultural importance. This aspect could usefully have been treated more fully, for even to-day it remains true that in a great many schools science is regarded as on a lower educative plane than the so-called humanities. A strong lead from the British Association of Chemists would have found wide support from science masters and mistresses, and since the fundamental education of chemists is given in the schools, the tone should have been pitched high from the start. The report does, however, make many valuable observations on school science, especially the remark that there is sometimes too much insistence on 'the spirit of science' and too little on providing in an assimilable form an essential basis of facts and their relationship. This is a fully justified charge : the pendulum has, indeed, swung to the opposite extreme from the old South Kensington days, and university chemistry teachers have good reason to complain of the lack of factual knowledge shown by freshmen. Though the report does not specifically refer to it, one contributory cause of this situation, so far as chemistry is concerned, is the neglect of qualitative analysis in the schools : analysis admittedly requires a great deal of time, but it does make the student familiar with the materials of his craft.

On types of school, the report refers to the suggestion in the White Paper on Education that at eleven, and at thirteen, pupils should be allocated to one of the three kinds of secondary school—grammar, modern or technical. This suggestion is regarded as unsound, because no preference is shown by most pupils at these ages ; instead, the Committee recommends that the three proposed types of school should be divisions of one multilateral institution under the general control of the same board of governors and arranged if possible on the house system. The chief advantage claimed for this system is a social one; it would help to prevent the development of superiority or inferiority complexes surrounding the type of child in a particular grade of school. The Committee agrees that there is a case for grouping pupils at about the age of thirteen into classes of differing intellectual abilities, but makes the very sound point that this grouping should be such as to allow those who learn quickly to make more rapid progress in a common curriculum than to divide children into classes taking widely different courses.

On the question of external school examinations, the Committee feels that some such test at School Certificate age should be maintained, since industry and society require some datum line on which they can base an initial estimate of educational attainment, and an internal standard must inevitably vary from school to school. The test should, however, be conducted in such a way as to yield an estimate of general intelligence rather than of an ability to reproduce set problems and books. After the school minimum leaving age, the Committee recommends for all pupils the continuation of a general course in certain compulsory subjects, including science, with a choice of others, such as languages, handicrafts, and so on. The basic subjects common to all would be English, science, mathematics, a modern language, history and geography, with the addition of Latin for potential science specialists if it has not been studied previously.

As to the Higher Certificate, the Committee feels, like so many of us, that the whole basis of the examination should be broadened, and that the certificate should not exempt the student from the first-year course at a university. Similarly, scholarship examinations should not be tests to discover how far candidates have already progressed towards their degree, but should be a means by which those most capable of profiting by further education on more specialized lines may be selected.

At the university and technical college, the report continues, the science student must have time to make contact with students in other faculties and sufficient leisure to follow some cultural interests. This would probably involve an increase from three years to four years in the normal pass degree course, and is particularly necessary in chemistry if the proper background to the subject is to be imparted.

Further suggestions by the Committee include closer co-operation between the universities and the chemical industry, a modification in the conditions of military service for undergraduates, the formation of training centres for technical grades, better prospects for junior employees, an improved financial standard of remuneration for chemists and the encouragement of well-qualified teachers. The report ends with an appeal to all the organisations now representing the craft of chemistry to make a common approach to the whole subject.

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ECHINODERM FAUNA OF AUSTRALIA

DR. HUBERT LYMAN CLARK'S large work, "Echinoderms from Australia", was reviewed in *Nature* of September 24, 1938. That review and the obituary notice of Dr. Clark in *Nature* of September 20, 1947, show how many and how important were his contributions to the knowledge of Australian echinoderms. He had made them his peculiar province ; it is fitting that they should be the subject of his *chef-d'œuvre*, "The Echinoderm Fauna of Australia : its Composition and its Origin"*, which was published in 1946 and has now reached Great Britain. For it he received on his deathbed the award of the Australian Clarke Medal.

Part 1, which is by far the greater part of the volume, is an account of all the echinoderms, living or extinct, which are known from Australia. There are keys to all orders, families, genera and species ; and, under each species—and there are nearly nine hundred of them—notes on synonymy, range, occurrence, habitat, habits, colour, variation and food so far as they are known. There are no illustrations, since nearly all the species have been figured elsewhere, and references to those figures are given.

Part 2 is a discussion of the composition and origin of the Australian echinoderm fauna. Its most characteristic feature is the predominance of East Indian forms and influences, so that there can be no doubt it is derived from there. It appears to have come along two paths, one on either side of the land-bridge which once spanned what is now the Torres Strait; for the faunas of the north coast and of east Queensland bear each a different facies, having not yet completely commingled. The farther away one goes from Torres Strait, whether south by Queensland and west along the Bight, or north by Darwin and so around to Perth, the more characteristic the fauna becomes, until in the south-western corner it is nine-tenths endemic.

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* Carnegie Institution of Washington, Publication No. 566. The Echinoderm Fauna of Australia; its Composition and its Origin. By Hubert Lyman Clark. Pp. iv+567. (Washington, D.C.: Carnegie Institution, 1946.) 4 dollars.

The conclusion that the Australian echinoderm fauna is East Indian in origin is preceded by successive and detailed comparisons with the echinoderm faunas of all surrounding lands—of Antarctica, Kerguelen, Mauritius, South Africa and so on north-about to New Zealand. Dr. Clark believed that because of their "relatively sedentary habits, their aversion to fresh or even brackish water, the brevity or complete absence of a free-living larval life, and the usually small bathymetric range, echinoderms are remarkably suitable material for studying changes in shore line or the relation of land masses to each other". Where in distant faunas he finds similarities to that of Australia he attributes them, for the most part, to a common source in the East Indian fauna. A number of perplexing forms, like, for example, the sea-urchin *Dermechinus*, which occurs off the southern tips of America, Africa and Australia, cannot be so explained; but Dr. Clark concludes "that only a desperate desire to validate the Wegener hypothesis can find in the echinoderm fauna of Australia any evidence that it is at all closely related to that of South Africa or even of New Zealand". D. Dilwyn John

TOWARDS AN INTERNATIONAL PHARMACOPŒIA

The first meeting was held at Geneva during October 13–17 of the Expert Committee on the Unification of Pharmacopœias of the World Health Organisation. There were present Prof. H. Baggesgaard Rasmussen (Denmark), Prof. E. Fullerton Cook (United States), Prof. I. R. Fahmy (Egypt), and Dr. C. H. Hampshire (Great Britain); Prof. R. Hazard (France) was prevented by illness from attending. The members were welcomed, in the name of the Executive Secretary, by Dr. R. Gautier, who said that the duties of the Committee would be to continue the work on the unification of pharmacopœias which had been begun by the Technical Commission of Pharmacopœial Experts of the League of Nations. Dr. C. H. Hampshire was elected chairman.

The Committee accepted the general principles expressed in the Interim Report of the previous Commission published in 1945, and approved the monographs contained therein, subject to consideration of any comments which might be received later. The intention that the recommendations of the Committee should take the form of an International Pharmacopœia was approved, the scope to be limited in the first place to drugs considered to be essential in medical practice. It was understood that such an International Pharmacopœia could have no authority in any country until it had been adopted by that country.

A list of 534 drugs was considered and 244 were selected for immediate attention. It was decided that monographs on the drugs for which the Committee on Biological Standardization had provided standards should be included. Thirty draft monographs were completed, making with those in the interim report a total of seventy-two.

The preparation of drafts of monographs, general notices and appendixes, and of reports on special subjects was allocated among the members present, who also undertook the necessary experimental work. Arrangements were made for special reports on such subjects as alkaloidal assays, boiling points and melting points, fineness of powders, and the sterilization of injectable materials.

In view of the fact that the place of galenicals in medicine had been largely taken by the new synthetics, alkaloids and injectable materials, the Committee decided not to re-establish the Reference Sub-Committee on Galenical Pharmacy, appointed by the previous Commission. The possibility of establishing an international procedure for naming new drugs at an early stage of their introduction into medicine, and the standardization of surgical ligatures, sutures and dressings, were also discussed and reserved for future consideration.

In view of the volume of work to be undertaken and of the necessity for widening the international basis of the work, the Committee recommended that at least three additional members should be appointed and that a unified secretariat with specialized staff should be formed.

FORTHCOMING EVENTS

Monday, January 5

Society of Chemical Industry (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. H. J. Bunker: "Some Scientific Aspects of Beer".

Tuesday, January 6

Institution of Civil Engineers (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. Clifford Heyes and Mr. J. Brierley: "Airfield Lighting".

Institution of Mechanical Engineers, Automobile Division (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Capt. G. T. Smith-Clarke: Chairman's Address.

Institute of Welding, Manchester and District Branch (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. S. W. Carpenter: "Automatic Welding".

Wednesday, January 7

Illuminating Engineering Society, Manchester Centre (joint meeting with the Association of Public Lighting Engineers, in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. E. J. Stewart: "The Lighting of Housing Estates".

Thursday, January 8

Physical Society, Acoustics Group (at the National Hospital, Queen Square, London, W.C.1), at 4.30 p.m.—Prof. H. Hartridge, F.R.S.: "The Use of Supersonic Sound by Animals"; Dr. C. S. Hallpike and Miss M. R. Dix: "Pure-Tone Audiometry in Young Children, a New Technique" (Film and Demonstration); Dr. Dennis Fry: "Tone Deafness".

Chemical Society, Manchester Section (joint meeting with the Local Sections of the Society of Chemical Industry and the Royal Institute of Chemistry, in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Dr. M. P. Applebey: "Crystallisation of Fertilisers".

Institution of Civil Engineers, North-Western Association (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. W. J. O. Scott: "Roads and their Riding Qualities".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. T. P. Hilditch, F.R.S.: "Structural Relationships in the Natural Unsaturated Higher Fatty Acids".

Friday, January 9

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Dr. A. Roberts: "Education for Management in the Textile Industry".

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. F. Armitage and Mr. J. J. Sleightholme: "Further Developments in Styrene Co-Polymers".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Physical Society (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. D. R. Davies: "Shock Waves in Air at Very High Pressures"; Mr. D. C. Pack, Mr. W. M. Evans and Mr. H. J. James: "The Propagation of Shock Waves in Steel and Lead".

Institution of Mechanical Engineers, Applied Mechanics Group (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. E. Schmidt: "Design of Contra-Flow Heat Exchangers".

Plastics Institute (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Mr. J. M. J. Estevez: "Contact Resins".

Sheffield Metallurgical Association, Methods of Analysis Group (at 198 West Street, Sheffield), at 7 p.m.—Mr. E. J. Vaughan: "The Spekker—What it Is and How it Works", Part 1.

Institution of the Rubber Industry, Leicester Section (at the Bell Hotel, Humberstone Gate, Leicester), at 7.30 p.m.—Mr. G. A. Shires: "Libraries and the Handling of Technical Information in the Rubber Industry".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Resident Instructor and Lecturer in Agriculture at the Training Centre for Ex-Service men, Pulborough—The Secretary, West Sussex War Agricultural Executive Committee, County Hall, Chichester (January 10).

Senior Scientific Officer or Scientific Officer (Ref. No. A.337/47) to be responsible for radiation survey work and health radiation measurements, and a Senior Experimental Officer or Experimental Officer (Ref. No. F.773/47) to be concerned with problems of transportation and handling of chemicals, at the Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (January 10).

Junior Physicist—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5 (January 16).

Lecturer in Physics—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (January 17).

Analytical Chemists (male or female) for works in N.E. Scottish town—The Ministry of Labour and National Service, Room 669, York House, Kingsway, London, W.C.2, quoting F.515/47A (January 20).

Lecturer in Chemistry—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (January 24).

Lecturer or Assistant Lecturer in the Department of Civil Engineering—The Registrar, The University, Sheffield (January 31).

Watson-Watt Chair of Electrical Engineering in University College, Dundee—The Secretary, The University, St. Andrews (January 31).

Director of the Sugar Milling Research Institute (Natal University College)—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (February 14).

Lecturer or Assistant Lecturer in Zoology—The Registrar, University College, Southampton (February 15).

University Demonstrator in Agriculture—The Secretary, School of Agriculture, Cambridge (February 21).

Chair of Applied Mathematics at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (February 28).

Assistant Professor and an Associate Professor of Psychology—The Bursar, McGill University, Montreal, Canada (March 1).

Senior Lecturer in Theoretical Physics—The Secretary of Faculties, University Registry, Oxford (March 15).

Principal Scientific Officer, Empire Potato Collection, Cambridge—The Secretary, Commonwealth Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (April 1).

I.C.I. Research Fellowships in Chemistry or Physics, or some allied subject such as Biochemistry, Colloid Science, Chemotherapy, Pharmacology, Metallurgy or Engineering—The Registrar, The University, Liverpool (April 30).

Expert in Soap Manufacture, Department of Commerce and Industries, Government of Ceylon—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.17602.

Forestry Surveyor for Directorate-General of Agriculture, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18180.

Lecturer or Assistant Lecturer (man) in Colonial Social Science—The Secretary, London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2.

Fisheries Officers (2) in Uganda—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

Microanalyst—Sir Norman Haworth, F.R.S., Chemistry Department, The University, Birmingham 15.

Physical Chemist—The Secretary, British Hat and Allied Feltmakers Research Association, 12 St. Peter's Square, Stockport, Cheshire.

Lecturer in the Mathematics Department—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

Laboratory Assistant in the Department of Biochemistry—The Secretary, University College London, Gower Street, London, W.C.1, quoting Biochemistry/1.

Design Engineers, Design Engineers (Instruments), Planning and Progress Engineers, Estimating Engineers, Buying Engineers, Electrical Engineers, Power Engineers, Standards Engineers, Civil Engineers, and Technical Engineers—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

Lecturer in Geography—The Registrar, University College, Exeter.

Soil Laboratory Assistant for Public Works Department, Government of Northern Rhodesia—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18396.

Assistant Inspector of Scientific Supplies by the India Store Department—The Office of the High Commissioner for India, India House, Aldwych, London, W.C.2, quoting S.965/46.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, No. 591, Vol. 232: The Pallial Organs in the Aspidobranch Gastropoda and their Evolution throughout the Mollusca. By C. M. Yonge. Pp. 443–518. (London: Cambridge University Press, 1947.) 12*s*. 6*d*. [85

Philosophical Transactions of the Royal Society of London.. Series A, Mathematical and Physical Sciences, No. 818, Vol. 240: The Earth's Magnetic Field in Southern Africa at the Epoch, 1 July 1930. By E. N. Grindley. Pp. 251–294. (London: Cambridge University Press, 1947.) 10*s*. [95

World Power Conference. Annual Report, 1946. Pp. 15. (London: World Power Conference, 1947.) [95

World Power Conference. Reports on Fuel Economy since 1939. Argentine National Committee. Pp. 6. 6*d*. net. Australian National Committee. Pp. 10. 6*d*. net. Report for Austria. Prepared by the Austrian Ministry of Trade and Reconstruction. Pp. 4. 4*d*. net. Czechoslovakia National Committee. Pp. 4. 4*d*. net. Report for Germany. Prepared under the auspices of the Allied Control Commission for Germany (B.E.). Pp. 8. 6*d*. net. (London: World Power Conference, 1947.) [95

Institute of Fuel. Report of the Council for the Year 1946. Pp. 12. (London: Institute of Fuel, 1947.) [95

Ollscoil na h-Éireann: National University of Ireland. Calendar for the Year 1945. Pp. x + 308 + 910. (Dublin: National University of Ireland, 1945.) [125

Other Countries

United States Department of the Interior: Geological Survey. Professional Paper 205-D.: Late Mesozoic and Early Cenozoic History of Central Utah. By Edmund M. Spieker. (Shorter Contributions to General Geology, 1943–45). Pp. iii + 117–162 + plates 18–25. 15 cents. Professional Paper 206: Upper Cretaceous Foraminifera of the Gulf Coastal Region of the United States and adjacent Areas. By Joseph A. Cushman. Pp. iii + 242 + 66 plates. 1 dollar. Professional Paper 207: Geology and Paleontology of Palos Verdes Hills, California. By W. P. Woodring, M. N. Bramlette and W. S. W. Kew. Pp. v + 146 + 37 plates. 1·50 dollars. Professional Paper 210–A: Tertiary Foraminifera from St. Croix, Virgin Islands. By J. A. Cushman; with a Note on the Geology, by D. J. Cederstrom. (Shorter Contributions to General Geology, 1946.) Pp. ii + 18. 20 cents. Professional Paper 210–B: A Pennsylvanian Florule from the Forkston Coal in the Dutch Mountain Outlier, Northeastern Pennsylvania. By Charles B. Reed. (Shorter Contributions to General Geology, 1946.) Pp. ii + 17–28 + 2 plates. 15 cents. (Washington, D.C.: Government Printing Office, 1946.) [85

United States Department of the Interior: Geological Survey. Water-Supply Paper 986: Water Levels and Artesian Pressure in Observation Wells in the United States in 1943. Part 1: Northeastern States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iv + 290. 50 cents. Water-Supply Paper 1001: Surface Water Supply of the United States, 1944. Part 1: North Atlantic Slope Basins. Pp. x + 634. 1.25 dollars. Water-Supply Paper 1002: Surface Water Supply of the United States, 1944. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. ix + 552. 1 dollar. Water-Supply Paper 1005: Surface Water Supply of the United States, 1944. Part 5: Hudson Bay and Upper Mississippi River Basins. Pp. ix + 422. 70 cents. Water-Supply Paper 1006: Surface Water Supply of the United States 1944. Part 6: Missouri River Basin. Pp. viii + 473. 75 cents. Water-Supply Paper 1008: Surface Water Supply of the United States, 1944. Part 8: Western Gulf of Mexico Basins. Pp. vi + 311. 45 cents. Water-Supply Paper 1012: Surface Water Supply of the United States, 1944. Part 12: Pacific Slope Basins in Washington and Upper Columbia River Basin. Pp. vi + 261. 45 cents. (Washington, D.C.: Government Printing Office, 1946.) [95

Kungl. Sjökarteverket, Stockholm. Ergebnisse der Beobachtungen des magnetischen Observatoriums zu Lovö (Stockholm) im jahre 1944. Von Sven Åslund. Pp. 30. Ergebnisse der Beobachtungen des magnetischen Observatoriums zu Lovö (Stockholm) im jahre 1945. Von Sven Åslund. Pp. 30. Jordmagnetiska Publikationer, Nr. 13: Magnetic Measurements on the *Kompass* in the Baltic Sea, 1938. By Gustaf S. Ljungdahl. Pp. 21 + 5 plates. Jordmagnetiska Publikationer, Nr. 14: The Magnetic Homogenity of Testing Grounds for Investigation and Compensation of Airplane Compasses. By Nils Ambolt. Pp. 9. (Stockholm: Kungl. Sjökarteverket, 1940–1947.) [95

Ceylon. Part 4: Education, Science and Art (F). Administration Report of the Director of National Museums for 1945. By P. E. P. Deraniyagala. Pp. F. 8. (Colombo: Government Record Office, 1946.) 10 cents. [95

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Polaroid Laboratory Products. Pp. 20. (New York: Pioneer Scientific Corporation, 1947.)

Edizioni di Cultura Libraria. (No. 1.) Pp. 24. (Firenze: Leo S. Olschki, 1947.)

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NATURE

No. 4080 SATURDAY, JANUARY 10, 1948 Vol. 161

CONTENTS

Page
Limitations of Planning in Scientific Research 35
Superconductivity. By Dr. H. Fröhlich 37
National Intelligence. By Dr. Julian Blackburn 37
The Sea 38
Soil Fertility 39
The New Eruption from Hekla. By Dr. G. W. Tyrrell 41
Corn (*Zea Mays* L.) Genetics in the United States. By Gordon Haskell 42
Aspects of the Locomotion of Whales. By R. W. L. Gawn, O.B.E. . 44
Obituaries :
  Dr. C. C. Hurst. By Prof. R. C. Punnett, F.R.S. 46
  Dr. Stephen Miall. By A. L. B. and P. J. V. 47
  Prof. G. C. MacCurdy. By Prof. D. A. E. Garrod 47
  Prof. Max Planck, For.Mem.R.S. 47
News and Views 48
Letters to the Editors :
  Variation of Geomagnetic Intensity with Depth.—Prof. Sydney Chapman, F.R.S. ; S. K. Runcorn 52
  Beta-quinol : an Example of the Firm Union of Molecules Without the Formation of Chemical Bonds Between Them. —H. M. Powell and P. Riesz 52
  Use of Ultra-Violet Fluorescence in Paper Chromatography.—D. M. P. Phillips 53
  Inhibition of the Photodynamic Action of 3 : 4 Benzpyrene.—G. Calcutt and J. P. Newhouse 53
  Reduction of 1 : 4-Diketones.—Dr. Neil Campbell and Nandoomal Khanna 54
  Total Conjugation of Linoleic Acid in Oxidation with Lipoxidase. —Prof. Sune Bergström and Ralph T. Holman 55
  Ammonium Salts of Sulphanilamides and Sulphonic Acids.—S. K. Munshi, B. D. Tilak and Prof. K. Venkataraman . . . 55
  Effect of Under-nutrition and Alterations in Diet on the Choline Esterase Activity of Serum.—Prof. R. A. McCance, E. M. Widdowson and A. O. Hutchinson 56
  Premortal Increase in the Output of Sodium and Chlorine in Fasting Rats.—Dr. Peter Bálint and Dr. Helene Kabdebó . 57
  Thyroid Gland as a Special Factor Influencing the Conditional Disposition to Infectious Diseases.—Dr. S. Zimanyi . . 57
  Effect of Feeding 2-Acetaminofluorene on the Adreno-Gonadal System of Rats.—Cornelia Hoch-Ligeti 58
  Electrophoretic Patterns of Lamb Serum Before and After Transfer of Colostrum.—P. A. Charlwood and A. Thomson . 59
  Coincidence Device of 10^{-8}–10^{-9} Sec. Resolving Power.—Z. Bay and G. Papp 59
  Electron Multiplier Tube of Large Effective Cathode Surface Area.—P. S. Faragó 60
  Variation of Thermo-electric Power of Electronic Semi-Conductors with Vapour Pressure.—C. A. Hogarth . . 60
  Nuclear Models.—Dr. I. N. Sneddon and B. F. Touschek . . 61
  Spectrum of White Dwarfs.—Dr. Evry Schatzman . . . 61
  The Bikini Bomb and the Seismology of the Pacific Region.—Prof. K. E. Bullen 62
  Sublimation in the Atmosphere over the Oceans.—Dr. B. Cwilong 62
  Occurrence of Troilite.—Dr. J. J. Frankel 63
  Minimum Perceptible Energy and Brownian Motion in Sensory Processes.—Dr. Hl. de Vries 63
  Occurrence of *Elminius modestus* (Darwin) in British Waters.—D. J. Crisp and P. N. J. Chipperfield 64
  An Atypical Scale of *Sciaena coitor* (Hamilton).—Dr. Sivatosh Mookerjee 64
  Resistance to Inanition in Grass Seedlings.—H. G. Chippindale . 65
  Mauthner's Cells in the Larvæ of Anuran Amphibia.—A. G. Willis 65
  Demonstration of the Heart Beat.—Dr. C. A. Beevers . . 65
Natural Amœbic Infections in Laboratory Rodents. By Dr. J. D. Fulton and L. P. Joyner 66
Science in Social Affairs. By Dr. John Cohen 68
Internal Stresses in Metals and Alloys 70
Ground Blocks of the Continents and Ocean Bottoms. By Prof. H. Cloos 71
Preservation of the *Kauri* in New Zealand. By Prof. H. G. Champion, C.I.E. 72
Electrical Properties of Soil and Water at Centimetre Wave-lengths 73

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LIMITATIONS OF PLANNING IN SCIENTIFIC RESEARCH

THE best form for the central organisation of scientific effort in Great Britain is so complex a problem that it may be wise not to determine it finally with undue haste. We should have regard to the orderly evolution that marks the advance of science, and be on guard against rash generalizations and unsound analogies just as much as against the tendency to excessive planning at the centre. In this connexion, a review by Dr. F. B. Jewett of the future of scientific research in the post-war world (*Amer. Sci.*, 34, 439 ; July, 1946) should be studied. Dr. Jewett does much more than sound a note of caution as to whether there is not a limit to the speed at which society can wisely assimilate radically new scientific developments *en masse* into the social structure. He is concerned both with the effect on the balance of society, and, what is much more commonly overlooked, with its bearing on the attitude of the man of science himself towards his work as well as towards the society of which he is a part. Sir Henry Dale, in his presidential address at the Dundee meeting of the British Association, was obviously concerned with this latter aspect, though unlike Dr. Jewett he made no reference to the importance of further stimulating research into other fields of knowledge than the physical or biological sciences. In this connexion the forthcoming report of the National Committee on the Social Sciences set up by the Association of Scientific Workers (see p. 68) will be of interest.

The broad picture of the present conditions for scientific research drawn by Dr. Jewett is generally similar to that outlined by Sir Henry Dale, but he has filled in more of the detail. He reminds us that in fundamental and applied science the corps of highly trained research men is substantially the same numerically as at the beginning of the War ; but its average age is higher by four or five years and its creative potentiality has probably decreased. The next lower age-group of fully trained men is almost entirely lacking, and although partially trained men from the Services or war-work may ultimately fill the gap after completing their training or on the basis of experience, many will not be productive for some time. There is also a dearth of those who would normally be candidates for post-graduate training.

The contour and extent of fundamental knowledge do not differ greatly from those of four or five years ago ; but in the field of applied science, large extensions have been made in some sectors and none at all in others. A major problem of industrial research is to secure a better balance of technology in relation to social needs. The range, diversity and often the power of research tools have been greatly increased, and in some sectors tools, methods and materials previously rare, expensive or difficult to obtain, have been made comparatively easily available. The interdependence of different sectors of science for their mutual advancement has also been strikingly demonstrated during the War, just as have the value of new methods of planning and organising research, of team-work and the whole technique we know as operational research.

Only time can rectify the shortage of scientific man-power which Dr. Jewett and his colleagues in the United States emphasize, just as much as is done in Great Britain; but wise planning and the right priorities can speed up the process. As to the subjects of research, Dr. Jewett expects that if science is afforded the freedom it needs, it will for the next few years be mainly concerned with developing the fields on which interest is at present focused. He anticipates, however, a much wider use of, and greater demand for, the mathematician; and that there will be increasing co-operation between mathematicians and physical scientists; and in the field of applied science he anticipates a considerable expansion in the size and number of co-operative laboratories of the type of the Mellon and Battelle Institutes.

Dr. Jewett is concerned, however, that there should be no deterioration in the quality of research; and it should be remembered that this is one of the factors to be considered at every level in production. As Mr. A. C. Bossom observed in the concluding lecture on economic reconstruction delivered at the Royal Society of Arts last May, austerity production does not equip men to make better, or craftsmen's, articles. The manufacturing fame of Britain rests largely on the craftsmanship responsible for the high quality of our goods, and there is no more important aspect of industrial efficiency than this. It is one to which joint production committees and any other means we adopt for securing better industrial co-operation must give close and continuous attention.

It is in ways like this that the collaboration of the social scientist with the worker in the physical or the biological sciences can prove so fruitful; indeed, it should be remembered that the development of scientific management and the improvement of methods of administration do to some extent involve further research into problems of social science, though primarily they involve the wise and thorough application of existing knowledge and of the scientific approach.

It cannot in truth be seriously maintained that the question of the best deployment of the resources of scientific man-power in Great Britain is a matter to be resolved entirely by the technique described as 'operational research'. No doubt both the Advisory Council on Scientific Policy, the Defence Research Policy Committee and the Committee on Industrial Productivity between them can do something to indicate the most profitable distribution, and even enlist the co-operation of industry in the attack on research problems. But it is difficult to visualize them as instigating or directing a redistribution of scientific effort on the scale suggested by the Association of Scientific Workers, or to believe that the change-over could be effected rapidly without serious loss of efficiency or waste of man-power and resources. Prof. D. H. Robertson has suggested that the direction or mobility of labour will be most satisfactorily secured for all concerned by the operation of the old price system in a free economy. The reception of the Control of Engagement Order indicates that he may be right, and this may be as true at the scientific as at any other level.

The technique of operational research may be used, however, to help in determining the most profitable targets, and in organising the co-operative attack on the selected objectives. It could also foster the conception of the effectiveness and non-effectiveness of industrial research according to the opportunity and help we gave it to fructify which Sir Clifford Paterson commended for the consideration of the Royal Society as a means of ensuring economy in scientific man-power. Presumably the Committee of the Fabian Society had such ideas in mind when, in its recent report on the Civil Service, it suggested that the Civil departments, and particularly the Board of Trade, might use such a technique. 'Operational research' has undoubtedly assisted the administrator and the numerous types of expert to combine in the attack on a single problem, and there are few problems in our industrial and economic, not to mention our political, life which do not involve such co-operation. It may well be that some such technique could make an outstanding contribution in the field of industrial psychology, or industrial anthropology, which has such a vital bearing on industrial efficiency and morale to-day. The investigation of such matters and into problems of industrial administration which Prof. P. Sargant Florence suggested in a thoughtful article, "Incentives and Government Policy", in the *Political Quarterly* is one field in which the technique should be indispensable.

The importance of this needs no further emphasis than Field Marshal Montgomery and General Slim have recently given it, for morale in industry means as much to success as in military operations, and can be studied as scientifically as was the morale of the fighting man in time of war. Nor are the other conditions of success so dissimilar in the two spheres: simplification of the problem, the choice of subordinates and reliance upon them, courage and determination to achieve a clearly visualized objective —these have just as much to do with the attainment of scientific or industrial objectives, and no mere system of organisation can be a substitute for the wisdom and moral qualities they imply.

We already possess in Britain in large measure the administrative organisation that is required. What has to be done is to ensure that it is used effectively and wisely, that it is staffed with men competent to take the right decisions and to select the right targets, and to keep a proper balance between long-term and short-term objectives. We need to encourage the wider use of the techniques and methods which progressive firms found fruitful in technical or scientific service to industries using their products long before the term 'operational research' was introduced, while avoiding the fostering of extravagant hopes. We have to secure the co-operation of every scientific worker, in the fields of work in which he is immediately engaged, through his professional associations making representation as to what is required, and no less on the regional research councils, production committees and other bodies through which scientific and technical opinion can be clearly and effectively expressed on the problems confronting the nation, industry and commerce, and the means by which they can be attacked. There are limits to human judgment and to human powers of organisation; but within those limits it is possible to plan the use of the scientific and material resources of Britain with some approach to relative, if not to absolute, efficiency, and to avert the encroachment of political tyranny on scientific or any other form of human competence. But we must recognize the limits of planning, and keep to a minimum the burden of those central decisions which at present so often tend to clog the machine and to stifle rather than to encourage initiative, enterprise and judgment.

SUPERCONDUCTIVITY

Theorie der Supraleitung

Von M. von Laue. Pp. iii + 124. (Berlin und Göttingen: Springer-Verlag, 1947.) 12 R.marks.

THERE are few theoretical physicists who at one time or another have not tried to develop a theory of superconductivity; but all attempts so far have been unsuccessful. It might have been expected that it would be possible to explain such a spectacular phenomenon in a simple way in terms of the properties of electrons in metals. The conclusion has to be drawn, therefore, that we have not yet learned to derive in a satisfactory way the features of an assembly of electrons from their individual properties. Similar failures in other branches of physics (for example, liquid helium II, or the mechanical properties of solids) indicate that these difficulties are not restricted to electrons but concern many-body problems in general.

In discussions on this subject it is often suggested that a more successful treatment of the many-body problem requires an improvement of the mathematical technique rather than new physical ideas. Yet even an attempt to derive the properties of ideal gases would find the atomic physicist (if assumed to have no knowledge of macro-physics) at a loss without the introduction of new physical concepts. He would probably start with a discussion of the motion of two and then of three weakly interacting particles, and afterwards be led to the conclusion that consideration of more particles is very complicated and unlikely to lead to any simple results. It is only after the introduction of new physical concepts which do not exist in atomic physics—such as pressure and entropy—that other simple laws of physics (the gas laws) can be found. It may well be that further concepts of this kind will be discovered and that they will be essential in solving problems like superconductivity. An important step in this direction is the formulation of an adequate phenomenological theory.

In the case of superconductivity, this step was taken about twelve years ago by the brothers F. and H. London, and M. von Laue has now written an excellent monograph on this theory. He starts with a short discussion of the two basic electromagnetic properties of superconductors, the existence of permanent currents and the magnetic properties, and then proceeds to formulate the fundamental equations of the Maxwell–London theory. Maxwell's equations, as is well known, require a number of supplementary equations specifying the properties of the substances in the electromagnetic behaviour of which one is interested (for example, Ohm's law in the case of non-superconducting metals). London's equations for superconductors consist of a differential correlation between the electromagnetic field vectors and the current density. In conjunction with the Maxwell equations, they give rise to interesting developments which are very thoroughly treated in von Laue's book. The book continues with a discussion of space charges in superconductors and of conservation of energy. There follows a detailed treatment of a number of specific cases such as cylinders and spheres in magnetic fields, the properties of permanent currents (requiring theorems on multiple connected spaces), electric waves and high-frequency resistance, and others. After an outline of the thermodynamics of the transition from the normal to the superconducting state, the book finishes with two sections on the properties of thin layers and of the intermediate state.

One might find the section dealing with the thermodynamics of superconductors comparatively short, but then as von Laue points out in the introduction, his book aims at giving an account of the London theory only. Unfortunately, he does not quote the two original papers by F. and H. London (*Proc. Roy. Soc.*, A, **149**, 71 (1935); *Physica*, **4**, 341 (1935)), but only a later review by F. London, and he attributes the whole theory to the latter author only. The responsibility for the contributions was, in fact, equally shared by the two authors. It is therefore to be hoped that a suitable correction will be made in future editions to eliminate a misleading impression.

The book is written in a very thorough manner; all theoretical results are derived in detail and difficulties are indicated and discussed. Some of these results will no doubt stimulate new experiments. The book will be read with profit by all interested in the theory of superconductivity. H. FRÖHLICH

NATIONAL INTELLIGENCE

The Trend of National Intelligence

By Prof. Godfrey Thomson, with a Symposium by Sir Alexander Carr-Saunders, Sir Cyril Burt, Prof. Lionel Penrose and Prof. Godfrey Thomson. Pp. 35. (London: The Eugenics Society and Hamish Hamilton.) 2*s*. net.

IN the Galton Lecture for 1946, Prof. Godfrey Thomson marshalls the evidence that leads him to the conclusion that there is at the present time in Britain, and has been for at least twenty-five years, a correlation of approximately −0·25 between the intelligence score of a child of about eleven years and the size of the family of which he (or she) is a member. The facts are no longer in dispute: yet it makes a profound difference to the points of policy on which emphasis might be laid, if any attempt were made to reverse the present tendency, whether the interpretation of the facts is that the average level of innate intelligence in the country is declining, or that the facts merely indicate a differential environmental influence on intelligence test scores. To obtain an accurate interpretation would involve, as Carr-Saunders and Burt point out in their contributions to the symposium in 1947 which followed Thomson's Galton Lecture, a team of research geneticists, psychologists, statisticians and sociologists, backed by a heavy endowment. Thomson's interpretation, on the basis of his own and other people's carefully prepared investigations, is that hereditary factors are causing a decline in the national intelligence of at least one point in *I.Q.* per generation, and probably more.

Thomson would be the first to admit that his conclusion marks the opening of a new, rather than the closing of an old, chapter of investigation. For if it be true that the average level of national intelligence is declining as a result of hereditary factors, then a number of questions affecting future policy at once spring to one's mind. Is the decline to be attributed to an increase in the absolute number of those with less intelligence than the average, or to a decrease in the absolute number of those with more, or to both ? And which of these is the more important or disastrous socially ? Is the change one that is affecting all intelligence-levels or only those individuals at either or both extremes of the range ? To what extent does a decline in innate intelligence imply a decline also in other desirable characteristics (since many mental qualities are positively correlated) ? Is the true position merely that the more intelligent people are having fewer children, or are we justified in making the further deduction that the differential birth-rate is adversely affecting innate intelligence ?

Again, one needs to know whether the decline is one that has been continuing for a number of generations or whether it is a modern, and perhaps temporary, phenomenon. In this connexion one would need to know how long differential fertility had been a significant problem. Thomson is rightly concerned by the fact that the educational system of Britain sieves the more intelligent, gives them a longer education and prepares them for a profession in which they will marry later and have fewer children than the less intelligent. Yet if the differential birth-rate should happen to have been a significant factor in the decline of intelligence over the past centuries, then are there any influences to mitigate these effects and to counteract our decline into a nation of defectives ? That there may be some factor to be discovered is suggested by Penrose's investigation into the height of Toronto children. A very small but significant inverse correlation between height and sibship provided the basis for the expectation that the mean height would decline at the rate of about a quarter of an inch a generation. Measurements in 1923 and 1939, however, indicated that during this half generation the average height had actually increased by between 1 and 2 in. It may be, as Thomson suggests, that better nutrition or other environmental conditions have temporarily masked a genetic decrease, and that improved educational nutrition might similarly, though only temporarily, mask a decline in inborn intelligence.

If this should be so, it would be arguable that social policy might profitably be directed along these positive lines until the genetic factors underlying the decline can be more clearly formulated. For if it be true that nutrition can affect to such a startling degree something with so considerable a hereditary basis as height, then how much more might it not be worth while to investigate the effect of educational nutrition on intelligence test scores ?

It is now time to remind ourselves that all the predictions about the future trend of innate intelligence are based on intelligence test 'scores', and that a great many more investigations need to be undertaken into the extent to which such scores are affected by environmental handicaps or advantages. To what extent is the fact that the lower *I.Q.*s are found in the larger families associated with the fact that the larger families are also to be found among those with fewer social advantages ? Thomson's important investigation into a socially very homogeneous group was an attempt to answer this question ; yet even here the negative correlation between intelligence score and family-size might be reasonably interpreted in terms of the more extreme poverty of those with the larger families in a group that was altogether very poor (coal miners in 1926).

The fact, too, that different average *I.Q.*s are often obtained from different groups, for example, rural and urban, northern and southern, etc., raises questions about the relative fairness of the items included in a single test given to both groups : it also raises questions about the original standardization of the test, for example, whether the population on whom the test was originally standardized corresponds fairly with the population that has been selected for the purpose of a special investigation. Again, further investigation needs to be made into the extent to which individuals with very different types of mind can obtain the same score on an intelligence test ; and of the effect on their relative scores of different methods of grading the marks on a test. As a corollary to this question, more needs to be known about the extent to which individuals with the same type of mind obtain different intelligence scores. Even identical twins rarely obtain identical scores ; what, then, is the reason for, and what the significance of, their differences ? Are they an indication of the influence of pre-natal or post-natal environmental differences, or that the measuring rod itself, the test, is unreliable ? If the latter, is this unreliability constant for all groups of whatever social class, or does it vary from one class to another ?

I have been able to do little more than touch on some of the implications of Thomson's Galton Lecture. How far any answer to these questions may be obtained must depend on the support that is forthcoming for future investigations.

JULIAN BLACKBURN

THE SEA

This Great and Wide Sea

By R. E. Coker. Pp. xvii+325+91 plates. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1947.) 27*s.* 6*d.* net.

THIS book covers the range of physical, biological and geological oceanography, from the point of view of a biologist. It gives a number of comprehensive, but not technical, presentations of the basic phenomena of the ocean as a place of life for plants and animals. It is well written and well illustrated by a large number of good photographs, well chosen.

Part 1 consists of five chapters on history and geography, one of which is on oceanography in

America. There are short interesting accounts of the work of Maury, Wyville Thomson, Murray, Hensen, Chun, the Prince of Monaco, A. Agassiz and many others.

Part 2 consists of seven chapters on chemistry and physics, one being on deposits at the bottom of the sea and three on sea water in motion. The leading idea in these chapters is that "the seas, all together, constitute a great dynamical system with an intricate and world-wide mechanism for mixing everything soluble that comes into it". Of course, physical and dynamical processes are not considered in any detail. Many results are quoted from the recent writings of H. U. Sverdrup, and the whole appears to be up to date and accurate. These chapters have many biological references and prepare the way for dealing with conditions under which marine plants and animals live.

Part 3 consists of seven chapters on life in the sea which are packed with information. There are numerous references in footnotes which pay a handsome tribute to Murray and Hjort's "The Depths of the Ocean", now unfortunately out of print. The author states that "life in the sea cannot be treated adequately in a few chapters : volumes are required", and the truth of this is constantly in the mind of the reader ; but the tension is eased by the inclusion of a useful summary at the end of each chapter. The author depends, to some extent, upon a historical approach to unfold the theme of each chapter. He takes the reader back to the benthos and nekton of Haeckel, and is obviously impressed throughout with similar classifications of marine animals according to their mode of life. One chapter deals briefly with algæ, diatoms and dinoflagellates as pasturage of the sea, with a passing reference to the growing importance attached to the study of marine bacteria. There are two chapters on plankton. This is described by reviewing members according to the groups or phyla to which they belong. Then follow chapters on the benthos and nekton, the latter concentrating upon fishes with a special paragraph headed "Useful Fishes". There are also interesting references to the methods of capturing fish which fall in line with the equally useful descriptions in earlier chapters of gear used for obtaining plankton and bottom fauna. To complete the survey, turtles, seafowl, sea otters, sea lions, sea cows and whales are included. Altogether, a full programme which may leave the reader a little breathless, but which ought to stimulate his interest in "This Great and Wide Sea".

SOIL FERTILITY

Chemicals, Humus and the Soil

A Simple Presentation of Contemporary Knowledge and Opinions about Fertilizers, Manures and Soil Fertility. By Donald P. Hopkins. Pp. 278 + 5 plates. (London : Faber and Faber, Ltd., 1945.) 12*s.* 6*d.* net.

A FEATURE of the present-day attitude to agriculture is the increasing concern about soil fertility. Formerly this was confined to a limited number of specialists; but the impact of two world wars and the resulting shortages made all of us think about food, and awakened an interest about soil problems in the more reflective. There is an increasing literature about these matters both from the scientific and economic points of view, and Mr. Hopkins' very readable book deals with a section of this field which has perhaps received wider publicity than any other. The late Sir Albert Howard and his followers have for many years advocated certain methods of soil management in which humus maintenance by means of composts plays the chief part, and chemical fertilizers are entirely excluded. It is claimed that crops grown on compost are healthier and of better feeding value than those grown with chemicals and, further, the continued use of inorganic salts damages the soil population. The full thesis of the compost school has never been accepted by soil scientists ; but the case has been put forward with such energy and conviction that there have been many converts, while others are left wondering if there may not be another side to the story. It is here that Mr. Hopkins' book fills a real need. Its purpose is to set out for non-specialist readers the evidence for and against fertilizers as fairly as possible. The author is a chemist engaged in the manufacture of fertilizers, so complete detachment can scarcely be expected; nevertheless his case is presented with a skill and moderation not always found in the rival school.

The book is in two parts. The first deals with the broad facts of plant nutrition, and shows that, unaided, most soils are unable to supply sufficient readily available nutrients for high production. Innumerable field trials have proved that fertilizers rightly used can supply this nutrient deficiency. A discussion of the various means of enriching the soil in organic matter follows, and estimates are given to show that all the organic wastes in sight are insufficient to meet the nitrogen requirements of an intensive arable agriculture. The rational procedure, which has the backing of almost all scientific opinion, is to use as much organic material as possible for its humic value and supplement its nutritional content with chemical fertilizers. In the second part of the book the author examines the charges that fertilizers inhibit mycorrhizal development, and exterminate earthworms and bacteria. He concludes that these charges are not proved ; although gross misuse of fertilizers, such as the rendering of soil excessively acid by continued heavy doses of ammonium salts, may upset the soil populations. Passing on to the argument that fertilizers cause plant disease, the author points out that there were devastating outbreaks of disease before artificials were in general use. Once again wrong use of fertilizers, unbalanced nitrogen applications, may increase susceptibility to certain diseases. It is on the grounds of the alleged improved food value of produce grown with humic fertilizers that the compost school have gained many adherents. Even here the evidence from official research stations appears to be negative. Experiments that gave positive indications have, strangely enough, not been extensively repeated ; while evidence based on the state of health of widely separated communities consuming different diets is not convincing.

Several topics not directly in the line of argument are included ; for example, a concise and well-informed chapter on the fertilizers themselves.

Mr. Hopkins' book is written in a much less formal style than the scientific text-book, and he goes to some trouble to dissect faulty arguments. Apart from the public to whom it is addressed, many students who have mastered the elements of their subject might read this book with considerable profit.

Material for Visual Education

By Betty M. B. Harris. Edited by G. Patrick Meredith. (Published for the Film Council.) Pp. 96. (London: *Daily Mail* School-Aid Department, 1947.) 2*s.* 6*d.*

A VISUAL aid may fail through some inherent defect; or the right aid may be used in the wrong place, in which case the fault lies with the teacher. Yet not wholly so, for in the absence of any comprehensive survey of sources of visual material the teacher has too often been obliged to rest content with what he knew was available.

The book under review can fairly claim not only to map out the main areas of visual provision but also, by an ingenious and practical system of indexes, to make everyman his own explorer. Thus the inquirer for, say, a filmstrip on Chinese art is led through successive summaries, each of which narrows his field of search, until he arrives at the address of the organisation most likely to meet his need.

This book will be much thumbed and deserves a more substantial binding. Regarded from the point of view of a work of reference, the appendix, which deals more generally with the theme of visual education and with the work at University College, Exeter, might well have awaited the separate and more detailed account which is promised in the text.

It is to be hoped that there will be future editions which will expand the work where necessary and keep it up to date. In which case, again for ease of reference, pages of advertisements should not be interspersed with the text. The pertinent reminder, in the Films Section, that "inclusion in a catalogue is no guarantee of merit", might well be transposed to the preface. Eric Lowe

They Live in the Sea

By Douglas P. Wilson. Pp. 128 (90 plates). (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1947.) 12*s.* 6*d.* net.

THIS book of most beautiful photographs cannot fail to delight. To the biologist it is fascinating, and to those with only a superficial interest in natural history, or little appreciation of natural beauty, it is a revelation. From such a collection it is difficult to select individual pictures for special mention. The most dramatic are the series showing a Portuguese man-of-war capturing and feeding upon a wrasse, and that showing a cuttle-fish securing a prawn after a first attempt successfully dodged by the prospective victim. But the author is not content with the dramatic only, and follows up the studies of *Physalia* with an excellent photomicrograph of nematocysts, discharged and undischarged, and an enlarged view of the gastrozooids digesting the fish. No less striking are the studies of the strobilation and release of medusæ by the scyphistoma of *Aurelia*. Some of the most beautiful pictures are those of semi-transparent animals, where the author has been highly successful in showing the translucency of sea-anemones, alcyonarians, prawns, ascidians and larval forms. The text, avoiding technicalities and Latin names, gives a clear and accurate account of the animals portrayed in the plates. A short chapter deals with dredging and trawling; and any biologist who has worked at Plymouth during the last half-century will recognize with pleasure the characteristic portrait in Plate 25. From this author we expect outstanding pictures, and we are not disappointed. L. Harrison Matthews

Light, Vision and Seeing

A Simplified Presentation of their Relationships and their Importance in Human Efficiency and Welfare. By Dr. Matthew Luckiesh. Fourth printing. Pp. xiv+323+16 plates. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1946.) 25*s.* net.

IN this book will be found a popular and readable account of numerous problems relating to lighting and vision. A large number of important psychological and physiological experiments carried out under the author's direction are reported in simple terms, with very clear diagrams illustrating the meaning of the results in a practical form. After reviewing the difficulties presented to the human eye by the needs of reading and innumerable everyday activities, the author proceeds to consider eye-defects, and the practical problems and history of artificial lighting. Then he studies the influence of various factors in making objects visible: intensity of illumination, relative size, brightness contrast, eye movements and the time required for seeing, visual acuity and its measurement by test charts. Later he considers the physiological effects of seeing, practical problems of lighting, various common illuminants, colour discrimination, glare and other important matters, including the relation of safety and efficiency to the ease of seeing. At the end of the book he includes answers to one hundred common questions about vision, light and colour.

The industrial psychologist and lighting engineer will find this book a mine of valuable information and practical help about problems of applied science as far as vision is concerned. R. W. Pickford

Molds, Yeasts and Actinomycetes

A Handbook for Students of Bacteriology. By the late Dr. A. T. Henrici. Second edition, by Dr. Charles E. Skinner, Dr. Chester W. Emmons and Dr. Henry M. Tsuchiya. Pp. xiv+409. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 5 dollars.

AS a short and readable handbook for the many different categories of student and research worker concerned with mycological problems, whether industrial or medical, this new edition of Henrici's well-known book should prove of real value. It is up to date—in so far as this is possible at a time when the whole subject is in a state of rapid advance, with the concomitant production of a vast new literature. Indeed, a more or less complete re-writing of the earlier edition has been necessary in order to do justice to the many exciting discoveries of the past decade. The aim, like that of the earlier edition, has been to provide bacteriologists with some of the knowledge which they ought to possess concerning other groups of parasitic and saprophytic micro-organisms, that is, yeasts, moulds, and actinomycetes.

The result is a book which, within its set limits, should prove useful to many. The stress, of course, is on the medical and industrial applications of mycology. In fourteen chapters, a wide range of topics is discussed and admirably illustrated. These include general dissertations on the structure, classification and methods of study of moulds, yeasts, etc., and particular accounts of fungi causing diseases of man and animals, and of use in industrial fermentations, etc. Yeasts and actinomycetes are accorded a fairly full treatment, and a final chapter is devoted to antibiotic substances.

THE NEW ERUPTION FROM HEKLA

By Dr. G. W. TYRRELL
University of Glasgow

AFTER a hundred and two years of quiescence, Hekla broke out in violent eruption at about 6.50 a.m. on March 29, 1947. Three days later, Dr. Jòh. Àskelsson, of the High School of Reykjavik (University of Iceland), sent me a fragment of the new lava, which I described in a 'letter' in *Nature* (May 10, 1947). The lava proved to be identical with previous Hekla lavas and, indeed, with the general run of Recent lavas in southern Iceland. I got into touch with Dr. Trausti Einarsson, also of the University of Iceland, who, as well as Dr. Àskelsson, had been a research student in the Geological Department of the University of Glasgow. Dr. Einarsson sent me numerous newspaper cuttings (in Icelandic), two long letters descriptive of the eruption, and a new book, "Hekla", by Gudhb. Kjartansson (167 pp., with numerous illustrations and a map), which was published as a Yearbook of the Icelandic Touring Association, 1945. What follows is mainly derived from Dr. Einarsson's letters.

Numerous observers have been following the eruption, and relays of workers have made it possible to record its phenomena hour by hour. In addition to J. Àskelsson and T. Einarsson, G. Kjartansson (author of the above-mentioned book), S. Thorarinsson, P. Hannesson, T. Tryggvasson and S. Sigurdsson among Icelandic geologists, N. Nielsen and A. Noe-Nygaard from Denmark, A. Gavelin from Sweden, and L. Hawkes of Bedford College, London, have visited Hekla and have worked on various aspects of the eruption. Samples of rocks and gases are being analysed in the State Research Laboratory, and some geophysical work is being done. Kjartansson and Tryggvasson will collaborate in a petrological and chemical study of all Hekla lavas.

According to Einarsson (letter of May 26), the main events of the eruption were as follows. It began a little before 6.50 a.m. on March 29, apparently without any preliminary symptoms. A considerable earthquake shock was felt as far away as Reykjavik; but, curiously enough, few noticed it in the region immediately surrounding the volcano, and people in farms only 9 km. distant were not even awakened. No serious damage was done by this shock. The sky was clear and, immediately after the shock, an enormous column (of steam and ash ?), more than 20 km. in height, was seen from Reykjavik. A north wind was blowing which carried the erupted material southward. The inhabited regions of Fljòtshlidh and Eyjafjöll were enveloped in complete darkness and soon covered by a layer of pumice and ash three inches thick. A continuous wall of black 'smoke' 10 km. high extended far out to sea.

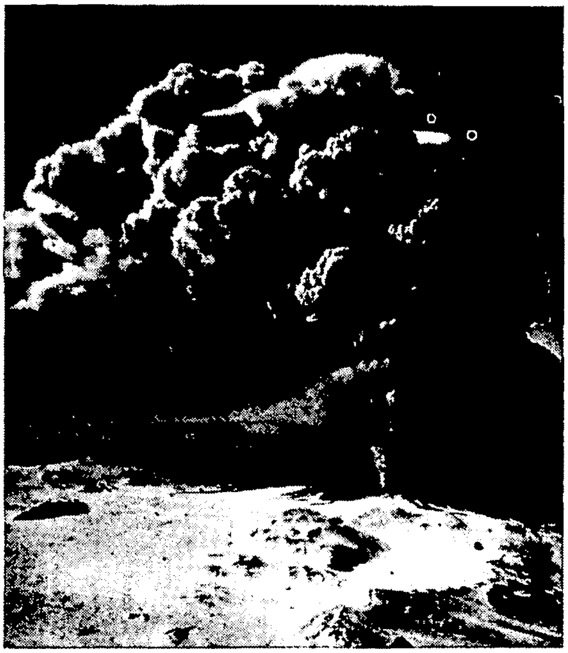

Fig. 2. HEKLA, MORNING OF MARCH 29, 1947, LOOKING SOUTH-SOUTH-WEST. PHOTO BY V. SIGURGEIRSSON, REYKJAVIK

At 10 a.m. Einarsson and others took aeroplane to the scene and found black clouds of ash being whirled out with tremendous force from a number of craters along the whole length of the volcano. (Hekla is an elongated ridge rather than a cone; see map, Fig. 1.) The mountain itself seemed a trifle in comparison with the enormous columns of ash (see Fig. 2). Lava had even then reached the plateau surface to the north and east of Hekla, and it was ascertained later that the lava was actually issuing from the whole length of the ridge. Streams of black mud were also being generated, no doubt by the mixture of thawed glacier ice and snow with ash; and on the first morning of the eruption an enormous rush of water from the north-west slope of the volcano caused a flood in the River Ytri-Rangà—a common feature of previous eruptions (see map).

Einarsson measured the temperature (950° C.) of a lava flow from a low-level crater on the south-western flank near Nafrholt. The lava here is welling out quietly as a fountain, and is very viscous. "With good asbestos insulation", says Einarsson, "it would be a simple matter to walk on it in the crater

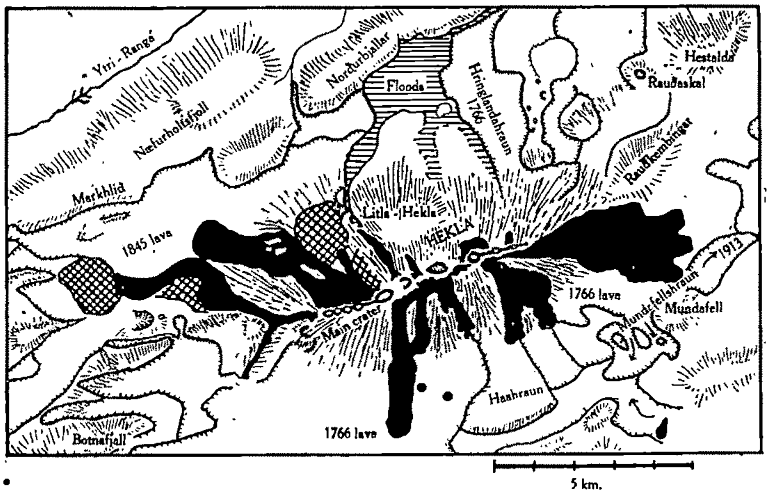

Fig. 1

itself. You can stand on the rim in the crater and reach the lava with a stick."

At the same time furious explosions were taking place in the higher craters. In a few days, however, the activity greatly diminished, especially at the northern end of the ridge. Lava ceased to flow from the crest, but flowed continuously, and still flows, from the low south-western craters. The extent of the new lavas on April 8 is shown on the map (in solid black).

While all activity ceased in the north-east and lava ceased to flow from the crest, violent explosions continued at the summit crater and the high-level craters of the south-western flank. In many of the explosions large blocks were thrown to a height of 500–600 m., and the detonations were so loud that it was difficult to sleep in Thórsádalur, 20 km. distant from the volcano. Again, at shorter distances, the same explosions did not seem to be so loud owing to some acoustical trick.

Flashing arcs of light were a common sight. Ash was only occasionally blown out in quantity and was harmless at first. Nevertheless, if it continued into the haymaking period serious effects would follow. The pumice fall in Fljótshlidh and Eyjafjöll, however, caused the evacuation of some farms.

With the exception of the initial shock, notable earthquakes have not occurred in the vicinity of the volcano; but in the district of Ölfus very heavy shocks occurred on May 19. Hot-spring activity was greatly augmented, and every quiescent pool in a long, narrow strip of country became a violent geyser of dirty water.

In a further letter (July 17), Dr. Einarsson states that the eruption goes on. Lava still flows uninterruptedly (presumably from the south-west craters) without any noticeable decrease of volume. The eruption of ash, however, has diminished to insignificant proportions, and is doing no harm. A curious result is that "during one period of heavy ash fall and dry weather the sheep got the usual 'eruption disease', which is caused by fluorine, but when a rainy period set in they somewhat recovered. The disease is, so far, not very serious."

With regard to the magnitude of the eruption, Dr. Einarsson is of opinion that the present eruption is at least as great as that of 1845, and will probably prove ultimately to be greater.

I visited Copenhagen on a lecture tour during October, and gained a few further details from Prof. A. Noe-Nygaard, and saw his very fine film of the eruption. The new crater on the summit is 300–400 m. in diameter, and has reached a height of 100 m. The orifice which continues to emit lava at the south-western end of the ridge is a fissure with six or seven small craters, very clearly seen in the film. The line along which the new eruption has taken place is situated some distance to the west of the still visible rent from which the eruption of 1845 was emitted. The film shows the minute details of the over-rolling and incorporation of solid lava-blocks by the liquid lava, and of auto-intrusion.

The accompanying map is re-drawn from a map published in the newspaper *Morgunbladid* (April 15, 1947) by Kjartansson, Hannesson and Thorarinsson. It shows the extent of the new flows (solid black) with additions (hatched) up to May 20. The very fine photograph of the eruption was taken by V. Sigurgeirsson of Reykjavik on the morning of March 29, the first day of the eruption, looking south-south-west.

Addendum. In a recent letter (November 9), Dr. Einarsson states that lava is still flowing in undiminished quantity from the crater on the south-west. Explosive activity ceased at the end of June. The lava is becoming very rich in gases and is more fluid than before, while the temperature remains constant.

CORN (*ZEA MAYS* L.) GENETICS IN THE UNITED STATES

By GORDON HASKELL

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MAIZE (*Zea Mays* L.), or 'corn' as it is known throughout North America and so called throughout this article, is by far the largest crop grown in the United States, having many different uses ranging from animal food, a basis for the manufacture of nylon, to its use as table sweet corn. It is therefore not surprising that much time and money are spent investigating the corn plant. In addition to its economic importance, corn possesses a number of properties making it useful experimental material for cytologists, geneticists, plant breeders, and for evolutionists interested in the origins of cultivated plants. Some aspects of the genetic and breeding problems now attracting attention and an indication of lines of approach for solving them will give a brief indication of current work with this plant in the United States.

The problem drawing very wide attention at the moment is how to estimate combining ability of inbreds used in the production of hybrid seed corn. Modern strains of corn used commercially throughout the United States are known as 'double crosses' derived from crossing four inbred pure lines thus: $(A \times B) \times (B \times C)$. It is therefore highly important to know what open-pollinated varieties still in existence are more likely on inbreeding to give rise to inbreds which have the ability to produce the largest amount of hybrid vigour when crossed with other inbred lines. Jones, Singleton, Nelson and Hayes believe that it is best first to obtain the inbreds themselves possessing good plant characters before determining their potency in various combinations with other inbred lines, their principal argument being that it is no use having excellent hybrids if the inbreds which go into them are difficult to keep going from year to year. This is very important for the seedsmen. On the other hand, Jenkins, G. F. Sprague and colleagues at Iowa State College advocate early testing, that is, to determine the potency of different lines before inbreeding. General combining ability defined as the average performance of a line in hybrid combinations, and specific combining ability with a standard tester line, may both be used as pre-testers before commencing the inbreeding programme. Early elimination of varieties which pre-testing indicates will not produce inbreds possessing good combining powers, and selecting only the upper range, saves much labour inbreeding potentially unproductive material. The disadvantages of this method are, however, that testing requires a large amount of land and that open pollinated lines of corn are so heterozygous that often inbreeding has a drastic effect. There is no stability of the numerous genes segregating until after several generations of inbreeding, so that the combining ability of the derived inbreds has still to be estimated later, and this will vary *intra se*.

There has been some attempt to predict the value of inbred lines, using a cytological method. It now seems probable that the dent corn of the Mid-West was originally derived from hybridization between southern prolific dents and northern flint corns. Inbreeding mid-western dents releases variability, which manifests itself in plant habit and ear characters. The problem is to determine what two inbreds give the greatest heterotic effects and to determine whether this is predictable on the basis of the characters of the derived inbreds. It has been known that the greatest jumps can be expected from inbreds derived from open-pollinated varieties which differed widely in plant type and source of origin, for example, the northern corn belt hybrids which are dent corn crossed with flint corn, and the sweet dent silage hybrids. Inbreds derived from mid-west dents range from flinty types to extreme dent kinds. Longley had previously studied the positions of corn chromosome knobs, and Brown is now applying this method to inbreds derived from mid-west dents; those inbreds having knob numbers of approximately two are most like the northern flints, while those with higher numbers are more like southern dent corn. One would therefore expect that hybrids between inbreds of high and low knob number would be better than those between high knob numbers or between low knob numbers. Therefore a combination of seed characters and knob number of inbred lines may assist in reducing their number for testing and may indicate what inbred combinations are likely to prove most profitable.

The present basis for the hybrid corn industry has depended upon inbreeding different strains of open pollinated varieties to obtain the inbred lines, and then to make two sets of F_1 hybrids and cross these together to obtain the double-cross commercial hybrid. To obtain satisfactory homozygosity the lines may require not less than four or five years of selfing, and even then the amount of inbreeding depends upon how far the eye can judge the purity of such lines. Thus any method that could (*a*) short-cut the inbreeding programme and (*b*) give a more dependable amount of homozygosity would be valuable. Such attempts have been made. For example, a number of workers have investigated the effect of using pollen, sufficiently damaged by X-ray treatment as to be incapable of effecting fertilization, yet still viable and capable of growing down the style. By so doing it was hoped to stimulate haploid development of the egg cell without fertilization. So far results have been negative, and now Lindstrom is making a new attack on the problem, first by the application of numerous chemical substances to the silks to induce parthenocarpy, and also by exploring the possibility of using a method already successfully applied to *Linum*, namely, the selection of polyembryonic seeds in the hope that some of the embryos will be haploid. The haploid set of chromosomes can then be doubled with colchicine, immediately giving rise to autodiploid plants. Such plants would have much value in future investigations. It would seem, however, that these short-cuts must at the moment be considered more in the light of academic interest than of economic value.

Another problem of corn breeders is that even though they may establish inbred lines which carry with them the required amount of homozygosity to allow their use in hybrid combinations producing hybrid plants uniform for such quantitative characters as maturity, height and ear length, major mutations constantly occur. Jones first thought that degenerative changes were associated with the change in combining ability of the inbred lines; but now it seems likely that invisible mutations controlling combining ability continually occur in them, and are not readily detected until the inbreds are hybridized, either to inbreds from different sources or back to the original inbred lines. Hence the major degenerative changes only acted as stimulants for testing and so disclosing the cryptic mutations, but were not themselves responsible for such changes.

There are quite a number of general selection experiments with various types of corn for characters under multifactorial, or polygenic, control. One group of experiments refers to the selection of certain chemical constituents of the corn kernel. For example, at Iowa State College work directed towards the production of inbreds and hybrids of waxy corn is comparable with methods used for the production of field corns. The waxy gene corn was successfully utilized during the war years as a substitute for tapioca. Similarly, the oil content of kernels has been increased by the selection of strains with large embryos, hence increasing the value of corn feed. Many straight selection experiments with corn are being practised at the northern edge of the corn belt to obtain hardy lines which are also adjusted to the altered day-length of this area. Thus Minnesota, Wisconsin and Maine Agricultural Experiment Stations have developed crosses between flint and dent corn to give flint/dent hybrids with good plant and ear characters yet sufficiently hardy for the northerly areas. At the same time the Central Experimental Farm is selecting good flint lines for Ontario. So the corn-growing area is gradually moving farther north.

Another problem attracting much attention is the study of principles underlying the ability of some lines of corn to germinate after remaining under cold soil conditions while other lines are severely damaged. These investigations are being carried out at the Minnesota, Iowa and Connecticut Agricultural Experiment Stations and elsewhere. Hayes and his colleagues have now investigated the genetical basis for such phenomena, having established that different lines have different resistance to cold treatments. Haskell has determined the hardiness of some of the Connecticut inbred sweet corn lines and found, contrary to expectation, that they are not always worse than the behaviour of the starchy control under the conditions of the experiment. In general, although the usual experience of breeders is that sweet corn seed over a wide range of conditions germinates more poorly than that of other types of corn, this may not be due directly to the *Su*/*su* relationship, but to closely linked genetical factors and also to easier damage of the wrinkled sweet kernels during drying and threshing in the seed factories, which later allows pathogenic soil organisms to penetrate more easily. Commercial seed companies now use cold-room tests for determining the value of their corn strains. This is important, as the effects of the continental climate of the United States, with extreme hot and cold rapid changes in the soil at germination time, require strains to be adapted to such conditions. In general, it has been found that conditions of 50° F. for 8–10 days are most expedient for test purposes, and probably also as a selection criterion for a breeding programme.

Since the production of the first Golden Cross sweet corn by Glen Smith, hybrid sweet corn production has greatly progressed, with the adaptation of special inbreds and their hybrids for particular areas of the States. In view of the fact that sweet corn is primarily a canners' crop, great stress has been laid on uniformly maturing hybrids, and sweet corn breeders have established a complete series of early, medium and late inbreds and *single cross* ($A \times B$) hybrids, so that growers can use mechanical pickers and sweet corn canneries can work over a spread of time. Compared with field corn, sweet corn breeding has been to some extent simplified because single crosses may be used, the prices of seed being higher than for field corn. With the maturity range established, attention is now largely focused on quality testing. This is an elusive item to estimate, and although the sugar content of kernels is of some value, still the only satisfactory method is by tasting, usually in the raw state, rather than by any laboratory tests, such as estimating translucency, or puncture testing for pericarp tenderness. By experience, sweet corn breeders generally agree upon what good-quality sweet corn should taste like. Attention is also paid to the behaviour of the different sweet corn hybrids under freezing methods, since more ears are sent to market on ice each year.

Many of the northerly experiment stations in the United States and also in Canada are selecting early, hardy sweet corn lines. Owing to the sudden killing frosts towards the end of the season, these strains must be so adapted that seed is sufficiently matured for safe picking and for artificially drying before being otherwise killed on the ear. There have been various determinations of the optimum drying conditions. In general a temperature of 100° F. for three days is often sufficient to bring down the moisture content of the seed in the hard dough stage to a level permitting safe storage. Besides pushing sweet corn production northwards there is also an active attempt to spread sweet corn for canning and direct eating into the Southern States, where white dent corn is now grown for roasting. The resistance to the use of yellow sweet corn seems largely to be based on ignorance of the southern farmers and to the fact that no hybrid strains have been adapted to their climatic conditions, many northern hybrids being unable to meet the severe attacks of the corn ear worm in this region. These particular problems are now being overcome.

For a long time much attention has been paid to the history of the corn plant, concerning the origin of present forms and how it spread through the North American continent with the movements of the early American Indians. In addition, corn is one of the few cultivated plants the prototype of which has so far not been discovered growing wild in Nature, and its ear, so different from the female inflorescence of other members of the Gramineæ, offers interesting material for investigation. There is a division of opinions as to the source of corn. Mangelsdorf, Reeves and Merrill believe corn is a specialized product of selection by early American Indians of a grass that grew wild on the American continent. The present site of this prototype is still to be located, but evidence points to South America as the primary centre of origin. Teosinte (*Euchlæna*) is a hybrid between maize and *Tripsacum*, and is not a progenitor of maize, although where teosinte grows as a weed in Mexican corn fields there is a high incidence of hybridization. On the other hand, Edgar Anderson suggests that besides genetical indications, there are several pieces of ethnological evidence which suggest Burma as a possible source for the origin of corn. He has enumerated several pieces of circumstantial evidence showing similarities between Asiatic and Pre-Conquest civilizations. In addition, it is known that other members of the Tribe Maydeæ, to which maize belongs, occur in tropical Asia.[2]

Similarly, views on the origin of sweet corn are at variance, Mangelsdorf believing that the *su* mutation for sugary kernels has occurred spontaneously in different areas throughout America, and has been adopted by local farmers in those areas for specialized use, such as making fermented liquors; while Edgar Anderson conceives that the sugary mutation has gradually spread northwards across the American continent from a more southerly point of origin. At the present time, although much light has been shed on these problems, the origin of corn still awaits a final solution.

Acknowledgments are made to the Agricultural Research Council of Great Britain for funds allowing the writer to visit the corn belt of the Mid-Western States.

ASPECTS OF THE LOCOMOTION OF WHALES

By R. W. L. GAWN, O.B.E.
Superintendent, Admiralty Experiment Works, Haslar

REPORTS of the 1946–47 British Scientific Expedition to the Antarctic Whaling Ground have revived interest in the locomotion of whales and other marine mammals and fish. Some interesting studies and information on this subject already exist, but many of the reports of speed recorded in the past have proved rather conflicting in character. Care appears to have been taken on the recent Expedition to obtain reliable observations, and it now appears to be substantially confirmed that a blue whale can attain a speed of 20 knots for a short burst of about ten minutes duration, and maintain a speed of 14½ knots for two hours and probably longer. A killer whale may obtain slightly higher speeds.

The shape of fish and marine mammals has naturally been an inspiration for the forms of underwater bodies for a great many years, and investigations have been carried out accordingly. It is pertinent to examine whether any lessons can be learnt from the whale and other marine creatures that can contribute to faster speeds of submarines and other underwater locomotive bodies.

Particulars of the shape of fish and marine mammals were given so long ago as 1919[1]. The form is not unlike that of a good streamline body. A blue whale of normal proportions may be about 90 ft. long and as much as 120 tons weight. The shape is illustrated in Fig. 1.

In order to propel a smooth rigid body of this size and shape at 20 knots, it is estimated that 520 horsepower would have to be developed by the whale. The estimate for other speeds is shown in the curve in Fig. 4. This curve is deduced from measurement of the resistance of models of smooth rigid bodies towed in water.[2] These bodies form eddies which account for a fair proportion of the total power. It may be argued that the whale may succeed in avoiding eddy resistance by the natural flexure of the tail and

FIGURE 1

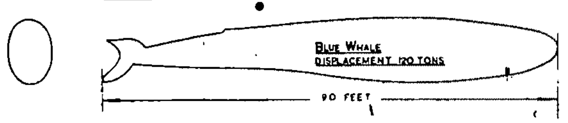


FIGURE 2

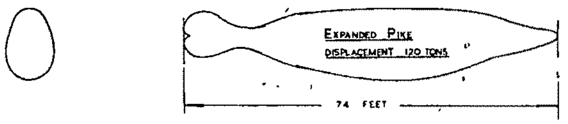


FIGURE 3

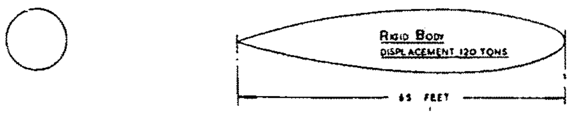
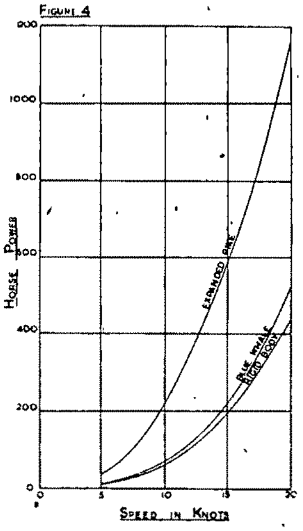


FIGURE 4



after-body generally. On the other hand, the unevenness caused by the fins and the fluting of the body will result in some increase of the horse-power required as compared with a smooth rigid body. It is also assumed that the propulsive efficiency of the tail of the mammal is equal to that of the best marine propeller, namely, 75 per cent. Here again it may be argued that a higher efficiency should be assigned because the tail of the whale is a comparatively large surface and moves at a slow rate. It may therefore be assumed that the rate of change of momentum to propel the whale is achieved by discharging a large quantity of water astern at a comparatively low speed. As a result the kinetic energy wasted in the race will be reduced. The energy so lost may be only about 10 per cent of the total, which indicates a possible 90 per cent for the efficiency. In assessing an efficiency of 75 per cent, I have, however, been guided by the results of a few experiments on flapping fins that have been carried out abroad.

It is of interest that the horse-power curve so obtained is very similar to that previously recorded in *Nature* by Prof. A. Krogh[2], although the method of estimate is different. In particular, the previous estimate assumed an efficiency of 100 per cent for the 'propeller', which is clearly inadmissible because of the loss due to kinetic energy in the water discharged sternwards.

If the curve in Fig. 4 truly represents the performance of the live whale, the developed horse-power per ton is 4·35 at 20 knots and 1·75 at 15 knots. This expenditure of power in relation to the weight is comparatively large and implies that the whale attains its remarkable speed by exertion of large power rather than by any special virtue in shape of body or smoothness of skin. There is no known measurement of the power which a whale can develop. Some approach to the problem can, however, be obtained from physiological researches. This question has been discussed by Gray[3] and Barcroft[4]. It appears that 0·01 horse-power per lb. of muscle is developed by athletes and dogs. There seems no reason for believing that whale muscle is more efficient as a machine than the muscle of other mammals. It also seems established that about 40 per cent of the weight of a whale consists of muscle. On these assumptions it would appear that the whale can develop 9 horse-power per ton of total weight. Thus the estimate of horse-power given in the curve is not inconsistent with the power obtainable from the muscles of the mammal.

It may be suggested that the surface friction resistance of the whale is less than that for turbulent flow past a rigid body. Taking a favourable view, the flow may be laminar. The horse-power would then be much less than that given in Fig. 4. While there is no definite evidence to prove or disprove this, such an explanation of the speed of the whale is unnecessary, since the horse-power mentioned above is not beyond that to be expected from a creature of 120 tons weight. There is also independent evidence[1] that great power is, in fact, developed by the whale; for example, a Sei whale is reported to have towed a vessel at 12 miles per hour, and a blue whale to have towed a steamer at 7 miles per hour, although the engines were working full speed astern.

A point which must not be overlooked and on which further information would be valuable is the means by which the whale avoids excessive rise of temperature when developing this large power. Assuming 22 per cent efficiency for the muscular engine, then the rise of temperature of the whale for a 10-minute burst of speed at 20 knots may be about 3° F., unless arrangements are made for dissipating the heat.

It should be added that the estimate of horse-power in Fig. 4 assumes that the whale is so deeply submerged that surface waves are not produced. It is understood that a whale normally proceeds at about three fathoms submersion and frequently on the surface. If the whale is proceeding on the surface at low buoyancy, it is estimated that the horse-power at the top speed would be treble that in the figure. If at three fathoms depth, the increase would be about 50 per cent. These estimates are deduced from experiments that have been made in water on models of shapes analogous to the whale.

A fish for which there is reliable information is the pike[5]. Experiments were carried out in the Hamburg Ship Model Experiment Tank. An anæsthetized pike was towed in the experiment tank, and the resistance measured at various speeds. The resistance was much greater than for a smooth solid body of similar shape. The oil exuded by the fish mollified the unevenness of the skin due to the scales to some extent, but the reduction in skin friction was inconsiderable. Observations of the speed of pike gave maxima of 6–8 knots, the mean speed being 5 knots. The effective horse-power per ton is considerable and varies from 26 at 8 knots for a large pike to 53 at 6·8 knots for a small pike. The tests established that the speed and form of individual fishes of the same type vary considerably. So far as they go, the experiments do not support the theory that fish have abnormally low surface friction.

Possibly anglers whose equipment has suffered in the struggle with a lively victim might hold the view that the pike tested in the Hamburg Tank were rather unenterprising. I am not an angler, but I have observed fish and have been impressed with their capacity for developing high acceleration over short periods. This led me to take the opportunity when in Hamburg before the War to discuss the experiments on pike with Prof. G. Kempf, director of the Hamburg Experiment Tank. I feel assured that the investigations on the pike were most carefully conducted, and that the results should be accepted as an accurate record of the performance of the species tested. Very complete particulars were taken of the shape of the pike. Fig. 3 indicates a pike of weight 9·05 lb. expanded to 120 tons to compare with the blue whale shown in Fig. 2. The horse-power for the pike as measured in the Hamburg Tank has also been expanded by the usual method adopted in ship-model experiments to compare with a whale. It has again been assumed that the propeller efficiency is 75 per cent. The horse-power curve for the expanded pike is shown in Fig. 4. The horse-power considerably exceeds that for the whale. This naturally casts a doubt on the estimate for the whale, but it may also reflect the wide difference between a small freshwater fish and a large deep-sea mammal. It is of interest to compare the performance with that of a rigid body of good design. Such a body is shown in Fig. 3. A model of this body has been tested both in water at the Admiralty Experiment Works, Haslar, and also in a wind tunnel. The horse-power curve deduced from the results is also shown in Fig. 4. The results compare favourably with the expanded pike and the whale.

Porpoises have been credited with a speed of 25 knots. This is a very high speed for a small creature to maintain for any length of time. Proceeding in the same way as for the whale, it is estimated that 14 horse-power would be required at this speed for a porpoise of 0·16 ton weight. This represents the high figure of 87 horse-power per ton. If, however, the speed is 20 knots, the horse-power per ton is reduced to 43, which is comparable with the pike.

It would be of great interest to ship designers and more particularly those associated with the design of submarines and other underwater bodies to obtain some reliable information concerning the whale. The day may be far distant when the towing power developed by the muscles of the whale can be accurately measured, but it would be of considerable interest to have the views of physiologists as to the muscular power. It should not prove a difficult matter to obtain a reasonably accurate measurement of the towing resistance of whales at various speeds. This is recommended for consideration by those responsible for organising future whaling expeditions. The whale differs from other marine creatures in that the tail is horizontal and moves vertically. Some information on the size of the tail and fins, and the method by which the whale dives and surfaces and maintains stability for course and depth, would also be of interest. If the particulars of the fin surfaces could be obtained, there is scope for wind tunnel investigations on the whale similar to the interesting tests on fish stability carried out by Harris[6].

I wish to express my appreciation of the help generously given by Dr. R. A. M. Case, of the Royal Naval Physiological Laboratory. Dr. Case was the leader of the 1946–47 British Scientific Expedition to the Antarctic Whaling Grounds, and he has provided particulars of the size and speed of the blue whale and has very kindly given references to the physiological work quoted in this article.

[1] "Experiments in a Wind Channel on Elongated Bodies of Approximately Streamline Form". *R* and *M* 607, March 1919 (Advisory Committee for Aeronautics).

[2] Krogh, A., *Nature*, **133**, 635 (1934).

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[4] Barcroft, J., "Features in the Architecture of Physiological Function" (Camb. Univ. Press, 1938).

[5] *Z. Ver. Deut. Ing.*, **79**, No. 33.

[6] Harris, J. E., "The Role of the Fins in the Equilibrium of the Swimming Fish. I. Wind Tunnel Tests on a Model of *Mustelus canis* (Mitchell)", *J. Exp. Biol.* (1938). II. "The Role of the Pelvic Fins", *J. Exp. Biol.* (1936).

OBITUARIES

Dr. C. C. Hurst

CHARLES CHAMBERLAIN HURST, whose death occurred on December 17, was born in 1870 and educated at Wesley College, Sheffield. As a member of the family firm at Burbage, near Leicester, he was early brought into contact with horticultural practice and problems, and at the same time afforded opportunity for embarking on the investigations with which his name is connected.

Hurst was working at cross-fertilization in orchids when Bateson's papers in the *Journal of the Royal Horticultural Society* in 1900 brought the news of Mendel's discovery to the English-speaking world. Hurst at once got into touch with Bateson and started experiments with rabbits and poultry with the view of testing Mendel's conclusions. With rabbits he was able to confirm the results of Cuénot on coat colour in mice, and his extensive series of crosses among poultry, an account of which appeared in the Reports to the Evolution Committee of the Royal Society in 1904, added considerably to our knowledge of the genetics of the fowl. Better known was his demonstration of the recessive nature of chestnut in horses, which provoked much discussion when read before the Royal Society.

Perhaps the piece of work for which Hurst is most likely to be remembered is his paper on the "Inheritance of Eye-colour in Man". Through the careful and laborious collection of data from his native village of Burbage, where he was well known and trusted, he was able to determine the recessive nature of blue to non-blue eyes, and must thereby receive the credit for being the first to demonstrate the Mendelian inheritance of a 'normal' character in man.

Although he had, as it were, strayed for a time in the animal kingdom, he had by no means given up his horticultural interests. His attraction to the genus *Rosa* led him to form an outstanding collection of wild forms from all over the world, and his hybridization work contributed much to the understanding of this remarkable case of polyploidy.

As to many another scientific worker, the outbreak of war in 1914 came as a sad misfortune. In his capacity of a Territorial officer he joined the Army, and at the conclusion of hostilities he found himself unable to carry on at Burbage. Thereupon he entered Trinity College, Cambridge, as a fellow-commoner, and eventually his research work led to the award of the Sc.D. degree by the University. Fortunately he had been able to shift much of his collection of rose species to the Botanic Garden at Cambridge and was able to carry on his study of the genus, cytologically as well as in the field. Meanwhile he wrote his book on "Creative Evolution", an attractively illustrated exposition of the state of genetics at the time.

Hurst was gifted with fine powers of observation. He had, too, enthusiasm for an idea and a capacity for sustained and pertinacious work, both of which he devoted whole-heartedly to the furtherance of genetical science. That he was somewhat lacking in critical faculty may have been due to the fact that he had not been through the academic 'mill'. He was fortunate, however, in that his collaboration with William Bateson brought him into close touch with a critical mind of the highest order. Without that influence he might have become more the gifted amateur than the solid contributor to the science that claimed his interest.

R. C. PUNNETT

Dr. Stephen Miall

THE death of Stephen Miall on October 12, 1947, in his seventy-fifth year, inflicted on chemists an irreparable loss. Yet, paradoxically—and he enjoyed a paradox as much as any man—Miall was not a chemist at all. Of Yorkshire stock, with an inherited leaning towards science or, at any rate, towards natural philosophy, he was articled to his uncle, partner in a London firm of solicitors, when nineteen years old. He took prizes and the degree of LL.D., but right up to his end many hundreds of industrial chemists in Great Britain and elsewhere must have been entirely unaware that 'Doctor' Miall—that kindly, erudite, sociable, eclectic personality emerging almost as clearly from his editorials in *Chemistry and Industry* as from his twinkling eyes and grave smile, when one met him—was, in fact, a doctor of law and not of science at all.

Nevertheless, his contact with the chemical industry dates back to the beginning of the century, when he became very much concerned with the manufacture of white lead and, as a result, with the humanitarian aspect of that technology; that is, with lead poisoning as an industrial hazard, in connexion with which he more than once attended an International Labour Conference or discussions at the International Labour Office. Some time after qualifying in law, he also took a London B.Sc.

Miall's editorship of *Chemistry and Industry* began in 1922, and he remained at this post until two and a third years before his death. During his retiral, his health was not what his many friends and admirers had hoped for him; but he often found time and ability to join them at his favourite local haunt or in the Savage Club, where his wisdom, knowledge and slightly mordant wit, almost always mitigated by a cheerful grin, made him a most popular as well as a distinguished and unmistakable figure. He had great erudition, though it was wide rather than deep. He used it to illuminate both his attractively and, indeed, uniquely written editorials and his very deliberate but equally unique conversation, an art the apparent passing of which he always deplored. Homer and Horace as often furnished his reading—and his quotations—as did the English classics: he knew them all intimately.

Among his activities, besides his editorial work, have been the compiling of a light-verse anthology, "Poets at Play", active participation in the Society of Yorkshiremen in London and 'The Catalysts' Club', and the writing and editing, jointly or alone, of books designed to strengthen the links between chemists, especially industrial chemists, and the non-scientific world, particularly that part of it concerned with the arts. It is not surprising that his death will be mourned by a large and varied collection of individuals, some of whom may never have met him and will therefore not experience the strong sense of personal loss that is common to all those who had.

A. L. B.
P. J. V.

Prof. G. C. MacCurdy

NEWS has been received of the death in a road accident, at the age of eighty-four, of Dr. G. G. MacCurdy, the well-known prehistorian and professor emeritus of Yale University.

George Grant MacCurdy came from the southern branch of a well-known New England family, which had retained a close contact with Great Britain. He was a graduate of Harvard and of Yale, and from 1894 until 1898 he followed postgraduate courses in anthropology at the Universities of Paris, Berlin and Vienna. During 1900–31 he was successively lecturer in anthropology, assistant professor of prehistoric archæology, and research associate with the rank of professor at Yale University, and during the whole of this time he was also curator of anthropological collections. In 1921 he took a leading part in the foundation of the American School of Prehistoric Research, and was its first director, a post he held until last year, and in which he was supported by the collaboration of his wife, Janet Glenn Bartlett, whom he had married in 1919. His tenure of the directorship was marked by the organisation of many successful vacation tours in Europe, and by participation with various British funds and institutions in prehistoric excavations in Iraq, Palestine and Bulgaria.

This work was very close to Dr. MacCurdy's heart, and he was justly proud of the leading part played by a member of his own school, Theodore D. McCown, in the discovery of the new human fossil, Mount Carmel man, during 1931–32. His disinterested courage and vision in thus committing his school to a participation in field-work in which he himself was not free to take an active part has been of incalculable value to the advancement of prehistoric studies in the last twenty years, and will be his lasting monument.

His friends and pupils will cherish an affectionate memory of a distinguished scholar with a singularly kindly, gentle and modest personality.

D. A. E. GARROD

Prof. Max Planck, For Mem.R.S.

PROF. J. R. PARTINGTON writes: I knew Planck as professor of theoretical physics in the University of Berlin. His course was spread over more than one year, and I began with the last and most difficult part, comprising thermodynamics, the theory of heat, relativity, and quantum theory, next year taking the first part, which dealt with general mechanics and the theory of deformable bodies. The lectures began at 9 a.m. in the University building in Unter den Linden; they were very well attended, and there were always many standing around the room. As the lecture-room was well heated and rather close, some of the listeners would from time to time drop to the floor, but this did not disturb the lecture. The windows were all closed, partly because of the intense cold and partly because of the noise of the changing of the guard outside. There was also an exercise class, conducted by Planck himself, which nominally began at 8 a.m., but usually about 8.15. The medical lectures began at 6 a.m., so the University building was well aired by that time.

Planck lived some distance away, in the Grünewald, and travelled into Berlin by the Stadtbahn. His train often ran parallel to the one I was in from Charlottenberg for a short distance, and Planck could be seen, in a compartment filled with clerks and shop-girls, conning his notes in preparation for the lecture. In the lecture itself he used no notes. He began by writing down a simple equation, but would soon be in the middle of a Fourier series, or, as in the theory of elasticity, a complicated equation which seemed to develop itself. He never made a mistake and never faltered. Very rarely he would take his notes out, look at the board, say "Ja", and put them back again. He spoke in a quiet, audible and pleasant voice, and was the best lecturer I ever heard. He had no mannerisms except one: he had two sticks of chalk before him in parallel arrangement, which he changed about in place from time to time when he was not writing; he had a small reading desk and did not walk about. The mathematics on the board was extremely neat and legible, even when German vector symbols were used, and was set out in systematic order.

Planck's method was to develop the subject logically from general principles, and even when short cuts were possible, he liked to bring each topic into its logical sequence in a general scheme. This made some of it hard going for such as myself. He disliked vector methods, and although he usually wrote the final result in vector form when desirable, the deduction was in terms of Cartesian or polar co-ordinates. He had two favourite sentences. One was "Wir können noch einen Schritt weitergehen", and the other "Jetzt ist die Sache vollständig genügend erledigt".

His lectures on sound included some theory of music, and he gave an extra demonstration with a special harmonium of the natural scale and its necessary modification, "während die praktische Musik, besonders seit der Einführung der Instrumente mit festen Tönen, mit einer endlichen, nicht zu zahlreichen Menge von Tönen auskommen muss".

Planck was just then developing the 'second' quantum theory of continuous absorption and discontinuous emission (which brought in the half quantum of zero-point energy). He was conservative, and a little shocked by Einstein's bold development of the photon. He was keenly interested in the impact of the quantum theory on general philosophical ideas, and shrank from the extreme view that its later phases removed the validity of the law of causality. To the rather pessimistic outlook which came over what was once regarded as the solid foundation of science he was unsympathetic. Theoretical physics had progressed, it is true, but to him it still had a meaning.

PROF. E. N. DA C. ANDRADE writes: "In the last paragraph of my obituary notice on Prof. P. Lenard (*Nature*, December 27, p. 895), I venture to refer to him as 'a dark genius'. Going through some old papers I have just found a letter, dated 1936, from a well-known German physicist whose name I refrain from quoting because of the difficulty, at the present time, of obtaining his permission. It contains the following passage which I have translated except for the actual quotation.

"I have found the following lines in Hebbel which refer there to the Lord God, but apply very well to Lenard in our Heidelberg time:

" 'Und aus seinen Finsternissen tritt der Herr, *soweit er kann*'."

WE regret to announce the following deaths:

Prof. E. C. C. Baly, C.B.E., F.R.S., Grant professor of inorganic chemistry in the University of Liverpool during 1910–37, on January 3, aged seventy-six.

Prof. P. A. C. Dangeard, member of the Botanical Section of the Paris Academy of Sciences, on November 10.

Dr. C. A. Mitchell, formerly editor of *The Analyst*, on January 5, aged eighty.

Mr. W. H. Pick, of the Meteorological Office, on December 26, aged fifty-seven.

Prof. H. A. Prichard, White's professor of moral philosophy in the University of Oxford during 1928–37, aged seventy-six.

NEWS and VIEWS

New Year Honours

THE New Year Honours list includes the names of the following men of science and others associated with scientific and university work:

G.C.I.E.: Sir Maurice Gwyer, vice-chancellor of the University of Delhi.

G.B.E.: Sir Edward Mellanby, secretary of the Medical Research Council.

K.B.E.: Sir James Irvine, principal and vice-chancellor of the University of St. Andrews.

Knights: Prof. F. C. Bartlett, professor of experimental psychology, University of Cambridge; Mr. H. Claughton, recently principal of the University of London; Dr. J. D. Cockcroft, director of the Atomic Energy Research Establishment, Ministry of Supply; V. Z. de Ferranti, chairman and managing director of Ferranti, Ltd.; Dr. W. Ivor Jennings, vice-chancellor of the University of Ceylon; The Hon. C. J. Lowe, chancellor of the University of Melbourne; H. R. Ricardo, chairman and technical director, Ricardo and Co., Ltd.; Dr. R. V. Southwell, rector of the Imperial College of Science and Technology, London.

C.B.: Dr. G. M. Bennett, Government chemist.

C.S.I.: W. T. Hall, chief conservator of forests, United Provinces, India.

C.M.G.: A. P. Mitchell, director of land surveys, Palestine; W. A. Robertson, forestry adviser to the Colonial Office.

C.I.E.: J. Petty, chief conservator of forests, Sind; W. D. West, director of the Geological Survey of India; Dr. R. E. Mortimer Wheeler, director-general of archæology, India.

C.B.E.: H. W. Bennetts, principal of the Animal Health and Nutrition Laboratory, Western Australia; G. L. T. Brough, deputy director of electrical engineering, Admiralty; J. C. Bugher, director of the Yellow Fever Research Institute, Yaba, Lagos, Nigeria; B. G. Crewe, assistant comptroller, Patent Office; W. J. Dawson, late metallurgical director of Messrs. Hadfields, Ltd.; W. S. Gordon, director of the Agricultural Research Council Field Station, Compton; J. Henderson, formerly director of the New Zealand Geological Survey; Mrs. S. Sutherland Isaacs, psychologist; London Clinic of Psycho-Analysis; Dr. L. A. Jordan, director of the Research Association of British Paint, Colour and Varnish Manufacturers; Prof. W. Kerr, Royal Technical College, Glasgow; F. Lambert, president of the Museums Association, director of the Walker Art Gallery, Liverpool; W. L. S. Mackintosh, director of Veterinary Services, Uganda; R. O'F. Oakley, assistant secretary, Department of Scientific and Industrial Research; Prof. G. W. Robinson, professor of agricultural chemistry, University College of North Wales, Bangor; Prof. C. Y. Shephard, professor of economics, Imperial College of Tropical Agriculture, Trinidad; G. F. Stebbing, honorary secretary of the Radium Commission; Miss M. V. Taylor, for services to archæology; J. S. Teasdale, for services to agriculture in Western Australia.

Prof. Hamilton Hartridge, F.R.S.

PROF. HAMILTON HARTRIDGE has recently retired from the University chair of physiology at St. Bartholomew's Hospital Medical College, London, in order to take up the post of director of the Medical Research Council's newly constituted research unit on the physiology of vision. The appointment shows the importance which the Medical Research Council attaches to this subject, and is a recognition of Prof. Hartridge's pre-eminent position and his contributions in this field. Educated at Harrow and King's College, Cambridge, Prof. Hartridge has had a distinguished academic and scientific career. A former fellow of King's College, he was lecturer on the organs of special sense and senior demonstrator in physiology at Cambridge at the time when Prof. Langley had surrounded himself with the brilliant team of investigators which included Keith Lucas, A. V. Hill and E. D. Adrian. Although Prof. Hartridge has published many important papers and articles on the physiology of the special senses, his research work has not been entirely confined to this field; the brilliant work which he carried out with Prof. F. J. W. Roughton on the rates of gaseous exchanges of the constituents of the blood is one of many examples of a wide interest in the problems of physiology. An account of Prof. Hartridge's activities would not be complete without reference being made to his great powers of exposition. He has delivered popular lectures at meetings of the British Association, given a course of Christmas Lectures at the Royal Institution and is Gresham professor of physic at Gresham's College in the City of London. After occupying a university chair for twenty years (1927–47), Prof. Hartridge carries with him the good wishes of a wide circle of friends for a continuation of his outstanding experimental work.

British Welding Research Association: Dr. H. G. Taylor

THE Council of the British Welding Research Association announces the appointment of Dr. H. G. Taylor as director in succession to Mr. A. Ramsey-Moon, who has been with the Association from its earliest stages and whose resignation has been announced. Dr. Taylor joined Messrs. Vickers, Ltd., at Barrow-in-Furness in 1921, and three years later obtained the firm's scholarship, with which he entered the University of London, graduating with first class honours in electrical engineering. He was awarded a Royal Scholarship and conducted research at the City and Guilds of London Institute, receiving the degree of M.Sc. (Eng.) for a thesis on the collection of current from commutators and slip rings. Joining Messrs. Metropolitan-Vickers Electrical Co., Ltd., as a college apprentice, he was later posted to the Research Department. In 1929 he joined the staff of the Electrical Research Association to start investigations on earthing, and many reports have since been published on this subject. With these Dr. Taylor was associated, and for them he received the degree of doctor of science in engineering of the University of London. In 1937, he was appointed electrical engineer to the Copper Development Association, and it was here that he commenced his connexion with the welding industry. This has been continued in his appointments as technical adviser to Philips Industrial Co., Ltd., and as manager of the Industrial Development Department of Philips Lamps, Ltd., in which posts he has been closely connected with the latest developments in arc and resistance welding.

Biochemistry in the University of California: Prof. W. M. Stanley

DR. WENDELL M. STANLEY, of the Rockefeller Institute for Medical Research, has been appointed professor of biochemistry in the University of California at Berkeley and director of a new Virus Laboratory which will undertake a programme of research on viruses affecting plants, animals and man. The new virus research centre is regarded as a major effort on the part of the University of California. Prof. Stanley, who is forty-three years old, was awarded a share of the Nobel Prize for Chemistry in 1946, for his work on the isolation, in pure form for the first time, of a virus, the tobacco mosaic virus (see *Nature*, 158, 826; 1946).

Since this early work, which began in 1935, Prof. Stanley has remained in the forefront of research in his field. The isolation of viruses and the consequent determination of their physical properties opened the possibility of systematically producing chemical modifications of the disease agents for use as antigens in immunization. Prof. Stanley has already altered the chemical structure of the tobacco mosaic virus by means of known chemical reactions. He has also shown that mutation in viruses is accompanied by certain definite changes in chemical structure. During the War, Prof. Stanley and his colleagues developed an efficient method of producing a centrifuge-type influenza virus vaccine which was used in the Armed Services and is now available for civilian use.

U.S. National Academy of Sciences: Medal Awards

THE Daniel Giraud Elliot Medal for 1945 of the U.S. National Academy of Sciences has been presented to Prof. Sewall Wright, Ernest D. Burton distinguished service professor, University of Chicago, for his fundamental work dealing with the genetics of evolutionary processes, a programme based on work over a long period, including his paper "The Differential Equation of the Distribution of Gene Frequencies" (*Proc. Nat. Acad. Sci.*, 31, No. 12; 1945). In making the presentation, Prof. Th. Dobzhansky said that in a series of papers published during the last twenty-five years, and particularly since 1931, Prof. Wright has developed the modern mathematical theory of biological evolution. In the past, different authors attributed the principal role in evolution to different factors; there existed partisans of natural selection, of mutation, of hybridization, etc. Wright has shown that what is most important is the quantitative interrelations of all the factors. He has also discovered a new evolutionary agent, now known as the genetic drift or the Sewall Wright phenomenon. This hitherto almost unsuspected phenomenon is probably very effective, in connexion with the other previously known agents, in bringing about the theoretically most important and interesting form of evolutionary change, known as progressive evolution. The brilliant synthesis reached by Prof. Wright makes him the outstanding living evolutionist and the father of the modern neo-Darwinism.

The Public Welfare Medal for 1947 of the U.S. National Academy of Sciences has been presented to Karl Taylor Compton, president of the Massachusetts Institute of Technology, for his notable contributions of an original character to the science of physics, for his long and valuable career in the field of education and of university administration, and in recognition of his eminent service in the war-time research effort of the American nation, and in the reinforcing of collaboration and understanding between civilian scientific workers and military men. In his presentation address, Dr. A. R. Dochez pointed out that the Marcellus Hartley Fund was established and placed at the disposal of the National Academy of Sciences for the purpose of giving conspicuous recognition to eminence in the application of science to the public welfare. From the inception of the National Defense Research Committee, when the hazard of possible war emergency demanded a major effort by the United States, through the years of the emergency, to the final successful conclusion of hostilities, both as a physicist and as an administrator, Dr. Compton made outstanding contributions. As chief of the Office of Field Service of the Office of Scientific Research and Development, he headed a unique and eminently effective effort at partnership between military and civilian experts in bringing to bear the full strength of science and technology in the defence of the American way of life.

Research in Surveying at University College, London

The institution in 1946 in the Department of Civil Engineering at University College, London, of the first chair in surveying and photogrammetry in the United Kingdom, to which Dr. C. A. Hart was appointed, has excited considerable interest in the Commonwealth and overseas. This has been particularly so because of recent advances in air survey and of the increasing employment of radar techniques both for air survey and geodetic surveying. At University College funds have been made available for the provision of first-class teaching and research equipment in surveying, with particular reference to photogrammetry. Emphasis on surveying in the Civil Engineering and Geography Schools has long been a feature at the College, and it is now proposed to institute a one-year special course of a postgraduate character in surveying, commencing in October 1948. This course will be arranged so as to provide a training-ground for those who wish to enter the Colonial Survey Service or take up other careers of a similar character.

Colonial Geological Survey Service

An important part of a comprehensive plan for the economic development of the British Colonies is a thorough investigation of their mineral resources. This involves a considerable expansion of the Colonial geological surveys and the completion of maps on reconnaissance and more detailed scales with the view to discovery of mineral deposits and the determination of their economic significance. Such a programme of investigation offers geologists a wide range of interest—scientific and economic—with the added attraction of pursuing field-work under varied geographical and climatic conditions. There is place, too, for those who wish to specialize in petrology, mineralogy, economic geology, geophysics, etc. Most Colonial geological surveys offer opportunities for research, and men are encouraged to do new work and prepare for research degrees. Wherever possible they are given facilities also to study special subjects related to their work. A considerable number of geologists will be required during the next four years and a slightly lesser number in succeeding years to carry out such a programme. The vacancies in view are announced so far as possible in advance so that men who desire an active life of field-work may be encouraged to pursue geological studies with reasonable prospect of securing an appointment in the Colonial Geological Survey Service. The vacancies anticipated during the next few years are as follows: 1948–52, an average of 25 a year; 1953–56, an average of 15 a year. The Colonies in which these vacancies will occur include the following: Kenya, Uganda, Tanganyika Territory, Northern Rhodesia, Nyasaland, Bechuanaland, Swaziland, Nigeria, Gold Coast, Sierra Leone, British Guiana, British Honduras, Malaya, North Borneo, Sarawak, and certain other smaller Colonies. The posts offered are, in general, permanent and pensionable in themselves, or such as to lead to permanent and pensionable posts; temporary service would ordinarily count for pension where there has been no break in service. The qualification required is a good honours degree in geology, preferably supplemented by a research degree or research experience. Forms of application for appointment to the Colonial Geological Survey Service are obtainable on request from the Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

A Standard for Quality Control

An increasing number of British Standards refer to quality control in acceptance clauses, and B.S. 1313: 1947 has been prepared to meet the need for a publication which would describe the simplest method of quality control, by the examination of the fraction defective in samples. It sets out accepted methods which are easy to use and which may safely and profitably replace 100 per cent routine examinations. They are widely applicable, and the publication, without dealing with the statistical principles underlying the methods, attempts to show how to use them. Simple instructions are given for the construction and use of a quality control chart in the first section. The second section deals with the methods in more detail, describing the basis of fraction-defective charts, with detailed recommendations for sample size and interval, and normal control limits. Refinements in the general method are indicated in the third section, such as the uses of average level of defectives, two-way control charts and compressed-limit control charts. The necessary tables with instruction sheets containing fully worked out examples are given in a further section, and a bibliography is appended.

Air-depolarized Primary Cells

BRITISH STANDARD SPECIFICATION No. 1335; 1946 (Publications Sales Department, British Standards Institution, 28 Victoria Street, London, S.W.1. 2*s.* post paid) prescribes the minimum rating of air-depolarized-type primary cells on continuous discharge and gives the methods of test on which the rating is based. An air-depolarized cell is defined as a primary cell with two electrodes, one mainly of carbon and the other of zinc, in an electrolyte of ammonium chloride, or other salts, or caustic soda, and in which the depolarization is mainly effected by air, to which free access must be given. A nomenclature is prescribed for the designation of the cells, a letter representing the type, and a number the size of cell. The letter code to be used consists of: *A*, *D*, *W*, *R*, *S*, and *C*, for air-depolarized, dry, wet, round, square and caustic soda, cells respectively. The quality of the materials to be used, the dimensions of the electrodes, containers, connecting wires and terminals of the cells are also specified in detail.

Rubber Technology Conference

IN 1938 the Institution of the Rubber Industry organised an International Rubber Technology Conference in London. It was the intention of the Institution to organise another conference within the following two or three years; but it has been necessary to wait ten years. A conference will accordingly be held at the Central Hall, Westminster, London, S.W.1, during June 23–25. The Conference will cover the following subjects: natural and synthetic rubber lattices; chemistry of rubber; physics of rubber; testing and analysis; synthetic rubbers; compounding ingredients; fibres and textiles; developments in factory processes and products since 1938. Invitations to attend the Conference have been sent to well-known technologists all over the world, many of whom have already promised papers. All the papers and full details of the Conference will be published in a volume entitled "The Proceedings of the Rubber Technology Conference, London, 1948", a copy of which will be issued free to all those enrolling for the Conference; extra copies will be available for sale generally at £2 2*s.* each. Application forms and details can be obtained from the Conference Secretary, Institution of the Rubber Industry, 12 Whitehall, London, S.W.1, who is prepared to assist in obtaining hotel accommodation.

University of London: Appointments

THE following appointments in the University of London have been announced:

Mr. G. E. H. Foxon, lecturer in zoology and comparative anatomy at University College, Cardiff, to the University readership in biology tenable at Guy's Hospital Medical School as from April 1.

The following titles have been conferred: professor of bacteriology in the University on Lord Stamp, in respect of the post held by him at the Postgraduate Medical School of London; professor of biology in the University on Dr. J. H. Woodger, in respect of the post held by him at Middlesex Hospital Medical School; reader in surveying in the University on Mr. Alfred Stephenson, in respect of the post held by him at the Imperial College of Science and Technology.

The degree of doctor of science has been conferred on Mr. F. W. Andrews (Birkbeck College).

Colonial Service: Appointments

THE following appointments have been made in the Colonial Service: P. A. Greig, agricultural development officer, Nigeria; W. G. Brookbank, agricultural officer, Tanganyika; D. H. Drennan, agricultural officer, Tanganyika; N. B. Flockhart, agricultural officer, North Borneo; R. Henderson, agricultural officer, Malaya; W. J. C. Little, agricultural officer, Nigeria; R. R. Mason, agricultural officer, Fiji; D. G. Thomas, botanist, Uganda; I. H. Warren, agricultural chemist, Tanganyika; J. R. Williams, entomologist, Mauritius; D. W. Winter, agricultural officer, Zanzibar; R. S. Ayliffe, assistant conservator of forests, Trinidad; J. A. D. Jackson, assistant conservator of forests, Nigeria; J. A. Laurenson, assistant conservator of forests, Sierra Leone/Gambia; F. J. S. Phillips, assistant conservator of forests, Nigeria; A. W. M. Watt, assistant conservator of forests, Uganda; D. A. J. Wood, assistant conservator of forests, Gold Coast; J. R. Harpum, geologist, Tanganyika; H. R. Threlfall, surveyor, Tanganyika; D. L. Johns, research officer (entomologist), Tanganyika; A. F. MacKenzie (agricultural officer, Sierra Leone), senior agricultural officer, Sierra Leone; J. F. Ward (agricultural officer, Kenya), senior agricultural officer, Nigeria; F. A. Cassidy (inspector of mines, Sierra Leone), senior inspector of mines, Nigeria.

Announcements

THE Council of the Linnean Society of London has nominated the following as recipients of the Trail Award and Medal: for 1942, Dr. Honor B. Fell, of the Strangeways Laboratory, Cambridge; for 1947, Dr. C. D. Darlington, director of John Innes Horticultural Institution. The Trail Award and Medal was established by a donation by the late Prof. J. W. H. Trail "to encourage study that throws light on the substance known as Protoplasm, or the physical basis of life" and is awarded by the Council at intervals of not less than five years. The presentations of the Award and Medal will be made at the Society's anniversary meeting on May 24.

H. B. HENBEST has been elected to a Beit Fellowship for Scientific Research of the value of £400 a year, tenable at the Imperial College of Science and Technology, London, for research in organic chemistry under the direction of Sir Ian Heilbron.

THE late Dr. Collinge's collection of terrestrial Isopoda has been presented to the Yorkshire Museum, to which institution all future inquiries with regard to the collection should be addressed. The collection is important since it contains a large number of Collinge's described species and varieties. A list will be supplied on loan to any interested worker on application to the Keeper, Yorkshire Museum, York.

ERRATUM.—Referring to the communication on the 'floating thread' in *Nature* of November 15, 1947, p. 673, I. Kuščer writes: "The formula at the bottom of the left-hand column should be $d = \pi(\sigma_0 - \sigma_1)^2 \div 4\mu\rho v_0^3$. In both expressions for y (right-hand column) substitute 1 for λ. The unit 'cm.' against the value for the derivative $(dy/dx)_0$, which is obviously dimensionless, should be omitted."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Variation of Geomagnetic Intensity with Depth

In a recent letter[1], A. L. Hales and D. I. Gough compared their measurements of H_d, the horizontal magnetic intensity (H) at depth d, made in the Witwatersrand at $d = 4{,}800$ ft., with the formula

$$H_d/H_0 = 1 - 2\,(5\rho_1/\rho + 1)\,d/a \qquad (1)$$

obtained by S. K. Runcorn from Blackett's theory[2]. In (1), H_0 denotes the value of H at the overlying point on the surface ($d = 0$), a denotes the earth's radius, ρ_1 the mean density of the rocks down to depth d, and ρ the overall mean density of the earth. The observations were compared also with the formula

$$H_d/H_0 = a^3/(a-d)^3 = 1+3d/a \text{ (approximately)}, \qquad (2)$$

corresponding to any 'core' theory which places the source of the field wholly below the depth d.

It is clear that (1) cannot be correct, because it should agree with (2) if $\rho_1 = 0$, whereas in fact it gives $H_d/H_0 = 1 - 2d/a$ in that case. The correct formula, which can be derived from a vector potential or otherwise, is

$$H_d/H_0 \doteq 1 - 3(5\rho_1/k\rho - 1)d/a, \qquad (3)$$

where k denotes I/I_0, and I signifies the moment of inertia of the earth and I_0 that of a uniformly dense sphere of the same size and mass. The proof of this and allied and more general formulæ will be communicated to the Physical Society.

Taking $\rho = 5{\cdot}5$, $\rho_1 = 2{\cdot}8$, $k = 0{\cdot}88$, the factor of d/a in (1) is $-\ 7{\cdot}1$, and in (3) is $-\ 5{\cdot}7$. Hence $\Delta H \equiv (H_d - H_0)$, which for comparison with the Witwatersrand observations was calculated[1] as $-\ 26\,\gamma$ from (1), should be $-\ 21\,\gamma$ according to (3), whereas (2) gives $+\ 11\,\gamma$. The mean observed value, after making various alternative possible corrections for the effects of local magnetic matter, was given as lying between $-\ 10 \pm 4$ and $-\ 20 \pm 4\,\gamma$. These are not in accord with (2); but to what extent ΔH agrees with (3) must remain uncertain until a more unambiguous determination is obtained.

SYDNEY CHAPMAN

Queen's College,
Oxford.

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[1] Hales, A. L., and Gough, D. I., *Nature*, **160**, 746 (1947).

[2] Blackett, P. M. S., *Nature*, **159**, 658 (1947).

The formula giving the variation of the earth's horizontal field with depth quoted in the letter of Hales and Gough involves an approximation concerning densities which is only applicable to spheres the density distribution of which is only slightly different from a uniform one, such as is roughly true for the earth. Thus it is not to be expected that the formula should give the dipole variation law when $\rho_1 = 0$, but I am grateful to Prof. Chapman for pointing out a more general formula. It should be noted, however, that in the present state of the theory of Blackett's formula, $P = \beta \dfrac{G^{1/2}}{2c} U$, the treatment of densities must remain ambiguous, various assumptions leading to slightly different values of the predicted variation with depth. This point will be dealt with in detail elsewhere.

S. K. RUNCORN

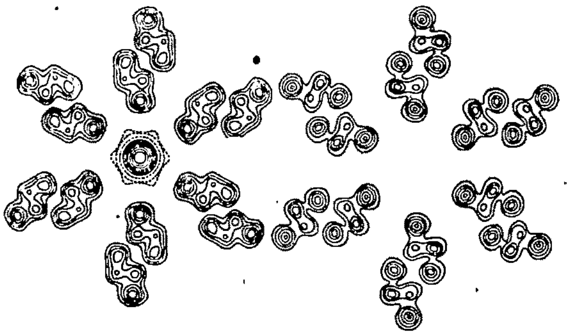
Physical Laboratories, University,
Manchester 13.

Beta-quinol: an Example of the Firm Union of Molecules Without the Formation of Chemical Bonds Between Them

The substance formerly called 'β-quinol' and obtained by crystallization of quinol from methanol has been shown[1] to be a compound of three molecules of quinol with one molecule of methanol. It is one of a series of solid compounds of very similar crystalline structure[2], which consists of two interpenetrating giant molecules of hydrogen-bonded quinol units together enclosing small molecules, such as that of methanol, in cavities that are left when these two giant molecules are fitted together as closely as possible. Compounds of this general type in which one component imprisons the other without necessarily having any strong attractive interaction with it have been named clathrate compounds[3]. When crystallized, for example, from ethanol in conditions such that molecules of suitable size are not available for enclosure in this way, quinol forms a more densely packed structure, α-quinol, by a different arrangement of quinol units which has not yet been completely determined.

In the clathrate compounds of quinol the presence of the enclosed molecules exerts a stabilizing effect on the double cagework quinol structure which, although it represents a simple way of satisfying the directional requirements of the hydrogen bonds linking the quinol units, is clearly of a very open character since it provides space for the second component. However, since some of the compounds are found to exist with a large proportion of the cavities unoccupied[4], it seemed possible that the completely empty structure might be capable of existence. Single crystals of quinol have now been obtained in this form. This crystalline form is given the name 'β-quinol', which should no longer be used for the methanol compound. It differs in unit-cell dimensions, refractive indices and density from α-quinol, and a preliminary Fourier electron-density synthesis shows that the structure is very similar to those already determined for the clathrate compounds '3 quinol.M', where M is SO_2, MeOH or a variety of other small molecules, with the essential difference that the spaces occupied in the compounds by molecules of the second component are here vacant. This may be seen in a comparison of the accompanying electron density maps for (*a*) 3 quinol.SO_2, (*b*) the empty β-quinol structure. Both show the projected electron density on the (0001) face of the crystal. Whereas the compound shows in the centre a high circular peak, corresponding to the (rotating) sulphur dioxide molecule, and the six surrounding quinol molecules which form its cage, the β-quinol projection shows similar quinol molecules with an empty space at the centre. In both projections the benzene rings are considerably out of the plane of the projection and consequently they appear distorted from their true regular hexagonal shape.

It may be shown from the unit-cell dimensions and from the number and dimensions of the cavities contained within it that in β-quinol about 7½ per cent of the total volume is empty space that could be



occupied by other molecules, and is so occupied in the clathrate compounds. In any structure regarded as composed of spherical atoms of fixed radius, a part of the total space is represented by the unoccupied small cavities between spheres in contact, and even in a closest packed arrangement of equal spheres this is a considerable proportion. The 7½ per cent mentioned above is in addition to the space of this sort.

β-Quinol is the first example of a special type of molecular compound. It is composed of two giant molecules which, although not linked by bonds of any sort, are held together in a manner much firmer than corresponds to van der Waals' interaction. Furthermore, the two molecules cannot be separated without the breaking of bonds, for example, hydrogen bonds, although these bonds do not connect the two molecules.

The state of the molecules may be described as follows. Let the skeleton of a steel-frame building represent a portion of the indefinitely extended three-dimensional giant molecule. Let a second identical framework be constructed displaced relative to the first so that each junction of girders in one framework is at the space centre of a compartment of the other framework. There is no join between the two systems of girders, and there is therefore some freedom of independent movement of the two; but they cannot be separated since each makes a multiple enclosure of the other and thus imprisons it. If the girders are regarded as quinol molecules and the junctions between them are taken to be hydrogen bonds, the description applies in all essentials, to β-quinol.

The imprisonment of one molecule by the other means that β-quinol is to be regarded as a special type of clathrate compound. Although a similar arrangement of molecules occurs in the compounds mentioned above, the complete absence of any enclosed molecules removes all possibility that they might play any part in the union of the two giant molecules. It is thus demonstrated that two molecules, which in this case happen to be identical in composition and structure, may be united as firmly as though there were hydrogen bonds between them, although, in fact, no such bonds exist.

Details of the crystal structure of β-quinol will be published elsewhere.

H. M. Powell
P. Riesz
Laboratory of Chemical Crystallography,
University Museum, Oxford.

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[1] Palin, D. E., and Powell, H. M., *Nature*, 156, 334 (1945).

[2] Palin, D. E., and Powell, H. M., *J. Chem. Soc.*, 208 (1947).

[3] Powell, H. M., *J. Chem. Soc.* (in the press).

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Use of Ultra-Violet Fluorescence in Paper Chromatography

It has been shown[1] that, by the action of chymotrypsin, insulin is broken down into a number of peptide fragments of comparatively small molecular weight, and a more massive residue. The higher molecular weight material can be precipitated by means of trichloro-acetic acid. Attempts have been made to separate the lighter peptide mixture, and the most effective method so far found has been paper partition chromatography[2].

With phenol as the mobile phase, the mixture is resolved into four broad bands each of which can be further resolved by the use of collidine. It has been found during these experiments that the α-amino-acids and peptides can be detected on the filter paper sheets by drying off the solvent and examining the sheet under illumination from a 'Hanovia' lamp in a darkroom, using a ⅜ in. thick Wood's glass filter.

De Ment has noted[3] the fluorescence of the common α-amino-acids and a few dipeptides in the solid state when illuminated with light of 3650 A. wave-length. On paper chromatograms this fluorescence can be seen even though drying has only been done at 37° C., but the intensity increases markedly when higher drying temperatures are used. The quality of the fluorescent light is visually about the same for all the acids and peptides, a whitish-violet colour standing out against the dark violet of the filter paper. Using this method, it is possible to mark out the positions of the substances and cut out the spots or bands for elution, without sacrificing material for ninhydrin testing. Sheets marked in this way and afterwards tested with ninhydrin have shown the coincidence of the markings and the colours; but the ninhydrin test is the more sensitive one, since 20 μgm. of an amino-acid per square inch of paper is about the least visible under the ultra-violet light used. The chief drawback of the method is that extraneous fluorescent substances can be obtained from the paper and solvents used. These impurities may not produce a chromatograph pattern until they have been eluted from a sheet and run with a different solvent on a fresh chromatogram.

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Inhibition of the Photodynamic Action of 3 : 4 Benzpyrene

It has gradually become apparent that the carcinogenic activity of 3 : 4 benzpyrene is linked with sulphur metabolism[1]. Some experiments have, therefore, been carried out to attempt to determine whether another biological property of 3 : 4 benzpyrene, namely, its photodynamic action, is involved with sulphur. These were done by measuring the photodynamic activity of the benzpyrene in the presence of sulphur containing compounds.

For this purpose thick cultures of Paramecia were used as a biological indicator. Irradiation was from a mercury-vapour lamp screened with a glass filter, opaque to radiations of less than 3,300 A. Exposures were made using large well-slides to contain Paramecia and the media. The benzpyrene was used in the form of a colloid in tap water.

Preliminary experiments were carried out to determine the toxicity and any photodynamic action of the compounds under test. Toxic concentrations were taken as those which would cause cytolysis within 30 min.; tolerance concentrations as those which had no apparent effect after two hours exposure. The results of these trials are given in Table 1.

TABLE 1

Compound	Toxic conc.	Tolerance conc.	Photodynamic action at tolerance conc.
Cysteine hydrochloride	1/1250	1/1500	Nil
Glutathione	1/1250	1/2000	Nil
Methionine	1/225	1/250	Nil

Using concentrations which were non-toxic, these substances were tested again in the presence of various concentrations of 3 : 4 benzpyrene. Controls, in which the test substance was replaced by an equivalent volume of tap water, were irradiated side by side with the experimental cultures. In all cases the test substance and the benzpyrene colloid were added to the Paramecia cultures immediately before commencement of irradiation.

Of the compounds mentioned in Table 1, the only one causing any variation in the time required for cytolysis of 90 per cent of the Paramecia as compared with the time required for controls was cysteine hydrochloride. The results obtained using 0·03 per cent cysteine hydrochloride and varying concentrations of benzpyrene are shown in Fig. 1.

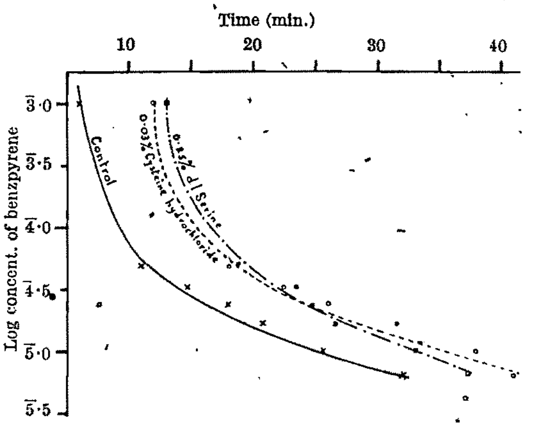

Fig. 1. INHIBITION OF PHOTODYNAMIC ACTION OF BENZPYRENE IN THE PRESENCE OF CYSTEINE HYDROCHLORIDE AND SERINE

Further tests were carried out with a series of amino-acids to determine whether any similar inhibition of photodynamic action could be obtained. The manner and conditions of testing were the same as used previously. The toxic concentrations, tolerance concentrations and photodynamic effects are shown in Table 2.

TABLE 2

Compound	Toxic conc.	Tolerance conc.	Photodynamic action at tolerance conc.
Glycine	1/225	1/250	Very slight
Histidine	1/250	1/300	Nil
Phenylalanine	1/200	1/250	Nil
d-l-Serine	1/200	1/250	Nil
Threonine	1/250	1/300	Very slight
d-l-Valine	1/200	1/250	Nil

Of this group of compounds, the only one having any effect on the photodynamic action of the benzpyrene was *d-l*-serine. The effect of using a 0·25 per cent solution is an inhibition very similar to that given by the cysteine hydrochloride (see Fig. 1).

Further results were obtained using a fixed concentration (0·001 per cent) of the benzpyrene and varying strengths of the cysteine hydrochloride and *d-l*-serine. The results are shown in Fig. 2.

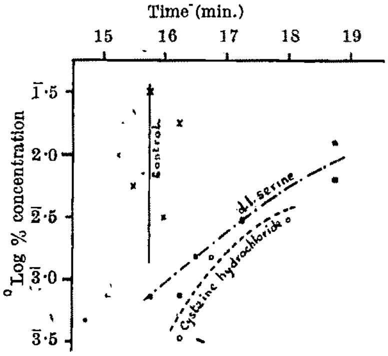

Fig. 2. VARIATION IN DEGREE OF INHIBITION WITH VARIATION IN CONCENTRATION OF INHIBITORS

The significance of these inhibitory actions and the manner in which they are exercised are still unknown, though it is interesting to recall the close chemical relationship between cysteine and serine. Further experiments are in hand to try to determine details of these actions.

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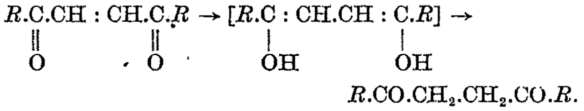
Reduction of 1 : 4-Diketones

THE dibenzoylethylenes on reduction with metal combinations or catalytic hydrogenation under certain conditions yield the corresponding diphenacyls[1], and there is evidence that the reaction occurs through 1 : 6-addition of hydrogen followed by rapid ketonization of the intermediate dienols[1]. Lutz and Reveley[2] showed the presence of one such dienol, without, however, isolating it:



$$\underset{\substack{\| \\ O}}{R.C}.CH : CH.\underset{\substack{\| \\ O}}{C}.R \rightarrow [R.\underset{\substack{| \\ OH}}{C} : CH.CH : \underset{\substack{| \\ OH}}{C}.R] \rightarrow R.CO.CH_2.CH_2.CO.R.$$

Confirmation of this mechanism is desirable, especially since 1 : 6-addition is comparatively uncommon[3]. We have done this by reducing several substituted dibenzoylethylenes with aluminium isopropoxide in *iso*propyl alcohol, a reagent known to attack carbonyl groups while leaving olefinic linkages intact. The reduction products were invariably the corresponding diphenacyls, identified (after chromatographic adsorption) by mixed melting points with authentic samples. Since direct hydrogenation of the carbon–carbon double bonds is ruled out, the reduction must have taken the course outlined above.

	Reduction product and yield	per cent
trans-Dibenzoylethylene	Diphenacyl	70
cis-Dibenzoylethylene	Diphenacyl	60
trans-Di-*p*-toluylethylene	4 : 4′-Dimethyldiphenacyl	75
cis-Di-*p*-toluylethylene	4 : 4′-Dimethyldiphenacyl	95
trans-Di(*p*-chlorobenzoyl)-ethylene	4 : 4′-Dichlorodiphenacyl	80
cis-Di(*p*-chlorobenzoyl)-ethylene	4 : 4′-Dichlorodiphenacyl	90
trans-Di(*p*-bromobenzoyl)-ethylene	4 : 4′-Dibromodiphenacyl	75
cis-Di(*p*-bromobenzoyl)-ethylene	4 : 4′-Dibromodiphenacyl	90

It is noteworthy that the *cis*-compounds react more rapidly with this reducing agent. With the *trans*-isomers some unchanged substance was always found in the product.

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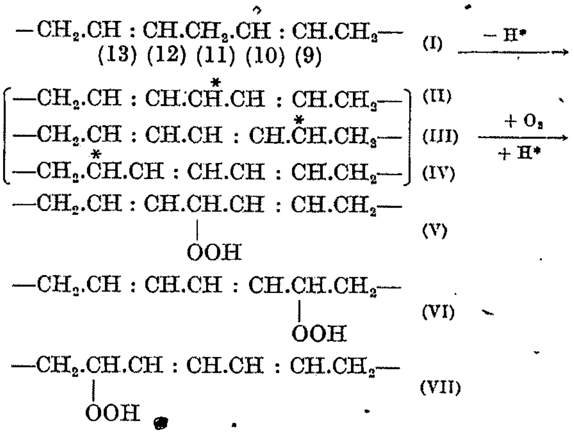
Total Conjugation of Linoleic Acid in Oxidation with Lipoxidase

Bolland and Koch[1] postulated the mechanism of autoxidation of linoleate to be:



$$\begin{array}{ll}
\underset{(13)\ (12)\ (11)\ (10)\ (9)}{-CH_2.CH : CH.CH_2.CH : CH.CH_2-} & (I) \xrightarrow{-H^*} \\
\left[\begin{array}{l} -CH_2.CH : CH.\overset{*}{C}H.CH : CH.CH_2- \\ -CH_2.CH : CH.CH : CH.\overset{*}{C}H.CH_2- \\ -CH_2.\overset{*}{C}H.CH : CH.CH : CH.CH_2- \end{array}\right] & \begin{array}{l}(II)\\(III)\\(IV)\end{array} \xrightarrow[+H^*]{+O_2} \\
-CH_2.CH : CH.\underset{\displaystyle OOH}{\underset{|}{C}H}.CH : CH.CH_2- & (V) \\
-CH_2.CH : CH.CH : CH.\underset{\displaystyle OOH}{\underset{|}{C}H}.CH_2- & (VI) \\
-CH_2.\underset{\displaystyle OOH}{\underset{|}{C}H}.CH : CH.CH : CH.CH_2- & (VII)
\end{array}$$

From the ultra-violet absorption due to the conjugation of the double bonds and from the active hydrogen content of the resulting mixture of peroxidic products, they concluded that it consisted of approximately equal parts of the hydroperoxides V, VI and VII, indicating that the free radical structures II, III and IV contribute equally to the free radical resonance hybrid.

Other workers' results are in agreement with the general outlines of the mechanism[2,3]. In the hydrogenated products, Bergström[2] identified comparable amounts of 9- and 13-hydroxystearate, but was unable to detect the 11-isomer.

The oxidation of linoleates in aqueous solution with crude soya-bean lipoxidase seems to follow the same general course as the autoxidation[2,3]. It was observed that the extinction at 234 mμ per absorbed oxygen increased when the enzyme was purified[4].

When crystalline lipoxidase[5] became available, the problem was reinvestigated under conditions least likely to promote side reactions or decompositions. The oxidations were carried out in Warburg vessels under air, using sodium linoleate substrate[4]. The reactions were stopped by addition of alcohol, and light absorption was measured using the Beckman spectrophotometer.

Apparent molar extinction coefficients of the primary oxidation product at 234 mμ were found to be 23,000 at 37°, 27,800 at 8° and 31,400 at 0°, indicating that reaction temperature affects the formation or decomposition of conjugated diene to a marked degree. Reduction of the extinction by elevated temperature is accompanied by increased absorption at 270 mμ. The extinction coefficient at 234 mμ remains near 30,000 up to 30 per cent oxidation at 0°, whereas at 37° it has decreased to 20,000 at 10 per cent oxidation.

Thus in the rapid enzymatic oxidation of linoleate at low temperature, one pair of conjugated double-bonds is formed for every oxygen absorbed. This indicates that III and IV are the main contributing structures to the free radical resonance hybrid, resulting in oxygen addition at the ends of the resonating system, giving only the conjugated hydroperoxides VI and VII. Variable amounts of products, other than conjugated hydroperoxides, formed at higher temperatures, with longer reaction times, or with impure enzyme, appear to be attributable to decompositions or secondary oxidations of conjugated peroxides.

Our evidence suggests that a similar mechanism may account for the low extinction coefficients observed in the autoxidation of linoleates.

A full report will appear in due course (*Arch. Biochem.*).

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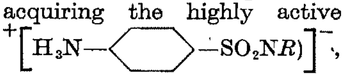
Ammonium Salts of Sulphanilamides and Sulphonic Acids

SULPHANILAMIDE salts of a few sulphonic and carboxylic acids have been described[1,2,3], but they have not been isolated in pure form and characterized. In the course of our work on surface-active compounds, and with the object of examining their activity as intestinal bacteriostatic agents, we have prepared sulphanilamide salts of di*iso*propyl naphthalene sodium sulphonate (m.p. 220–22°), sodium dioctylsulphosuccinate, and lauryl-*p*-toluidide-2-sodium sulphonate. Suitable experimental conditions were first determined by the preparation of (*a*) salts of naphthalene-β-sulphonic acid and sulphanilamide (m.p. 263–64°), sulphathiazole (214–15°), sulphapyridine (152–53°), sulphadiazine (188°), sulphamerazine (118–120°), sulphaguanidine (225–26°), N^1-acetylsulphanilamide (254–55°), and *p*-aminobenzoic acid (decomp. above 260°); and (*b*) sulphanilamide salt of phenol-*p*-sulphonic acid (241–42° decomp.). The last salt, described earlier[1] as giving m.p. 216–220° (decomp.), was apparently a mixture containing sulphanilamide hydrochloride.

The bacteriostatic activity (mgm. per cent) of salts of sulphanilamides and naphthalene-β-sulphonic acid is given in the table:

Sulpha drug	Sulpha drug in salt (%)	*St. aureus* Salt	*St. aureus* Parent drug	*Escherichia coli* Salt	*Escherichia coli* Parent drug
Sulphanilamide	45·0	500	500	500	500
N^1-Acetylsulphanilamide	50·7	150	200	150	225
Sulphapyridine	54·4	12	22	14	22
Sulphathiazole	55·1	8	12	8	10
Sulphadiazine	54·3	8	20	10	22
Sulphamerazine	56·1	20	40	30	30
Sulphaguanidine	50·7	250–300	250	250	300

The results indicate that the ammonium salts were more active than the parent sulphanilamides in spite of the lower content of the active sulpha component. The increased potency of our salts could not be due to increased solubility[2], as they were not more soluble than the sulpha components. The potentiation of the sulphanilamides by ammonium salt formation could be due to ionization, resulting in the sulpha component acquiring the highly active zwitterion form  $\overset{+}{}\left[H_3N-\bigcirc-SO_2NR\right]^{-}$, stabilized by the complementary inductive effects of the positively charged ammonium and the negatively charged sulphonamide groups. Inactivation of the sulpha drugs *in vivo* during metabolism by N^4-acetylation might perhaps be prevented or minimized by the use of sulphanilamide salts instead of the parent sulpha component.

Further, we have found that replacement of sulphanilamide in its salts with naphthalene-β-sulphonic acid by *p*-aminobenzoic acid took place to a small extent even at room temperature (26–29°), when an aqueous solution of *p*-aminobenzoic acid and the sulphanilamide salt was kept for ten days. The sulphonic anion might, therefore, make a small contribution to the bacteriostasis by removing part of the essential metabolite, *p*-aminobenzoic acid, by salt formation, as also by complex formation with the positively charged part of the enzyme molecule.

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Effect of Under-nutrition and Alterations in Diet on the Choline Esterase Activity of Serum

THE activity or 'concentration' of choline esterase in serum has been considered as a test of liver function[1], and an interest in this enzyme has been stimulated in recent years by the developments which took place in chemical warfare during the period of hostilities. So far, diet has not been implicated as one of the agents regulating the activity of either the 'total' or the 'true' choline esterase of serum; but within the last eighteen months we have made numerous observations which show that the general level of nutrition and also certain changes of diet may exert a considerable influence. All the determinations of activity were made by measuring the carbon dioxide evolved by the enzyme in a Barcroft apparatus. The enzyme activity of a serum such that 1 c.c. liberates 1 c.mm. of carbon dioxide in 1 min. from the reaction mixture has been taken as unity. The 'total' choline esterase in serum was measured in the presence of 2·5 per cent of acetyl choline chloride. This concentration of substrate is well above the optimum for true choline esterase, and the activity determined by this method is due mainly to 'pseudo' choline esterase. The 'true' choline esterase in the serum was determined by the method of Mendel, Mundell and Rudney[2].

An average of 80·2 units of 'total' choline esterase (*S.D.* 15·5) was found in the sera of thirty-nine healthy British men who were living on British civilian or army rations. The mean concentration in a group of eighty-two German factory workers living on German civilian rations in 1946 was found to be 56·7 (*S.D.* 14·5), and forty-five German civilians, who were attending a hospital in Wuppertal-Barmen on account of nutritional œdema, gave an average of 48·5 (*S.D.* 16·2). An average of 42 units was obtained from twelve German civil internees who had œdema, and the very low average of 29·0 units from a group of nine civilian prisoners in a gaol at Kiel. Although severe under-nutrition and œdema may be accompanied by low serum proteins, there is good evidence that the changes in choline esterase were not due to this.

EFFECT OF AN IMPROVED DIET ON THE CHOLINE ESTERASE ACTIVITY OF SERUM

	'Total' choline esterase activity (c.mm. CO_2/c.c./min.)		'True' choline esterase activity (c.mm. CO_2/c.c./min.)	
	Average and range	Standard deviation	Average and range	Standard deviation
12 civilian prisoners, July 1946	51·56 (27·6–88·2)	18·60	0·807 (0·596–1·130)	0·143
The *same* 12 prisoners after 5 months on improved rations	62·90 (32·4–96·4)	18·00	1·050 (0·749–1·270)	0·127
19 under-nourished German civilians, September 1946	47·40 (29·8–63·5)	7·65	0·917 (0·710–1·140)	0·127
The *same* 19 civilians after 2 months high caloric diet, November 1946	75·20 (59·4–101·5)	13·00	1·020 (0·789–1·370)	0·145
The *same* 19 civilians after 5 months on German rations, April 1947	55·40 (39·3–82·2)	11·49	0·969 (0·775–1·330)	0·145

A rise in the choline esterase has twice been observed to follow an improvement in the diet (see table). Between July 1946 and December of the same year, twelve civilians in Siegburg prison gained an average of 10 kgm. in weight because they were given more food. The effect of this on the choline esterases in their sera will be seen in the table. The differences were statistically significant both for 'total' and for 'true' choline esterase ($t = 2·56$, $p = 0·05–0·02$ and $t = 4·43$, $p < 0·01$ respectively).

In the autumn of 1946, nineteen under-nourished German adults were given for experimental reasons an excellent diet, unlimited in quantity, for eight weeks. This produced an average rise in the body-weight of 10 kgm. and an increase in their mean 'total' choline esterase which was highly significant ($t = 12·2$, $p < 0·01$). The increase in 'true' choline esterase activity was also statistically significant ($t = 2·63$, $p = 0·02–0·01$).

When these men returned to their civilian rations in November 1946, most of them lost weight again, and their choline esterases fell also during the next five months. The decrease in total choline esterase was statistically significant ($t = 6·6$, $p < 0·01$). The diets were not controlled or supervised during these five months, and three of the men who managed to maintain their weights better than the others also maintained their serum choline esterases much better. It is not thought that these increases in choline esterase were due to the digestion, absorption and metabolism of fat setting free non-specific esterases into the serum, for when six men were given a supplement of 100 gm. of fat daily for three days there was no increase in the 'total' choline esterase found in their sera.

These results, and others which have not yet been published, suggest that the average level of the 'pseudo' enzyme in the serum is a delicate index of the state of nutrition of any group of men in Germany to-day.

It is hoped to publish the results of this work in full in the near future, and various aspects of it are being actively studied at the moment; but we think it may be helpful to those working on the enzymes to know at this stage that we have obtained these results. The knowledge may possibly assist them to establish the relationship of the enzymes to the liver and to the other organs involved in their functional activity.

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Premortal Increase in the Output of Sodium and Chlorine in Fasting Rats

Kunstmann, in an experiment on himself[1], drank 10–20 litres of water daily, with an otherwise normal food intake. He felt fit during the experiment, his urinary output in sodium and chlorine sank to minimal values; but nevertheless his sodium chloride balance became negative. On about the thirtieth day of the experiment, his chlorine excretion rose to abnormally high values and he felt ill, so he ended the experiment. We attempted to reproduce this experiment with rats. We gave them maize washed out in water, and twice daily 10 ml. of a 5·5 per cent glucose solution subcutaneously. In this way we attained great quantities of a rather dilute urine; the animals slowly lost weight; but the output of sodium and chlorine showed no increase, even on the fiftieth day of the experiment, and we failed to obtain a negative salt balance.

We decided, therefore, to make the rats fast, without or with water *ad libitum*, with twice daily 10 ml. of a 5·5 per cent glucose solution subcutaneously; we collected urine specimens daily and analysed them for sodium, potassium, chlorine and nitrogen. In all cases, on the last day before death, the output of sodium and chlorine was three to six times as great as on the previous days. We varied our experiments by giving the rats free access to water, but no extra injections. In about half the cases we observed the same phenomenon: the last day's sodium and chlorine output was many times greater than on the previous days. With 2 per cent urea solution (10 ml. twice daily subcutaneously) we obtained the same result.

In some cases we succeeded in keeping the animals alive after the end of the experiment by giving them adequate food, so this phenomenon cannot be regarded as absolutely fatal. The fasting animals lived from four to nine days, and there seems to be no correlation between the duration of the experiment and the appearance of the increased sodium chloride output. No correlation was found between increased output of sodium chloride on one hand and sex, weight, room temperature, water intake, quantity of urine and nitrogen output of the rats on the other.

We have insufficient evidence to suggest the mechanism and cause of this increased output. We calculated according to Gamble, Ross and Tisdall's procedure[2] the loss of weight from the excreted amount of potassium, sodium and nitrogen and compared the data with the measured loss of weight. In most cases showing the increased sodium chloride output, the calculated loss exceeded the measured loss and this, with high serum sodium values, would suggest that the organism had some reserves of sodium chloride in 'dry' form, which are excreted after prolonged fasting. In other cases we found normal and even subnormal serum sodium levels as well. We realize that the existence or non-existence of 'dry' sodium chloride reserves is still a much discussed problem of physiology, and the evidence given above is not enough to give a positive answer. Further work on the mechanism involved is in progress.

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Thyroid Gland as a Special Factor Influencing the Conditional Disposition to Infectious Diseases

There are several old and recent observations concerning the important effect of the ductless glands on disposition against infections and infectious diseases. From this point of view the role of the thyroid should especially be emphasized.

Some authors[1] suggest a specific role (specific bacteriostatic action) of thyroxine; but the majority[2-7] assume a non-specific effect on the defence mechanism of the organism.

It is more correct to speak of conditions rather than causes producing diseases, regarding the constitution not as a static but as a dynamic unity. I reported in 1938[8] on my investigations with Reid-Hunt's method. They favour the assumption that alterations in the quantity of thyroxine in the blood are closely related to infections. My further investigations with Euler's method[9] pointed to the marked increase of the thyroxine-level in serum during infectious diseases (smallpox vaccination). It seemed that this increase was parallel with the reaction of the body to the infection and closely related to the development and stimulation of the defence mechanism. I found at the same time[10] that the patients displaying a higher thyroxine-level were rather free from the complications due to secondary infection in scarlet fever.

Starting from these observations, I administered daily to 283 patients[11] suffering from scarlet fever 50 cgm. of fresh thyroid powder from their entry to hospital until their discharge. The experiments were carried out during one season, the patients came from the same district, and nursing, treatments, diet, etc., were identical too. The administration of thyroxine was carried out regardless of sex and age of the patients. The object of this experiment was to diminish the number and mitigate the severity of the complications both in first and in secondary infection. Thyreotoxicosis ensued only in one case. The number of control cases was 1,112.

The data are summarized below :

	Controls (per cent)	Treated cases (per cent)
Cervical lymphadenitis	25·6	6
Fever without any symptoms, total	13	3
recurrence—once	73	95
recurrence—twice	24	5
recurrence—three times	3	0
Nephritis, total	6	6
mild cases	44	70
severe cases	38	30
fatal cases	18	0

The table shows that the administration of the powdered thyroid gland did, as compared with the course of the controls, achieve an increased resistance to the complications, so much so that their absolute and relative number has diminished.

According to my observations (and in accordance with the findings of other authors[12]) the thyroid (system diencephalon – adenohypophysis-thyroid) seems to be an important point of the conditioned predisposition. Besides this, there seems to exist a close connexion between the allergic phenomena and the infectious diseases. Among other things a typical blood cholesterin-level[13], extremely mild allergic symptoms[14] in hyperthyroidism[15] and the well-known dehydrative effect of the thyroxine were observed.

It has been shown by the experiments cited that besides the antibacterial substances, conditioned disposition plays a prominent part in combating infections.

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Effect of Feeding 2-Acetaminofluorene on the Adreno-Gonadal System of Rats

The administration of *p*-dimethylaminoazobenzene to female albino rats on a rice diet has been shown to cause a cessation of the œstral cycles two weeks after administration of the carcinogenic compound[1]. The weight of the ovaries was reduced, and histologically there was an almost complete absence of corpora lutea. In male rats the weight of the testes was reduced and spermatogenesis inhibited. The weight of the adrenal was found to be smaller in the male than that in the female rats, in conformity with the findings of Hatai[2]. There was no effect on the weight or histological appearance of the adrenal gland in either sex ; 78 per cent of these rats developed hepatic tumours[3].

In a new series of experiments 2-acetaminofluorene was fed to albino and piebald rats each weighing about 100 gm. They received a semi-synthetic diet in which 17 per cent of the caloric value was derived from protein and 30 per cent from fat ; the diet was supplemented with cod liver oil and greens. The 2-acetaminofluorene was added in a final concentration of 0·07 per cent. The weight of the rats was recorded weekly. All rats grew slowly (about 0·5 gm. daily), and no difference could be found between them and rats on the control diet. Vaginal smears were taken daily from ten females in each group. Rats were killed at intervals up to the 300th day, and those developing any disease other than tumour growth were discarded. The organs were removed immediately, weighed and fixed for histological examination.

The œstral cycle both of albino and piebald rats receiving 2-acetaminofluorene ceased in seventeen out of twenty rats ; that of the control rats remained normal. Histologically the ovaries showed a considerable number of very large corpora lutea (8–12), luteinization of the stroma and an almost complete disappearance of the follicles. The weight of the ovaries in the treated and control rats was much the same. Mean weights (mgm. per 100 gm. body-weight) : controls (16), 59 ; treated albinos (13), 51·7 ; piebalds (16), 59·0. (The figures in brackets give the number of rats in the group.)

The weight of the adrenals (mgm. per 100 gm. body-weight) of the *female* rats receiving 2-acetaminofluorene remained unchanged. The mean weights were : controls (10), 42·7 ± 2·9 ; treated females : albinos (13), 42·8 ± 4·0 ; and piebald (10), 42·7 ± 3·4. Histologically the adrenals were in most cases normal ; some showed degenerative changes in the zona glomerulosa and there was some cyst formation in the cortex. In male rats the weight of the testes was slightly but not significantly lower than that in the controls ; spermatogenesis was found in all instances. The mean weights (gm. per 100 gm. body-weight) were : controls (17), 1·43 ; treated albinos (12), 1·25 ; and piebald (11), 1·03.

The weight of the adrenals of *male* rats was increased, approximating that of the adrenals of female rats and being about 40–50 per cent greater than those of the male control rats. The mean weights were : controls (17), 27·4 ± 2·0 ; treated male albinos (11), 38·19 ± 3·4 ; piebalds (8), 39·7 ± 2·2, $P < 0{\cdot}01$. Histologically, the male adrenals showed hypertrophy of the cortex, most pronounced in the layers near the medulla. In some cases a well-developed juxta medullary eosinophilic zone was present.

No change in the weights of the other endocrine organs was noted. The weight of the liver increased in both sexes shortly after feeding 2-acetaminofluorene and before histological signs of tumour formation appeared. This increase seemed due to the deposition of fat in the liver cells. There were no changes in the weight of the other organs.

Eighty-five per cent of the sixty-three rats, whether albino or piebald of either sex, receiving 2-acetaminofluorene for more than twenty-one weeks developed tumours. These were located principally in the liver ; but tumours of other organs were also frequent, as found by others[4].

As in the case of *p*-dimethylaminobenzene, the administration of 2-acetaminofluorene caused cessation of the œstral cycle in female rats, but the histological picture of the ovaries was completely different; it seems that when 2-acetaminofluorene was fed, the organs which produce steroid hormones are affected. It produces in female rats a heavy luteinization of the ovaries and a consequent disturbance in the œstral cycle. The changes in the male adrenal make the gland similar to that of the females. How far these changes are related to the carcinogenic action of 2-acetaminofluorine is being investigated. In this connexion it is possibly of significance that two rats with normal œstral cycles had not developed tumours by the 300th day of the experiment.

I wish to express my indebtedness to Dr. G. Bourne for his help with the histological investigations and advice in the preparation of this paper. My thanks are also due to the British Empire Campaign for a grant supporting this work.

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Electrophoretic Patterns of Lamb Serum Before and After Transfer of Colostrum

THE increase in the serum globulins resulting from the ingestion of colostrum has been demonstrated by Howe[1] and also by Schneider and Szathmary[2], who employed precipitation methods. Jameson and Alvarez-Tostado[3] also employed electrophoretic analysis to demonstrate such an effect when cow's colostrum is fed to man or the adult rat; and, with Sortor[4], they have studied calf serum at birth and at subsequent times. Similar investigations have now been made in connexion with the passive immunity produced in lambs by the transfer of colostrum.

After dialysis the lamb sera were diluted with buffer to 1·1 per cent protein concentration, and runs were carried out in the Tiselius[5] electrophoresis apparatus in phosphate buffer (*p*H 8·0, ionic strength 0·2) to obtain the patterns shown. Figs. 1 and 2 show, respectively, sera obtained from a lamb at birth and 24 hours later, after transfer of colostrum by suckling. Fig. 3 shows, for comparison, a sample of pooled sera from a dozen normal sheep. The following points emerge. First, the lamb sera contain a rather higher percentage of α-globulin than does the sheep serum. Secondly, the β-globulin peak is scarcely distinguishable at all in the lamb sera, whereas in the sheep serum it can be distinguished as a small peak incompletely separated from the γ-globulin, and containing a sharp spike, the β-anomaly (see Longsworth, Shedlovsky and MacInnes[6]). Finally, the γ-globulin, almost entirely absent from the serum of the lamb at birth, shows a very large increase after twenty-four hours. In the normal sheep the γ-globulin content is much lower.

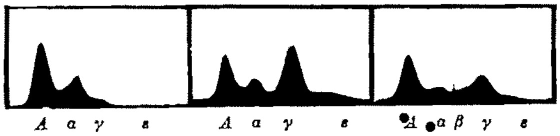

Fig. 1
LAMB,
BEFORE COLOSTRUM

Fig. 2
LAMB,
AFTER COLOSTRUM

Fig. 3
NORMAL SHEEP

Cathode-limb exposures are shown. Migration is from right to left. Peaks are designated thus: *A* = albumin; *α*, *β*, *γ* = *α*-, *β*-, *γ*-albumin; *ε* = *ε* salt boundary

Sera from eight lambs have been examined in the manner indicated, and the results shown are typical. Thus it appears that, as with other animals, so in the case of lambs the transfer of colostrum causes a remarkable increase in the γ-globulin. Advantage is taken of this transfer of γ-globulin from mother to offspring in the prophylaxis of certain diseases of the very young. In certain areas of Great Britain serious mortality occurs annually in young lambs from a disease which results from the ingestion of *Cl. welchii* type *B* organisms. The resulting enterotoxæmia is fatal to more than 90 per cent of affected lambs. The injection of in-lamb ewes in the autumn and spring with a vaccine prepared from suitable strains of the organism concerned produces antitoxin in the ewes' blood. At the time of lambing this antitoxin is present in the colostrum and the passive immunity acquired by the new-born lamb is sufficient to protect it during the first two critical weeks of life[7].

We are indebted to Mr. A. T. Glenny for advice on this work.

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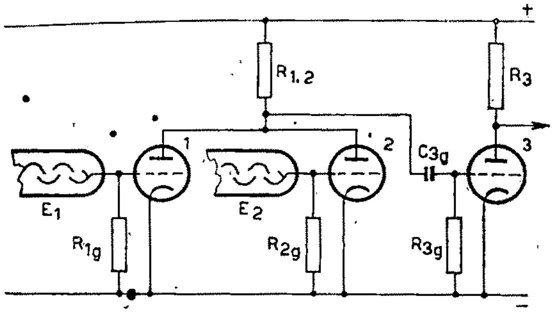
Coincidence Device of 10^{-8}–10^{-9} Sec. Resolving Power

COINCIDENCE circuits with resolving times much exceeding 10^{-6} sec. can be obtained by making use of electron multiplier tubes[1]. The device shown in the diagram is a modification of the Rossi type circuit. Ultra high-frequency electron tubes, lately developed, have been used. Because of the small inter-electrode capacities, the high mutual conductance and the small coupling resistances (50–100 ohms), the input pulses are not noticeably distorted by valves 1 and 2 and thus reach the grid of valve 3 without appreciable delay.

A difficulty which does not arise when coincidences between Geiger–Müller counters are recorded is as follows. While the input pulses obtained from Geiger–Müller counters are fairly uniform in size, the pulses arising from electron multipliers are subject to unavoidable random fluctuations. Thus the tubes 1 and 2 have to be operated at such a point of their characteristics that they tend to give equal output pulses independently of the size of the input pulse. This is achieved if tubes 1 and 2 have very sharp cut-off characteristics. In the tubes actually used the anode current was completely cut off by pulses exceeding 1 V. fed to the grid. The actual pulses received from the electron multipliers ranged between 1 and 10 V.

The tube 3 was biased so as not to respond to a pulse of 1 V. across $R_{1,2}$, corresponding to a single



input pulse, but so as to respond to pulses of at least 2 V., corresponding to coincidences.

The resolving power so far achieved is about 5×10^{-9} sec. The determination of this quantity was carried out—besides the usual method of counting random coincidences—by a direct method. The impulses of the same multiplier tube are fed into both inputs of the device, so that each impulse is recorded as an 'artificial coincidence'. If one of the leads connecting the multiplier to one of the inputs is increased by a length Δl, this side of the device will be reached by the impulse $\Delta t = \Delta l/c$ sec. later; for example, 1·5 m. corresponding to the resolving power given above. Because of this time-lag the amplitudes of the artificial coincidences decrease, and at a critical length they fade out entirely. By increasing the length of the other lead, too, the coincidences are made to reappear, demonstrating that fading-out of the coincidences was a consequence of the time-lag caused by the difference in length of the leads.

The device was designed chiefly for investigations in nuclear physics. At present, experiments similar to those of Bothe[2] are going on in the ultra-violet and visible region.

Further details will be published elsewhere.

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Electron Multiplier Tube of Large Effective Cathode Surface Area

Electron multiplier tubes have been used in this Laboratory for particle counting[1], and their extremely short impulse period[2] makes them very useful research tools[3]. One disadvantage of these tubes is their small effective surface.

One method for increasing the effective surface is the following: the electron-optical image of a cathode of large surface area is projected on the first multiplying electrode of a multiplier tube of the usual dimensions. In this way a tube similar to the partition-type multiplier of Zworykin and Rajchman[4] was designed. The electrons are emitted by a cathode of spherical shell shape, and the image of the surface of the cathode is projected on the first multiplying electrode by an electrostatic lens. The cathode subtends an angle of 90° viewed from the focus of the lens. In this manner an effective surface of 100 cm.^{2} can easily be obtained.

The centre of curvature of the cathode is at the focus of the lens; the transit time of the electrons between cathode and first multiplying surface is very nearly the same for all electrons, regardless of their point of origin. This is most important in coincidence devices of very high resolving power.

The dimensions of the lens electrodes and the potentials thereon can be adjusted so that practically every electron emitted by any point of the cathode can reach the first multiplying stage without being captured by intermediate electrodes or repelled to the cathode.

In the experimental tubes, electrons could be released from well-defined points of the cathode. Some of the tubes were enlarged models, having electrodes covered by a thin layer of fluorescent material. In this way the incidence of the electrons was made visible. This method was very useful, especially in the first qualitative experiments.

Another possible way of increasing the effective surface of the electron multiplier tubes is to increase the length of all electrodes of a circular-type multiplier[4]. This method, however, would increase the capacity of the collector plate, which is a disadvantage from the point of view of the impulse period of the tube and the amplitude of the voltage pulse.

The development of the tube for the purpose of researches on cosmic radiation is going on.

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Variation of Thermo-electric Power of Electronic Semi-Conductors with Vapour Pressure

When the principle of mass action is applied to explain the effect on the electrical properties of certain electronic semi-conductors having an ionic lattice structure, produced by varying the vapour pressure of one of the constituents of the substance, it is found that

$$n_f = KP_v^{1/n}, \qquad (1)$$

where n_f is the concentration of charge carriers, which may be free electrons or holes, K is an equilibrium constant, P_v is the vapour pressure, and n is a constant, negative for excess and positive for defect semi-conductors, which can be deduced from the chemical structure of the substance.

If this equation is introduced into the usual free-electron theory for the thermo-electric power of semi-conductors[1], equations may be obtained corresponding to the empirical equation

$$\frac{dE}{dT} \pm \text{const.} = -C_T \log P_v, \qquad (2)$$

where dE/dT is the thermo-electric power, taken as negative for excess and positive for defect semi-conductors, and C_T is a constant for a particular substance. From the theory C_T may be identified with $k/|e|n$, where k is Boltzmann's constant and e is the electronic charge, and a value for n thereby obtained.

Little experimental work has been performed on this subject except for a few spot readings by Wagner and his co-workers[2,3,4], made to test Wagner's differential thermo-electric circuit concept[5]. Assuming that these results obey equation (2) above, values of n have been calculated and are shown below for comparison with the values obtained from conductivity measurements :

Substance	Theoretical value of n	Value from conductivity measurements	Value deduced from thermo-electric measurements
Cu_2O	8	7	8·8
NiO	6	4	4·8
ZnO	6	4·3	6·1

The experimental results are not sufficiently comprehensive or accurate for a critical comparison, but it is noteworthy that in each case the value of n calculated from thermo-electric properties is in closer agreement with the theoretical than that obtained from conductivity measurements.

Experiments on various semi-conductors are being carried out and the results to date show that equation (2) is, in fact, obeyed. Details of the equations and their derivation will be published later.

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Nuclear Models

IN a recent paper[1], H. A. Wilson has proposed a spherical shell model for the nucleus of a heavy atom. In this model the nucleus is represented as an inextensible, flexible, spherical shell the shape of which is maintained by the Coulomb forces between the protons. The radius of the shell is assumed to be $R = R_0 A^{1/3}$, where R_0 is a constant and A is the total number of nucleons in the nucleus, and, according to Wilson, the frequency of the nth mode of vibration of the shell is given by

$$\omega = \omega_0 (n^2 + n - 2)^{1/2},$$

where $\omega_0 = eZ/2R_0^{3/2}M^{1/2}A$.

A model of this type has much to recommend it, but calculations we have recently performed indicate that it is not entirely satisfactory. To give a density of energy-levels of 0·1 V. for an excitation energy of 6,800 kV. in uranium requires that $\hbar\omega_0$ should be about 378 kV. for this nucleus. The value of $\hbar\omega_0$ for any other nucleus can then be obtained by multiplying by the appropriate factor Z/A as indicated by the definition of $\hbar\omega_0$. When the value for $A = 120$ is used to calculate the spacing of the energy levels for an excitation energy of 8,000 kV., we obtain a spacing of 0·05 V., which is definitely not in agreement with the experimental evidence. This fact cannot, however, be used as an argument against Wilson's *general* idea, but only against the extrapolation of the condition of the inextensibility of the shell to high-excitation energies.

On the other hand, calculations based on the assumption that the neutrons and protons forming a heavy nucleus are contained in the same spherical volume leads to a value $R_0 = 1·56 \times 10^{-13}$ cm. from which the nuclear radius can be evaluated. This value is not in agreement with the value R_α of the same constant derived from the many-body theory of α-decay[2]. The discrepancy between the two values can, however, be removed by modifying the type of nuclear model used. The use of the statistical method of calculation imposes no restriction on the location of the volumes occupied by the protons and neutrons forming the nucleus, so we are at liberty to construct a model in which they occupy different regions of space.

If for simplicity we assume that the number of neutrons is equal to the number of protons, then they will occupy equal volumes. The simplest way of constructing a nuclear model in which the protons occupy a volume equal to that occupied by the neutrons but not identically situated is to consider that the neutrons form a central spherical core which is surrounded by a spherical shell of protons. The radius of the inner core is then $R_0 A^{1/3}$, while the external radius of the whole nucleus corresponds to $R_\alpha A^{1/3}$ of the α-decay theory. Since the volumes of core and shell are equal, we have immediately that $R_\alpha^3 - R_0^3 = R_0^3$, so that $R_\alpha = \sqrt[3]{2}\, R_0$.

Taking the value $R = 1·56 \times 10^{-13}$ cm. given by our calculations, we then obtain $R_\alpha = 1·97 \times 10^{-13}$ cm., which is in good agreement with the value 2·0(5) cited by Bethe. Furthermore, taking R_0 to be the radius of a proton, we find by a simple calculation that the proton shell in heavy nuclei is only one proton thick, so that each proton in the shell is in contact with at least one neutron of the inner core.

The details of the calculations will be published shortly in the *Proceedings of the Cambridge Philosophical Society*.

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Spectrum of White Dwarfs

IN a recent paper, Blackett[1] has suggested that the Zeeman effect might be responsible for the peculiar absence of metallic lines in the spectra of most of the white dwarfs and may also contribute to the broadening of the hydrogen lines. Since this suggestion was given as one more argument in support of the theory of the magnetic field of massive rotating bodies, it may be of interest to point out that considerations of the internal constitution of white dwarfs seem to offer an alternative explanation of the peculiar features of their spectra.

Such an explanation may, in fact, be afforded by the strong separation of elements in the high gravitational field of white dwarfs. It has been shown[2] that we must expect in a white dwarf a core of heavy elements surrounded by a hydrogen layer. (In this paper I had assumed the inherent β-radiation to be forbidden (in the sense of the selection rules); but, as shown below, the results of Bethe and Critchfield are not in contradiction with astrophysical evidence.) Between them exists a mixed layer the thickness of which, proportional to the temperature and inversely proportional to the acceleration of gravity, is very small compared with the radius of the star. The decrease in concentration of heavy elements in the hydrogen layer is extremely rapid, so that the concentration of metals in the atmosphere could be many hundred negative powers of ten.

If the hydrogen layer is sufficiently thick, the metal lines should, thus, not appear in the spectrum. This case should correspond to stars like Wolf 489 or o_2 Eridani *B*. The presence of metal lines in the spectra of some white dwarfs is only possible when the hydrogen layer is very thin and the concentration of heavy elements great at the bottom of the non-degenerate outer part of the star. Convection currents, such as those found by Unsöld, could then carry heavy elements to the very surface of the star. This seems to be the model for a star like Van Maanen 2. The great proximity of heavy elements to the surface, and such convection currents, would be sufficient to explain the presence in the spectrum of lines of light metallic elements like calcium. The theory of production of lines in stellar atmospheres also indicates that collision damping should be sufficient to explain the broadening of lines of Ca^+. The weakness of lines of heavy elements such as iron should be connected with the strong separation of heavier elements in the gravitational field.

Such considerations about the thickness of the hydrogen layer agree also with calculations on the energy production. The main source of energy is represented by the reaction

$$^1H + {}^1H \rightarrow {}^2D + e^+,$$

and the ensuing reactions, the rate of which has been calculated by Bethe and Critchfield[3]. This rate is much greater than that corresponding to processes in the mixed layer, analogous to those occurring in the sun. For the white dwarfs we get in this manner an estimate for the thickness of the hydrogen layer which should be responsible for the actual energy production and which, in fact, turns out to be large compared with the thickness of the mixed layer for o_2 Eridani *B* and Wolf 489, and extremely small in the case of Van Maanen 2.

A more detailed account of the above ideas based on a fuller discussion of the constitution of the various types of white dwarfs will be given in a later paper. I wish to thank Prof. B. Strömgren for stimulating discussions on the subject.

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The Bikini Bomb and the Seismology of the Pacific Region

Gutenberg and Richter[1] have recently published numerical travel-time data for *P* waves recorded at eight stations in the United States, following the detonation of an atomic bomb over Bikini on 1946 July 24. They point out the importance of these waves in checking travel-time tables, and use the results to test the accuracy of earlier tables[2] published by them. The purpose of this note is to compare the data with the Jeffreys – Bullen tables[3]; and, further, to investigate the precision with which the result of this comparison may be applied to the question of the structure of the Pacific region.

The eight recording stations were at distances from the place of detonation ranging from 69° to 78·6°. The excesses of the 'observed' travel-times of the first *P* waves over the times given in the Jeffreys – Bullen tables are found to be −1·6, −0·4, −1·6, −2·1, −1·1, −2·7, −1·1, −0·4 sec., yielding a mean of −1·4 ± 0·7 sec. (the time of detonation of the bomb is known within 0·1 sec.). To this must be added the mean ellipticity correction[4] of −0·4 sec., giving a mean residual of −1·8 ± 0·7 sec. (It is assumed that the data of Gutenberg and Richter relate to geocentric and not geographic latitudes.)

A residual of this order is to be expected, because of special features of the Pacific structure[5]. Thus the results of the Bikini bomb suggest no improvements to the Jeffreys – Bullen tables for epicentral distances of the order of 70°–80°.

On independent grounds, the Jeffreys – Bullen *P* tables are indicated as being accurate within standard errors of the order of 0·4 sec. for 'average' earthquakes. This would indicate that the travel time of *P* waves between Bikini and stations in the United States is less by 1·8 ± 0·8 sec. than the corresponding travel-times for average earthquakes (in which epicentres are in continental regions). This figure may be of some importance in subsequent investigations of the Pacific region.

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Sublimation in the Atmosphere over the Oceans

THE results of measurements of the highest temperature at which ice particles were formed in a Wilson expansion chamber, using air at the Jungfraujoch Observatory, were recently reported[1]. Similar measurements have now been made in the air over the Atlantic and Pacific Oceans on board R.M.S. *Rangitiki*, N.Z.S. Co., during a voyage from London to Wellington (May 10–June 16, 1947).

Measurements made in the 'Horse Latitudes', in the North-East Trade Wind in the Atlantic and in the South-East Trade Wind in the Pacific, gave invariably − 41·2° C. as the ice threshold.

From these measurements and the previous ones at the Jungfraujoch it may be concluded with all probability that there are no nuclei of sublimation in the atmosphere at the cirrus-level, except possibly in cases where they are carried up from ground-level by the violent convection in thunderstorms originating over areas where the air contains industrial pollutions. In such cases the ice threshold will be some 9° C. higher, and owing to this, such areas might be more subject to showers.

My thanks are due to Sir Nelson Johnson for the loan of the necessary apparatus and to Capt. E. Holland of R.M.S. *Rangitiki* for providing facilities for the measurements.

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Occurrence of Troilite

MINERALS described from the Daggafontein Gold Mine[1] were later made available to me for detailed study. They included typical brownish magnetic tabular pyrrhotite crystals 2·5 mm. wide by 0·5 mm. thick, showing steep pyramid, prism and basal pinacoid faces. Some were intimately associated with black nodules of a hydrocarbon and grey chlorite streaks in lumps of white, finely crystalline dickite.

One large and one smaller crystal identical in form with the majority were more like pyrite in colour and practically non-magnetic. These crystals contained 62·4 per cent of iron, which is nearer to troilite (usually only found in meteorites) than to pyrrhotite in the series pyrrhotite-troilite. The typical pyrrhotite contained 60·31 per cent of iron (kindly analysed by Mr. T. Steele). Troilite has been recorded from the Witwatersrand previously[2], but the occurrence of two distinct varieties of the pyrrhotite series together is worthy of note.

It is suggested that detailed studies of pyrrhotite crystals will prove terrestrial troilite to be more abundant than was hitherto considered.

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Minimum Perceptible Energy and Brownian Motion in Sensory Processes

FOR all sense-organs there exists a lower limit to the minimum perceptible energy, which is set by the Brownian motion in the sensory equipment itself. The minimum perceptible energy must be so large that only a small number of spontaneous excitations by thermal motion can occur. The quantitative relations have been estimated tentatively in certain cases.

(*a*) *Vision.* The minimum perceptible stimulus corresponds to the absorption of a single light quantum by a molecule of visual purple in each of several retinal rods—about five according to Hecht *et al.*[1], or two according to Van der Velden[2]. Suppose that one rod only need be excited. The number of spontaneous thermal excitations will be approximately $q = \frac{N}{\tau} \exp - E/kT$ per sec., where E is the energy necessary to decompose a visual purple molecule and $\exp - E/kT$ is the probability that the essential part of the molecule has a thermal energy greater than E at a given moment (at 37° C., $kT = 4{\cdot}3 \times 10^{-14}$ erg). τ is the mean life-time of a given distribution of the energy; every second we have $1/\tau$ 'new' distributions. For molecules, τ is about 10^{-13} or 10^{-14} sec. (see ref. 3). Finally, N is the number of sensitive molecules in one cell. For applications, we can write our formula as

$$E = 2{\cdot}30\, kT \log \left(\frac{1}{q}\frac{N}{\tau}\right). \quad . \quad . \quad . \quad (1)$$

For the visual process, the calculation of the energy E which is necessary in order to avoid spontaneous excitations can be made with fair accuracy. For the rods, N is 4×10^9 (ref. 4). Strictly speaking, this was found for a frog retina, but it follows from the high sensitivity of the human retina (see ref. 2) that the concentration in dark-adapted human rods cannot be lower than about 10^9 molecules per rod. Hence $N/\tau = 10^{23}$, and according to formula (1) E must be $2{\cdot}3 \times 23\, kT = 53\, kT$ in order to experience less than one excitation per second. Even if ten excitations a second are admitted, E is not materially changed.

For the visual process the limit of 53 kT does not offer anything new, because from the sensitivity curves of the receptors it follows already that E is probably more than 70 kT. Moreover, the spontaneous excitation of only one rod does not give rise to the *sensation* of light; two excitations which occur within about 0·05 sec. are necessary[1,2]. (S. Hecht *et al.* arrive at about five quanta, but since the two-quantum hypothesis, developed by v. d. Velden, was checked by other observations, this number seems more probable.) Of course, the number of spontaneous *sensations* will be greatly reduced in this way, and this may be a reason why this remarkable 'coincidence mechanism' is present in the eye.

(*b*) *Excitation of a Nerve.* For other processes a similar reasoning can be applied, if the various constants are properly defined. As an example, we will consider the excitation of a nerve. For E should be inserted the energy which is necessary for the depolarization of an area O which is large enough to propagate itself. A reasonable value[5] for the energy per cm.^{2} is about 4×10^{-4} erg, so that O should be 3×10^{-9} cm.^{2} to have $E = 30\, kT$. (This value for O will only be assumed as a first approximation.) τ is unknown; it cannot be more than 0·001 sec., since after excitation the normal configuration is restored in about 0·001 sec.[5]. For N, the number of units any of which can start an excitation we should insert the total area of a nerve, divided by O. For a nerve, length 30 cm., diameter 5μ, $N = 3 \times 10^7$. From these data we find that in this case E should be about 25 kT (or more). Then $O = 3 \times 10^{-9}$ cm.^{2} or 2×10^{-6} cm. of the nerve. It is not probable that an area of depolarization of 2×10^{-6} cm. of a nerve is sufficient to propagate itself. This means that the nerve considered is very stable with regard to thermal excitation, and that 25 kT does not suffice for excitation. If the mechanism of the nerve were known in more detail, it would be possible to give a more elaborate discussion. Since the probability of excitation depends largely on the energy E, however, we can safely assume that for the nerve and probably *several other processes* the limit will be at least 25 kT.

(*c*) *Hearing.* For the process of hearing the limit of about 25 kT for one sense cell, mentioned above, is more important. This will be discussed in more detail in the near future in a paper to be published in *Physica*, but the leading idea is as follows. The minimum audible energy is some 300 kT. According to the present views, this energy is distributed over at least 1·5 mm. of the basilar membrane, or 1,000 sense-cells, so that one cell only receives 0·3 kT. This is obviously much too far below the limit mentioned in this letter to be accounted for by experimental errors. From this discrepancy interesting conclusions about the mechanism of hearing can be drawn.

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[1] Hecht, S., *et al.*, *J. Gen. Physiol.*, 25, 819 (1942).

[2] Velden, H. A. v. d., *Physica*, 11, 179 (1944).

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Occurrence of *Elminius modestus* (Darwin) in British Waters

The observations on the existence of *Elminius modestus* on British coasts reported by Mr. M. W. H. Bishop[1] have been confirmed and extended in an independent investigation commenced by Messrs. Blacklock and Macarthur, Glasgow, in January 1946.

Some of our records of this species are listed below. It will be noted that *Elminius* is widely distributed and abundant on the south-east coasts of England, and, in fact, has been taken at every point which we have visited, where a suitable substratum exists, between Norfolk and Dorset. It occurs intertidally, mainly below mean tide-level, but may be found higher in protected situations, and also at depths down to at least 5 fathoms. Its habitat and settling behaviour appears to be in British waters exactly as described by Moore in New Zealand[2]. In the Essex Rivers it competes very successfully with *Balanus balanoides* in the lower part of the intertidal zone, but the latter has the advantage of slightly earlier settlement and longer life; under water it is rather less successful in competition with *B. crenatus* and *B. improvisus*. *Elminius* ranks as a dominant littoral organism in the estuaries of the Colne, Blackwater, Crouch and Thames.

We have also considerable data suggesting that this species is mainly confined to the south and east coasts of Britain. Careful examination of the foreshore and of underwater exposure panels has failed to reveal any *Elminius* at our stations at Brixham, Devon; Pierhead, Liverpool; Port Erin, Isle of Man; and Portree, Isle of Skye, though a sparse settlement has recently been recorded at Neyland, Pembrokeshire. Less rigorous examinations of material from Conway and the Blyth Estuary, Northumberland, suggest its absence from these localities.

Elminius modestus has a longer season of reproduction and continuous settlement than any other barnacle in British waters, and the spat has been observed to reproduce early in the same season in the Rivers Blackwater and Crouch[2]. Indeed, it seems theoretically possible from our growth-rate and breeding data that two complete generations may occur during summer in such an estuary, since fully developed nauplii may be found at any stage after a rostro-carinal diameter of 4–5 mm. has been attained.

RECORDS OF *Elminius modestus* (Darwin)

Locality	Occurrence	Earliest record
Brancaster, Norfolk	Not common	August 1947
Lowestoft, Suffolk	Frequent	August 1947
Rivers Colne and Blackwater, Essex	Abundant	Settlement, April 1 to October 10, 1946
N. Fambridge, Essex	Abundant	October 1945
Thames, below Gravesend	Common	September 1947
Thanet coast, Kent	Occasional	September 1947
Brighton, Sussex	Frequent	October 1947
Poole, Dorset	Common	June 1947
Neyland, Pembrokeshire	Occasional	August 1947

The present distribution of *Elminius* does not indicate clearly a recent dissemination from one or more centres, but appears to be that of a well-established species. It is abundant in the favourable environment of shallow muddy estuaries with high summer temperatures, rarer on sandy and chalky foreshores and absent where there is considerable wave exposure[3]. The very intense barnacle-fouling experienced in these muddy estuaries is due in considerable degree to *Elminius*, and in view of the frequent coastal traffic, its absence from ports in the south-west and west of England may indicate an unfavourable environment. It is possible that lack of interest in the Cirripedia until recently, the paucity of faunistic work on the south-eastern shores of Britain, and a superficial resemblance to *B. balanoides* have combined to give the immigrant freedom from recognition for some years. The simultaneous records of Bishop and ourselves in 1945 at places as distant as Fambridge and Chichester support this view.

A comparison between the introduction of *Elminius modestus* and the invasion of the Essex rivers by *Crepidula fornicata* in about 1880 may be of interest. The latter species has succeeded in colonizing submarine levels of the same environment and, spreading rapidly at first, achieved a similar distribution over a period of forty–fifty years[4].

A fuller account of its distribution, development and breeding habits in British waters will be published at a later date.

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Oct. 17.

[1] *Nature*, **159**, 501 (1947).

[2] Moore, L. B., *Trans. and Proc. Roy. Soc. New Zealand*, **73**, 315 (1944).

[3] Cf. Darwin, "Monograph on Cirripedia", 348 (1854).

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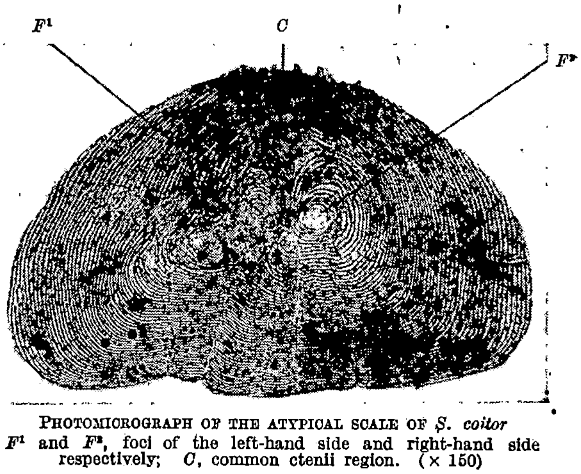
An Atypical Scale of *Sciæna coitor* (Hamilton)

In the course of studies of the structure and development of ctenoid scales of certain Indian fishes[1], an atypical scale was encountered (see accompanying illustration. It was found on the body of a male *Sciœna coitor* which measured 20 mm. in length. It was located in the middle region of the trunk on the fifth row below the lateral line. The neighbouring scales and those belonging to the other regions of the body were also critically observed but none of them showed any breach of normal development.

The most interesting feature of this scale was the presence of two foci instead of one. Both the foci lie in the middle zone of the scale. The focus of the right-hand side (F^2) was circular, while that of the left-hand side (F^1) was more elongated. The focus of the right was bounded by more or less complete concentric circuli. The circuli encircling the corresponding focus were extremely longitudinal and consequently incomplete. Of the two foci, the right



PHOTOMICROGRAPH OF THE ATYPICAL SCALE OF *S. coitor*
F^1 and F^2, foci of the left-hand side and right-hand side respectively; *C*, common ctenii region. (× 150)

one was larger than the left. Ctenii were at the formative stage, the deposition being laid. Seven of them (*C*) were conspicuous. They were devoid of basal components. The ctenii region occurred in such a position as not to come exclusively under the ambit of any particular focus, since it lay in the middle line passing between two foci. Eight radii had appeared and they extended centripetally towards the foci.

The foci, on being surrounded by their own circuli, could be taken to represent two scales at the incipient developmental stage. It might be imagined that at an early period of development, owing to some developmental irregularity probably caused by arrested growth, the inferior layers of these two incipient scales were fused to form a common lower layer. The hyalodentine of each of them, which was already calcified, retained its identity as the focus in spite of fusion of their lower layers. Thus the presence of two foci was explained. Thereafter by this union the rest of the features which were laid down by the activity of the inferior layer were common to both foci. Thus it appeared that two incipient scales merged so as to give the appearance of a single scale. The nature of ctenii being common to both the foci could be explained, because the ctenii were formed as delayed deposition, as previously shown by Ganguly and Mookerjee.

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Resistance to Inanition in Grass Seedlings

SOME years ago I found that grass seedlings which were in competition with other grasses older than themselves were able to remain alive for several months, although growth, in the sense of increase in size, could not take place[1]. In these experiments the competition of the older plants operated by the removal of mineral nutrients from the soil surrounding the young seedlings, and by the exclusion from the latter of light. The tolerance of the latter was so pronounced that an inquiry was started into the general ability of grass seedlings to survive inimical conditions.

The results can be summarized as follows:

(i) Increase in size of seedlings may be completely inhibited by a lack of mineral nutrients, but with this factor alone operating and with full light, the seedlings survive indefinitely.

(ii) Seedlings from which light is completely excluded remain alive for periods determined by the temperature prevailing; for example, at 22° C. survival does not exceed 20 days, whereas at 9° C. survival may extend to 18 weeks. At the end of this time, on the admission of light, chlorophyll is formed and normal development can proceed. Resistance to inanition is independent of the food reserves in the caryopses, and of the presence of chlorophyll. This behaviour is shown by seedlings grown *in vitro*, and in soil; and seedlings from seeds sown in the autumn may not appear above the soil until the following spring. Low mineral nutrition, and the admission of light at low intensities, or for intermittent short periods, increases the longevity of the seedlings.

(iii) The well-known ability of seeds to develop after desiccation during the initial stages of germination is shared in a lesser degree by grass seedlings which have developed two or three leaves. After six days air-drying at 14° C., survival is approximately 20 per cent, and the survival period can be considerably extended by intermittent moistening of the seedlings.

(iv) All the commoner species of British grasses show this ability to resist inanition and desiccation; but no dicotyledonous species so far tried has possessed it.

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[1] Chippindale, *Ann. Appl. Biol.*, 19, 221 (1932).

Mauthner's Cells in the Larvæ of Anuran Amphibia

IN a previous communication[1], confirming the occurrence of Mauthner's cells in the larvæ of *Rana*, each axon process was described as dividing into two similar fibres, each of which decussated separately. Subsequent work, while confirming the existence of this condition in other batches of material, has shown that it is not invariable. In many instances the axon process remains undivided, at least in the region of the medulla oblongata.

Although variability of this type is apparently unique, my records show clearly that it is not associated with any marked differences in the maintenance of equilibrium, the locomotory habits and general behaviour of living larvæ.

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Sept. 22.

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[1] Willis, A. G., *Nature*, 159, 410 (1947).

Demonstration of the Heart Beat

I SHOULD be interested to know whether any physiologist who is also a smoker has noticed the following phenomenon, and whether it has been previously reported. Choose a quiet room, fill the mouth with tobacco smoke, and blow gently out through a very small aperture between pursed lips. Careful observation of the fine jet of smoke will show that it has a definite periodicity—that of the heart beat. With a delicately controlled jet it is even possible to make the heart blow a smoke ring at each beat.

It is evident that the heart is giving a pulse of pressure to the air in the mouth, just as does the hand when tapping the stretched diaphragm of the well-known box used for the demonstration of smoke rings. The pressure pulse may be communicated directly through the heart wall, or perhaps it is given by way of the arteries in the throat and mouth. It is possible that observation of air-pressure in the mouth by means of a quick-acting micromanometer might give useful information about the condition of the arteries responsible.

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NATURAL AMŒBIC INFECTIONS IN LABORATORY RODENTS

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DURING the course of chemotherapeutic experiments on *E. histolytica*, the need for a suitable laboratory host for this parasite became early apparent. Jones[1] has obtained some interesting results by using young rats weighing 20–33 gm. for this purpose. We were, however, rather perturbed by the degree of infection with amœbæ which occurred in the animals of an age suitable for experimental work, when examined by us as a preliminary to their use in experiments of the above nature.

We therefore investigated the incidence and degree of natural infection in other laboratory animals which might prove suitable hosts. For this purpose we made a careful examination of the intestinal contents of white rats, cotton rats (*Sigmodon hispidus*), hamsters (*Cricetus auratus*) and Orkney voles (*Microtus orcadensis*). Wenyon[2] has indicated that amœbic infection is widespread in the animal kingdom. The amœba of the rat and mouse was first described by Grassi[3] and both were named by him *E. muris*. Numerous investigations on the rat parasite have since been recorded and in our case were made for comparative purposes. Wenyon[4] gave a clear description of *E. muris* in the mouse, pointing out that in fresh and stained preparations it had a striking resemblance to *E. coli*, as previously noted by Grassi. The character of its nucleus in stained sections agreed closely with Schaudinn's description for the latter parasite. Brug[5] described a second and rarer amœba present with *E. muris* in the rat intestine which resembled *E. histolytica*. He considered the new parasite was identical with the amœba of human dysentery and that the rat was a possible source of amœbic dysenteric infection for humans. Kessel[6] later introduced a new nomenclature for the amœbæ present in rats and mice, but his views have not yet met with general acceptance. Recently Neal[7] has described the presence of an amœba in golden hamsters differing from *E. histolytica*, with which he was able to infect young rats by feeding cystic forms of the organism. The presence of amœbæ in the cotton rat and the Orkney vole has not so far been reported. All the animals which we examined were normal specimens of known age except in the case of a few hamsters which had been used to maintain a strain of *L. donovani*.

Methods

Examination of cæcal contents was carried out after killing the animal with chloroform, and a rough count of the number of amœbæ present in fresh specimens made. Ten minutes was spent on each of six coverslip preparations before the absence of amœbæ in any animal was recorded. Examination was also made for the presence of cysts after concentration of the whole contents of the large intestine by the method of Yorke and Adams[8], and sometimes further concentrated by the zinc sulphate method. By means of a micrometer eyepiece, measurements of a hundred trophozoites and fifty cysts were made of the amœbæ of each animal species. Stained smears of both forms of the parasite were also made, as well as of sections of cæcum, especially in those cases in which infections were heavy, the latter in order to note whether any lesions of the gut wall were present. Smears fixed in Schaudinn's solution were stained by the iron-hæmatoxylin method of Heidenhain and counterstained with aqueous eosin. Prolonged differentiation was necessary to demonstrate nuclear structure. Sections were fixed in Bouin's solution and stained by the above method.

Distribution of Amœbæ

It was found, as shown in Table 1, that approximately 50–70 per cent of each animal species was infected with trophozoites; but the percentage of animals with cystic forms was considerably less. The intensity of infection varied greatly from animal to animal in each species. In general, one to twenty trophozoites were seen per hundred microscopic fields, using 1/6 in. objective and × 6 eyepiece, but in the case of a few white rats as many as thirty parasites were present per field. In hamsters and voles the highest number recorded was five to ten per field, but in cotton rats trophozoites were nearly always scanty and the heaviest infection seen was about one per field, while cysts were even more difficult to find in that animal.

TABLE 1. INCIDENCE OF AMŒBIC INFECTION

Animal	No. examined	% with trophozoites	%with cysts
Hamster	58	53	24
Orkney vole	41	68	19
Cotton rat	72	55	5
White rat	35	65	—

Quite early it became apparent that if trophozoites were very scanty or absent, the chance of finding cysts was negligible, and our methods were modified accordingly. Age groups from two weeks up to more than a year were included in these examinations. In no case was infection detectable in the youngest group; but in the case of white rats, about half were infected at the age of three to four weeks. Cotton rats and hamsters were infected at the same age, and the heaviest infection recorded for hamsters was seen in an animal four weeks old. Voles were not found to be infected before six weeks of age and only a few younger animals were available for examination. The presence of amœbæ in any of these animals was unaccompanied by symptoms or lesions of the gut wall.

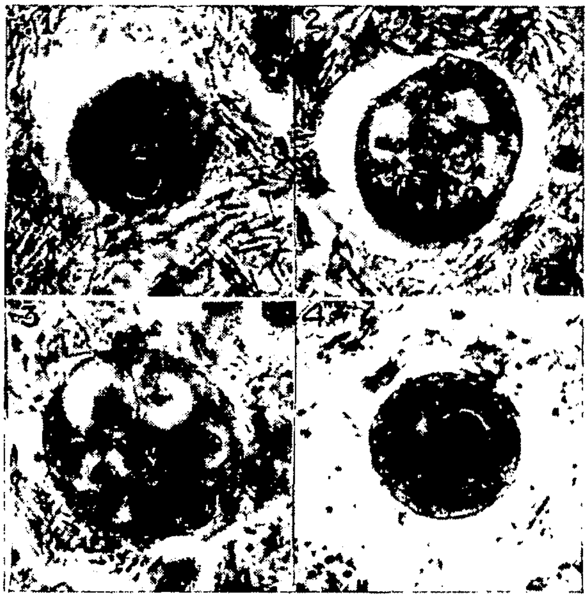
TABLE 2. DIAMETERS OF AMŒBÆ (IN MICRONS)

Host	Trophozoites Limits	Trophozoites Mean	Cysts Limits	Cysts Mean
Hamster	14·4–28·0	18·8	16·2–24·0	20·4
Cotton rat	13·8–26·4	18·6	14·4–19·2	15·6
Vole	13·2–24·0	18·3	12·5–17·6	14·6
White rat	16·3–32·5	20·1	13·7–24·0	17·3

As shown in Table 2, considerable variation in size of trophozoites was encountered, but their mean diameters for the different animals were approximately the same. The variation in size of cysts was not so great, and again there was considerable agreement among the different species of animal. The average diameter of the cysts recorded by us for the hamster is greater than that for trophozoites of the same animal, a result which may have depended partly on the number measured and partly on the considerable variation among trophozoites themselves.

Morphological Characters

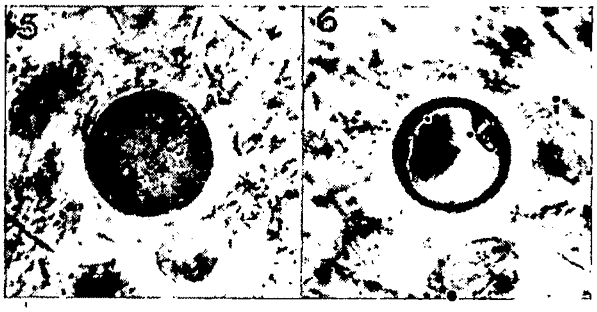
The following description of morphological characters is applicable to the parasites from the different hosts. In living preparations much of the activity of the amœbæ is confined to changes in shape without directive locomotion, pseudopodia being simply extended and withdrawn. The pseudopodia are at first composed of clear ectoplasm into which the endoplasm later streams. Several clear pseudopodia composed solely of ectoplasm may be extended in quick succession in several directions, so that at one particular moment an amœba may possess more than one pseudopodium. The ectoplasm is a narrow layer and is frequently only made visible during the formation of pseudopodia, while the endoplasm is granular and contains many vacuoles. The food matter is extremely variable and was seen to include bacteria, plant debris, and degenerated cells, probably of other Protozoa. The nucleus is also visible in the living amœba as a clear spherical inclusion surrounded by refractile granules.



Figs. 1–4. PHOTOMICROGRAPHS OF TROPHOZOITES FROM THE FOUR DIFFERENT HOSTS. × 1,000
1. HAMSTER. 2. COTTON RAT. 3, WHITE RAT. 4. VOLE

In fixed and stained preparations (Figs. 1–4), the ectoplasm is again indistinct; the endoplasm is usually vacuolated. The spherical nucleus generally has a uniform peripheral chromatin layer composed of fine granules in contact with one another and closely applied to the nuclear membrane; but in a few instances one or two condensed masses of chromatin were situated in the peripheral layer. The karyosome is compact and eccentrically placed within the nuclear membrane. The region between the karyosome and this membrane is occupied by a fine achromatic network and may contain a few chromatin granules.

In fresh cysts, chromatoid bodies were not noted with certainty. The maximum number of nuclei visible after treatment with iodine was eight; the karyosomes were usually eccentrically placed. The presence of glycogen was demonstrable in the usual way; it appeared to be more abundant in those cysts with few nuclei. In stained preparations of cæcal contents of the hamster, vole and white rat, binucleate cysts containing a large vacuole were encountered (Figs. 5 and 6) similar to those described by Wenyon in mice. In mature cysts the nuclear characters were similar to those of the trophozoites.



Figs. 5 and 6. PHOTOMICROGRAPHS OF BINUCLEATE CYSTS FROM TWO HOSTS. × 1,000
5. WHITE RAT. 6. HAMSTER (ONE NUCLEUS OUT OF FOCUS)

Attempts at cultivation were consistently made with fæces containing trophozoite forms from all sources as well as with concentrates of cysts on the media described by Dobell and Laidlaw[9], but without success. At best, survival was obtained over a 48-hour period in some cases, but subculture never succeeded, and amœbæ loaded with starch grains so common in stock cultures of *E. histolytica* and *E. coli* were not observed. The addition of acriflavine in a final concentration of 1/10,000 to the cultures, which is sometimes successful in restraining overgrowth of accompanying bacteria as described by these authors, did not materially improve our results, nor did cultivation at temperatures of 37° and 40° C.

Summary

It is clear from these numerous examinations of fresh and stained preparations that the amœbæ present in the different animal species investigated are very similar, as judged by size, distribution and morphology. Red blood cells were never seen within these amœbæ, which was in marked contrast to the findings when experimental *E. histolytica* infections were produced in the same animals. Parasites were present in the cæcal crypts, but no damage to the gut wall was ever apparent, although this is common in infections with *E. histolytica* in these animals. The amœbæ are therefore not pathogenic in their natural habitat and in this respect as well as in morphological characters possess many of the characteristics of *E. coli*. It is quite probable that the parasites described from these different sources are strains of the same species. We have not, for obvious reasons, attempted any cross-infection experiments. It is of interest that the cotton rats showed this amœbic infection shortly after their arrival in Great Britain although segregated from all other animals here. It was of further interest that a small percentage of these same animals should be found infected with *Hymenolepis nana*. A similar infection was present in hamsters, an observation which has recently been reported by Watson[10].

The bearing of these results on the choice of a suitable laboratory host for experimental infections with *E. histolytica* in relation to the chemotherapy of amœbiasis is under investigation.

Our thanks are due to Mr. F. Welch of this Institute for the photomicrographs.

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[3] Grassi, *Atti a Società ital. d. Scienze naturali*, **24**, 181 (1881). Quoted by Wenyon, ref. 4.

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[5] Brug, S. L., *Geneesk. Tydschr. Med. Ned. Ind.*, **59**, 577 (1919) (reviewed in *Trop. Dis. Bull.*, **16**, 8 (1920)).

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[10] Watson, J. M., *Brit. Med. J.*, ii, 576 (Oct. 19, 1946).

SCIENCE IN SOCIAL AFFAIRS

ON November 22, a conference of social scientists, convened by the Association of Scientific Workers, was held at Gas Industry House, London. The chair was taken by Mrs. W. Raphael, of the National Institute of Psychology, and the principal speakers were Prof. V. Gordon Childe and Mr. Roy Innes, general secretary of the Association.

The primary aim of the meeting was to enlist support for a draft report on "The Furtherance of the Social Sciences" prepared by a committee of the Association and shortly to be published. The meeting was the third of its kind, the first having been held in October 1945 to explore the interrelations between natural and social science, at which a Joint Sciences' Committee had been set up, and the second in December 1946 to consider the future of the social sciences. Some months earlier, the Joint Sciences' Committee had been reconstituted as the National Committee on the Social Sciences of the Association. The conference was well attended by workers in the cognate social disciplines at universities, Government departments and research institutes.

In her opening remarks, the chairman observed that social scientists are becoming a distinct and self-conscious body of workers, which may be due partly to the unpopularity which they share, particularly among some sections of the Civil Service, but more because the demand for their services is growing; although well-qualified persons are in short supply. The conference, she said, had the practical aim of inviting support for certain resolutions included in the draft report. This document had been prepared against the background of the report of the Clapham Committee on "Provision for Social and Economic Research", which was considered by many competent to judge as altogether too timid in its recommendations. She thought the national situation was such as to demand a much more vigorous approach to the whole problem of placing the social sciences upon a sound footing.

Prof. Gordon Childe illustrated the development of the social sciences by briefly sketching the history of anthropology, drawing a parallel with the growth of natural science; in both cases theory and practice had been closely interwoven. In the eighteenth and nineteenth centuries, traders, travellers, missionaries and Government representatives had begun to have direct dealings with primitive peoples in Africa, North America, the Pacific and other far-flung areas. Generally speaking, in spite of good intentions they were seriously handicapped in the concepts at their disposal, which had been assimilated in their own society. A theoretical basis for the understanding of other cultures was lacking. For example, they tended to assume that ownership of land everywhere conformed to the canons of Roman law. Their methods were thus as unscientific as primitive efforts to control the wind by appealing to a 'wind god', and injustice and administrative difficulties were the result. Nevertheless, the accumulated descriptions of primitive customs were suitable as data for scientific study and led to the discovery of new facts.

Both in Great Britain and in the United States the theoretical background of early anthropologists had been borrowed from the idea of evolution in the form of Lamarckism. To Tylor, Taylor, Morgan and others, property under capitalism and Christian marriage seemed to be the culminating forms of these institutions. The new study of prehistoric archæology arose out of the rectification of the theory of unilateral evolution which had long been a stumbling-block. Prof. Childe remarked that the inadequacy of early anthropological theory no more means that social science is impossible than the exposure of the phlogiston theory disproved the existence of chemical science.

In commenting on the proposed report, he pressed the need for 'pure' research to proceed side by side with the application of its results, and with this end in view financial provision should be forthcoming, new academic chairs and other posts created in the right numbers, and ample opportunities for work in Government service. Early students of anthropology, like their colleagues in the natural sciences, were men of leisure and private means, a source of supply which has run dry. The first academic anthropologists were drawn from other disciplines or from the ranks of administrators or retired Civil servants. Although this first generation was somewhat sterile in matters of theory, it produced students trained to observe primitive life, who returned from their field experience equipped with new interpretations. Anthropology had advanced in response to social needs. Prof. Childe referred in passing to the Euclidean methodology of academic economics, a subject which, like anthropology, has been lately regenerated by the infusion of the results of realistic experience.

The Clapham Report he thought rather out of date in its outlook, particularly in the modesty of its claims, which was due to a pessimistic view of the availability of qualified personnel. Reluctance to expand on these grounds, while admitting the need for new posts, sets up a vicious circle. Nor did he agree with the Clapham Committee's view that social scientists do not need expensive apparatus for research; their demands, he believed, are comparable with those of natural scientists, though their 'laboratories' may be sited overseas.

Prof. J. D. Bernal, in opening the discussion, said that the draft report was admirable in the way it set out the role of the social sciences as experimental disciplines; but it needed strengthening and extending in certain particulars. The report dealt with the internal position in these subjects and not with their link with the natural sciences. Like Prof. Childe, he singled out economics for special comment. Economists, he suggested, regard materials and technique as constant factors, while taking prices, market trends and interest rates as variables, whereas natural scientists take the reverse position. In fact, both sets of factors are variables. Hence the need for multi-disciplined research teams, which could be most useful in relation to present economic difficulties. A more immediate return could usually be expected from social than from natural science, inasmuch as the improvement of incentives, morale and organisation involved less delay and less dislocation than competition for capital goods. Experiments in social science, Prof. Bernal agreed, are costly, and he referred to the experimental houses now being studied by the Ministry of Works. The whole sociological investigation may cost a million pounds before it is finished. It may also happen, as sometimes occurs in the natural sciences, that a large-scale inquiry fails.

Prof. Bernal also agreed that it is urgently necessary to create senior posts in the social sciences, even if the available candidates have not attained eminence or maturity of years. In the early nineteenth century it was not usually decided to leave university chairs of science vacant rather than appoint persons who had not yet achieved fame. For example, Hamilton became professor of physics at Dublin at the age of twenty-two. If this practice were followed in the social sciences, the whole level of activity in the field might be raised. In any event, Prof. Bernal was doubtful whether so-called 'maturity of judgment' is an essential condition for success as a social scientist.

Prof. Bernal pointed to the value of regionalization in social science, by which he means the cultivation of local surveys in which people living in the area participate. Every area should have a team of social and natural scientists for this work, and out of this would come that co-operation between observer and observed which is so vital in social science. Indeed, this distinction might better be obliterated altogether.

Subsequent speakers expressed sympathy with the substance of the draft report and its recommendations, subject to certain amendments.

Prof. T. H. Marshall thought that the inadequacy of the financial need as assessed by the Clapham Committee is now fully recognized, and it would be a pity if the new report were committed to a definite figure. Grants should not be confined to universities; Government departments, research institutes and voluntary bodies concerned with social services or the development of techniques also need support. He felt that the position of sociology in the universities is extremely serious, facilities for study or research being virtually non-existent. The invariable difficulty of deciding on an occupant for a chair could be dealt with as suggested by Prof. Bernal.

Prof. Marshall argued in favour of permanent social research or survey units at universities, providing for some posts which do not carry teaching duties. The factor of size of the institution should also be examined. In a large institution, administrative and supervisory burdens are so great that they prevent the professor from getting on with his proper work. The solution is to be found in creating more senior posts and in delegating much of the teaching.

The plea for more senior posts in the universities was strongly supported by Dr. M. Fortes and several other speakers, without fear of suitable persons not being available. Dr. Fortes also compared standards. It seemed to him that at Oxford it is possible to win a higher degree in physical science by the patient manipulation of instruments without the investment of much thought; but in the social sciences the path is more difficult. The order of priority in the establishment of new university appointments in the various social sciences should, he felt, be carefully scrutinized and also the location of posts in areas where particular types of inquiry could most profitably be pursued.

The practice of the Royal Society in not admitting social scientists to membership received adverse comment. It is absurd, one speaker suggested, for ancient religious and political prejudices to determine limits of this kind; but speedy change of policy is unlikely, since the last reform of the Royal Society, initiated in 1833, has not yet been fully achieved.

A proposal in the draft report envisages an organisation of the same type as the Medical and Agricultural Research Councils, with advisory panels the chief function of which would be to stimulate research through the distribution of funds. Objections to this proposal were of two kinds: first, that a body might result interested in welfare to the exclusion of research, and second, in the absence of an independent body such as the Royal Society, social research would become dominated by Government control with all the possible ensuing dangers. Prof. Bernal believes that something of the kind is certainly needed if only to establish the intrinsic importance of the field, and he suggested that two bodies, one official and one independent, might serve the purpose. Another speaker favoured a council in the form of a 'federation' of social research units in Government departments and elsewhere. The most notable omission from the Clapham Report, he said, was the failure to recommend the setting up of social research units in Government departments like the Ministries of Labour, Health, and others primarily concerned with human organisation and relations. This would not preclude the use of mixed research teams when necessary. A social science research council, if formed, should be rooted in research units of this type as a condition of its success. It was eventually agreed to refer back for further clarification the whole section dealing with the proposal for a social science research council.

Mr. R. Innes, general secretary of the Association of Scientific Workers, said that the Association has always supported the idea of the unity of all branches of science in respect of their common interests and problems. It therefore welcomed the initiative displayed in preparing the report, and the executive committee had approved the recommendations in principle. The draft report had been circulated for comment to some 250 persons known to be active in the field. When the revised document was printed, the widest discussion would be needed wherever the possibility existed of implementing the recommendations. In these discussions natural scientists should take part, for they did not always fully appreciate the significance of the work of their colleagues. It was the hope of the Social Sciences' Committee that those present as well as others would help to implement the recommendations at universities and elsewhere. The Social Sciences' Committee would try to take a leading part in this. He added that a survey is in preparation of the fields of work, methods of training and career prospects in the social sciences.

Finally, the Conference adopted four resolutions: (i) urging publication of the report; (ii) supporting in general its recommendations; (iii) inviting the Association to support all steps leading to implementation; and (iv) requesting the Association to submit the report for the consideration of the Lord President of the Council, the Minister for Economic Affairs, the University Grants' Committee, the Vice-Chancellors' Committee and other individuals and organisations concerned.

JOHN COHEN

INTERNAL STRESSES IN METALS AND ALLOYS

On October 15 and 16, a symposium on internal stresses in metals and alloys was held in the rooms of the Institution of Mechanical Engineers. It was organised by the Institute of Metals, in association with the Faraday Society, the Institute of Physics, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Physical Society and the Royal Aeronautical Society, and was intended to bring together all classes of investigator interested in the subject, and to enable them to compare their points of view. In this it was quite unexpectedly successful, for the large lecture room of the Institution of Mechanical Engineers was filled throughout the programme, and discussion continued with a reasonably good balance between the different interests for the whole of the allotted time.

The proceedings were opened by Colonel P. G. Gueterbock, president of the Institute of Metals, and were divided into four sessions. The first dealt with the measurement of internal stresses. A considerable number of methods have been employed, but none is really convenient and reliable. The trend of the discussion suggested that for the measurement of the stresses which are broadly distributed through the mass of the metal (the *macro* or *body stresses*) the method of suitably cutting the article and measuring the resultant distortions is still the most generally applicable, though it has the disadvantage that it usually involves the destruction of the article. Some speakers thought that the technique of this method has not been adequately studied and developed. The X-ray method emerged as clearly the most suitable for the measurement of stresses which vary considerably within short distances (the *micro* or *structural stresses*); while those methods which depend on the measurement of properties such as electrical resistivity, magnetic properties and damping capacity proved to be open to criticism. The existence of variations of these properties can readily be demonstrated, but it is always difficult to decide in a particular case how much of the variation is due to internal stress and how much to other causes. Some time was devoted to the lattice strains detected by X-ray methods in plastically deformed metal. It is coming increasingly to be realized that, on account of its polycrystalline structure, plastically deformed metal is a mass of diverse stresses and strains; that this is also the case in plastically deformed silver chloride was elegantly demonstrated by Mr. J. F. Nye by the use of polarized light.

The afternoon of the first day was devoted to sixteen papers on the origin and control of internal stresses in metals. So many papers could scarcely be discussed fully in one afternoon, but the great variety of the conditions which can give rise to internal stresses in metals was brought out very vividly, and it was possible to pick out those questions which exercise the minds of the engineer and metallurgist at the present time. The possibility that internal stresses may cause distortions in components of high-speed machinery is a source of anxiety, for lack of balance can induce dangerous stresses; and it is more than likely that some special treatments designed to give strength or toughness result in higher internal stresses than should be tolerated. In some aluminium alloys the treatment which gives the freedom from internal stresses may result in liability to stress corrosion effects, and a nicely balanced treatment is necessary if the producer is to err on neither side. The last word has not yet been said on the influence of the stresses left behind by the welding process, and although there is no evidence that they are necessarily harmful, most engineers prefer to remove them if it is at all possible. On the other hand, the advantages to be obtained by deliberately introducing compressive stresses at the surface of components are regarded as demonstrated; but it is also felt that more, and more complete, data are needed on the effect of these stresses on the fatigue limit of the component.

The second morning was devoted to the effects upon metals of the stresses distributed on a microscopic scale, and produced a general discussion of the theory of the strength of metals. Sir Lawrence Bragg opened with an attractive development of his theory of the effect of crystallite size on strength, and, emphasizing the necessity of thinking in terms of strain rather than of stress, directed attention to the great difference in the mobilities of simple and complex faults in crystal lattices. Several speakers referred to the uncertainty of present measurements of crystallite size, and the ultimate conclusion appeared to be that measurements of crystallite size, X-ray line broadening and mechanical properties are wanted, carried out on the same specimens, and under widely varying conditions. A recurrence of interest in the conditions at grain boundaries was noticeable, and the vexed question of the ability of dissolved hydrogen to burst solid steel, which is so important in connexion with the defects known as hair-line cracks, was also debated. In this argument, much depends on what is assumed about the molecular condition at room temperature of the dissolved hydrogen, on which subject we are still insufficiently well informed. Little disagreement is now expressed about the origin of the internal stresses associated with reactions in the solid state, such as precipitation hardening and the formation of martensite. The complementary question of the effect of stresses on the course of the transformations is not so clear, the distinction between the effects of stress and of plastic deformation not always having been kept in mind.

The final discussion, which dealt with the effects of stresses distributed on a macroscopic scale, was largely concerned with stress corrosion cracking, and revealed a considerable unanimity of opinion. There were differences in the estimates of the susceptibility of different materials to this type of failure, and of the importance of particular factors; but all speakers agreed that corrosive conditions favourable to the production of localized pits, together with sufficient tensile stress at the surface of the metal to cause plastic deformation at the roots of the pits, are the essential factors. The well-known cracking of certain stressed metals in the presence of molten tin or lead does not, however, fit very well into this picture. A second theme which ran through this discussion was the spontaneous cracking which sometimes occurs in steels, particularly hard steels, in the presence of high internal stresses. Mr. J. F. Russell showed some very impressive examples of such ruptures in large steel ingots and forgings, but in practice the phenomenon has occurred chiefly in welded hard steel plates, and has caused some anxiety. Corrosion appears not to be concerned in this case, and the reason why the cracks appear only after the lapse of time is not yet clear. The cracks can, however, be prevented by suitable choice of the composition of the steel, and, more important, by ensuring that the steel is not put into use in an excessively hard condition.

In all, thirty-six papers were presented at the symposium and these, together with a report of the discussions, will be published in the Special Reports and Monographs series of the Institute of Metals. The symposium left a strong impression of the diversity and importance of the problems associated with internal stresses in metals, and the published account will prove to be a most valuable source of information.

GROUND BLOCKS OF THE CONTINENTS AND OCEAN BOTTOMS*

By PROF. H. CLOOS
Geologisch-palæontologisches Institut, Bonn

DURING the last twenty or thirty years, the scientific conceptions of the structure and development of the earth's crust have been widely influenced, if not dominated, by the Wegener theory of continental drift and by the idea of orogenetic phases dividing the structural history into short but world-wide times of movement separated by intervals of rest or of mere 'epeirogenetic' oscillations. The first theory disrupted the lateral, the second one the vertical (temporal) connexions. But within the same decades, the growth of geological knowledge of nearly all continents, combined with the results of submarine and even of geophysical investigations, pointed in another direction. They led to the conclusion that the major structural zones and units of the earth are much older than they formerly seemed, and that they indicate a long and strong continuity from the very first stages of the globe up to the present. It seems that from early geological time, the crust has been divided into polygonal fields or blocks of considerable thickness and solidity, and that this primary division formed and orientated the later movements.

My own contributions to this extensive problem date from 1910, when I first investigated the influence of old Tertiary faults upon young Tertiary folds within the Swiss Jura Mountains near Basle. Later on they dealt with the Rhinegraben, with the primary limits of the Rhenish Schiefergebirge, the Pre-cambrian stages of important block boundaries in Norway and Sweden, with the conservative development of Silesia and the Bohemian mass, with the Harz Mountains, with North-East and South Africa, with certain areas in North America, and the Atlantic structure, the Azores and the Red Sea. Among the many important observations of other scientific investigators in different countries, Dixey's discovery of an older Nyasa fault-trough in Africa is the latest but not the least. Sonder, in his papers on Europe and Central America, laid stress upon the straight direction of certain old and persistent lineaments.

To start with the blocks, or fields, themselves, their limiting walls are to be considered as thick zones of a highly variable behaviour and history, and should be called 'geofractures' or 'geosutures', analogous to the similar terms 'geosynclines' and 'geanticlines'.

The critical features of these ancient and deep units and of their limiting zones are: (1) stratigraphical traces of tectonic movements in earlier geological times; (2) the connexion with plutonic and volcanic activity in early and recent times, etc.; (3) their relations to deep-seated earthquakes of linear arrangement (down to 500 or even 700 km.); (4) the length of the limiting zones (up to several thousand kilometres); (5) the size of the blocks, which varies between 500 and 1,200 or even 1,500 km. in diameter. My experiments and the known physical and technical observations show that there exists a geometrical relationship between the mutual distances of the dissecting joints and the thickness of the dissected sheet.

The crust pattern formed by these ancient geosutures displays several astonishing regularities. Within the three northern continents, blocks of north–south trend limited by meridional sutures are predominant. In North America, eight such fields can be counted; in Europe, eight north of the young mountain ranges in the south; in Asia, a few more. In the Mediterranean girdle, east–west zones prevail. On the Atlantic bottom, longitudinal zones of oblique directions are well known. Their analogy and connexion with terrestrial zones lead to the conclusion that they are the submarine representations of the ancient continental lines. It seems that many continental slopes belong to the deepest, oldest and most important block boundaries, an opinion already included in the well-known theory of the 'permanence' of the continents and oceans.

As areas of different horizontal and vertical displacement, the great thick permanent ground blocks influence the sedimentation on their upper surface, and also the magmatic cycles on their under surface within their interior and along their limiting walls. Being older than most of the other tectonic features of the globe, they influence the preparation, the origin and the development of the folded mountain ranges as well. Roughly speaking, within the two main thermodynamic girdles, each block has its own folded range. The structural relations between the younger folding and the older configuration of the respective blocks vary broadly according to the direction of the folding movement relative to the pre-shaped contour of the field. Longitudinal ranges, for example, are usually straight (Urals). Transverse ranges are suspended between the marginal sutures either as garlands or festoons, or in a sigmoidal manner or both (Füllhorn of the Alps). Thus attempts to unite the different folded arcs into uniform and endless 'slings' can be replaced by their individual adaptation to pre-existing units of the crust.

In certain examples, the deformation of a broad superficial area (like the Rocky Mountains in the United States or the corresponding area in Western Europe) can be derived from a more or less homogeneous deformation (for example, a simple torsional shear) of the supporting block. In a recent experiment I succeeded in imitating the structure of the Rocky Mountains. A sheet of liquid clay lies on a square wire net. Films of thin paper impregnated with water lie closely on the smoothed surface of the clay. A minute torsion of the wire net suffices to produce the Rocky Mountain uplifts with their typical details and their oblique arrangement. The mutual distances of the individual uplifts are proportional to the number of sheets of paper applied, that is, to the thickness of the sheet of sediments. If the cover of paper is omitted and the other conditions are unaltered, the experiment produces the faults of the adjacent Basin and Ranges field. This variation corresponds exactly to the natural model.

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* Summary of the presidential address given to the annual meeting of the Geologische Vereinigung at Bonn on April 29, 1947, under the title, "Die Grundschollen der Festländer und Meere. Entwurf eines konservativen Erdbildes"; a detailed account is being published in the *Geologische Rundschau*, Stuttgart, No. 2 (1947).

Consequently, the tectonic deformations of the crust and the main features of its surface history can be more easily and better understood if we do not connect the visible structures directly with the supposed underground forces (subcrustal currents, convection as an effect of thermodynamic alterations, etc.). It is simpler to introduce an anisotropic and heterogeneous aggregate of pre-formed units which act as supports for the superficial material and as points of attack, as levers, and as instruments of transportation for the underground causal forces.

PRESERVATION OF THE *KAURI* IN NEW ZEALAND

In a series of short newspaper articles in New Zealand, Prof. V. J. Chapman (professor of botany at Auckland University College) gives the conclusions he has reached on a problem of much interest to botanists and tree-lovers the world over, namely, the preservation of that remarkable tree, the *kauri* (*Agathis australis* Salisb.).

The only surviving extensive block of natural forest carrying big *kauri* is Waipoua Forest, covering some 30,000 acres and in the care of the State Forest Service. Here the *kauri*, including trees of outstanding size, occurs scattered throughout, mainly in groups. It is claimed that this tree may exceed even the Sequoias in timber content, owing largely to the remarkable way in which the trunk holds to the cylindrical form instead of tapering considerably towards the crown. Younger trees and saplings are to be found, but only in limited numbers. Experimental sowings or plantings have not always been successful, and though the N.Z. Forest Service is now more or less prepared to guarantee regeneration of this species, its critics do not yet appear convinced —a matter which it should be easy to settle on the spot.

Two main questions have arisen: What steps should be taken to ensure the protection of an adequate number of the existing big trees and the perpetuation of the species; and if for this purpose areas are excluded from green fellings, should dead and dying trees be utilized before they decay? It is alleged that the Forest Service has not hitherto publicly guaranteed complete protection from interference for any part of the forest, not even for the roadside strip, and that when felling for timber, usually takes all trees down to 30 in. in diameter and all dead and unhealthy trees fit for milling.

In Prof. Chapman's party, when he made the inspection of the forest on which his articles are based, the botanical and amenity interests were strongly represented, but unfortunately there does not appear to have been an experienced forester with them. To get the disinterested forestry point of view, he referred the matter as just another instance of a general problem to the sylviculturist of the Indian Forest Research Institute, and to the present reviewer, who has for many years campaigned among his colleagues and others for the preservation of outstanding trees and adequate samples of the forest types of which they form part: neither knew that Prof. Chapman intended publication. Meanwhile, the New Zealand Institute of Foresters has published a well-reasoned account of its view (*J. N.Z. Inst. Forest.*, 5, No. 3, 173–175; 1946).

There seems to be agreement that a portion or portions of the forest should be excluded from fellings with suitable safeguards against change of policy, as has already been done by the N.Z. Forest Service in a working plan already six years old. All living trees on a fairly wide strip on either side of the State highway should be, and indeed are, to be kept untouched in this way, for in New Zealand, as in Great Britain, the truth is that appreciative as a large section of the general public may be of woodland amenities and big trees, it rarely goes far from the road. A certain number of exceptional trees should obviously also be specially protected, and access provided: this also has already been decided on.

Scientific interests, including those of forestry itself, call for the preservation of a further compact block of forest (not a narrow strip), which would be excluded from ordinary management. One or two areas of about 250–500 acres each might be suggested, and there is a good case in favour of leaving in them even dead trees standing or fallen, as it is very likely indeed that some part of the fauna is dependent on the dead and decaying wood for its existence and survival. We understand one such area has already been set aside for the purpose.

Over the rest of the forest, normal management for timber production can be permitted. It is remarkable how fully the amenities of a forest area can be maintained with such management where it is the settled policy so to maintain them: the New Forest in England provides an example, thanks to the care of the deputy surveyor, for it is almost incredible that more than two dozen sawmills were working there throughout most of the war-years with so little consequent loss to the amenities or even change in appearance. Prof. Chapman urges that in the managed portion, *kauri* should be retained as the principal species, just as in Britain it has been decided in certain forests that broad-leaved trees should not be replaced by conifers: we believe this to be desirable and that the State Forest Service is willing to agree. But just how that will be done is not yet known, for on the information before us the *kauri* is a baffling tree, and a good deal more systematic research work will have to be done before it can be regenerated to order. Recorded information makes it clear that rather special conditions are required for the successful germination of the seed and establishment of the resultant plant; it is, however, not yet adequately known what those conditions are, though, as with many other trees, a primary requirement appears to be exposure of the mineral soil from its excessive covering of humus. The grouped occurrence, though by no means a unique feature in forest vegetation, has repeatedly been described, and studies are needed on soil and vegetational differences inside the groups and outside: the *kauri*, of course, itself influences the soil in which it grows and on which it showers its dead leaves and twigs. There is also a question of fungal association with the roots, which may incidentally play some part in the difficulties experienced in the nursery with this species. The importance of greater concentration on this research is underlined by the recommendation that until it is well under way only dead timber should be removed.

We feel sure that agreement will soon be reached in these matters, as there are no serious difficulties in meeting the requirements of both sides in the controversy. The forester of to-day has been trained to realize the amenity and biological aspects of the handling of forests equally with the timber-getting and economic aspects. The New Zealand Forest Service is fully competent to apply the agreed policy to this important forest and is the obvious authority to do so: its research staff is expanding, and though the problems presented by this exceptionally interesting tree are perhaps complex, they should be quite capable of solution in a few years. Meanwhile, it is as well that keen interest should be taken in the preservation for future generations of one of the most remarkable trees of the world. H. G. CHAMPION

ELECTRICAL PROPERTIES OF SOIL AND WATER AT CENTIMETRE WAVE-LENGTHS

THE electrical properties of the materials forming the earth's surface have always been of interest to the radio physicist and communication engineer, since the propagation of long and medium waves is markedly dependent upon the absorbing effect of the ground. At shorter wave-lengths, for which the radiation can be transmitted more freely through the lower or upper atmosphere, the reflexion coefficient of the earth's surface plays an important part in the propagation of the waves. More recently, the varying reflexion coefficient due to the different electrical properties of the different portions of the earth's surface has been used with conspicuous success in a radar method of navigation.

At moderate radio frequencies, the appropriate properties of soil and water can be determined by placing samples of the material in question in a condenser of suitable size and shape; and the results of many measurements made in this way at frequencies up to 100 Mc/s. have been described by R. L. Smith-Rose[1]. A laboratory method of measuring the electrical properties of salt-water solutions has also been used by R. Cooper[2] at frequencies up to more than 4,000 Mc./s., corresponding to wave-lengths down to 7 cm. Alternatively, the reflexion coefficient of the surface of the ground can be measured directly, for example, by the standing-wave method developed by J. S. McPetrie[3], who with J. A. Saxton[4] has used this technique at various frequencies up to about 600 Mc./s. (wave-length 50 cm.). At the still higher frequencies of 3,300 Mc./s., corresponding to a wave-length of 9 cm., L. H. Ford and R. Oliver[5] have investigated the direct reflexion of radio waves from a wide range of surfaces including bare ground, both level and in ridges, ground covered with vegetation, fresh water and salt water approximating in composition to sea water. More recently, this free radiation technique has been extended by J. A. Saxton and J. A. Lane[6] to the experimental determination of the dielectric properties of water for wave-lengths of 1·24 and 1·58 cm.

With the growth and development of radar techniques in recent years, the above-mentioned British work has been supplemented by the work of other investigators, notably in the United States, some of whom have paid particular attention to the measurement of the reflexion coefficient of sea water at the small grazing angles met with in radar practice.

A report, which has recently been submitted to *Nature*, describes measurements of the dielectric properties of soils and water at a wave-length of 3·2 cm. (frequency 9,400 Mc./s.) carried out at the University of Texas as part of the programme of the United States Office of Naval Research. The report is by Prof. A. W. Straiton and C. W. Tolbert, and is of interest in so far as particular attention was devoted to the measurement of the properties of the dry, sandy soil found in Arizona where the Navy Electronics Laboratory had a site for special radio experiments. The measurements were made by placing samples of the material in a wave-guide or other suitable circuit arrangement, and measuring the phase-difference and attenuation caused by transmission through different thicknesses of the material. From such observations the dielectric constant and conductivity of the dry Arizona soil were found to be 3·2 and 10^9 E.S.U. respectively. (A conductivity of 10^{10} E.S.U. corresponds to 1·1 Mhos/metre.) Similar measurements made on dry sandy loam taken from near the University Laboratory in Texas gave values for the dielectric constant of 2·8 and $0{\cdot}7 \times 10^8$ E.S.U. for the conductivity. The authors of the report point out that the Arizona soil shows a conductivity of about three times as high as that obtained by Ford and Oliver[5] for very dry sandy loam in Great Britain, while the value for the Texas soil is much smaller. It is suggested that the considerable iron content of the Arizona soil may account for the higher conductivity in this case. This is scarcely consistent, however, with the results of further measurements made by the authors on samples of the Arizona soil sifted through screens of various sizes of mesh. The samples of smallest size of particle contained no free iron, but showed the highest conductivity. Furthermore, measurements made on the sample of medium-size particles varied from 6×10^8 E.S.U. when loosely packed into the container to more than 10×10^8 E.S.U. when very tightly packed. As was the case for measurements made by earlier investigators, the conductivity of the soils from both Arizona and Texas was found to increase several times when the samples were moistened with fresh water.

In a somewhat similar way, measurements were made under the same conditions on distilled water, and on a sample of sea water from the Gulf of Mexico. For the fresh water, at a temperature of 23° C., the dielectric constant was found to be 67 and the conductivity about 10^{11} E.S.U. (12 Mhos/metre); while for the sea water, which had a salt content of 2·2 per cent, the values obtained were 65 and 15×10^{10} E.S.U. (16 Mhos/metre) respectively for a temperature of 28° C. These values are in reasonably good agreement with the values deduced by Saxton[7] from a theoretical study of the anomalous dispersion of water combined with the results of measurements made at shorter wave-lengths than those used by Straiton and Tolbert. This recent work thus appears to form a useful extension of our knowledge of the electrical properties of soil and water at the frequencies corresponding to very short radio wave-lengths.

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[1] Smith-Rose, R. L., *J. Inst. Elect. Eng.*, 75, 221 (1934); *Proc. Phys. Soc.*, 47, 923 (1935).

[2] Cooper, R., *J. Inst. Elect. Eng.*, 93, III, 69 (1946).

[3] McPetrie, J. S., *Proc. Phys. Soc.*, 46, 637 (1934).

[4] McPetrie, J. S., and Saxton, J. A., *J. Inst. Elect. Eng.*, 90, III, 33 (1943); 92, III, 256 (1945).

[5] Ford, L. H., and Oliver, R., *Proc. Phys. Soc.*, 58, 265 (1946).

[6] Saxton, J. A., and Lane, J. A., Conf. Rept. Phys. Soc. and Roy. Met. Soc., 278 (1946).

[7] Saxton, J. A., Conf. Rept. Phys. Soc. and Roy. Met. Soc., 292 (1946).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, January 12

Farmers' Club (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Prof. D. B. Johnstone-Wallace: "Pasture Management and Animal Behaviour".

Institution of Electrical Engineers, London Students' Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Sir Arthur Fleming: "The Place of the Engineer in the Post-War World".

Tuesday, January 13

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. B. Edgington: "Detergency".

Illuminating Engineering Society (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. C. R. Bicknell: "Applications of Modern Flash Discharge Tubes".

Oil and Colour Chemists' Association, London Section (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Colonel L. Urwick: "Scientific Management".

Conway Discussion Circle (at Conway Hall, Red Lion Square, London, W.C.1), at 7 p.m.—Mr. Lancelot L. Whyte: "Science and the Next Development in Man".*

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.15 p.m.—Mr. A. J. Young: "Some Impressions of Modern American Instrumentation".

Wednesday, January 14

Society of Chemical Industry, Microbiological Panel of the Food Group (joint meeting with the Society for Applied Bacteriology, at the Medical Society of London, 11 Chandos Street, London, W.1), at 2.15 p.m.—Mr. P. C. T. Jones: "Decomposition of Resins by Micro-organisms in the Soil"; Dr. D. M. Webley: "Microbiological Changes in Compost"; Mr. M. J. Geoghegan: "Influence of Micro-organisms on Aggregate Formation in Soil".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institute of Petroleum (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. R. B. Richards: "The Structure and Properties of Ethylene Polymers".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. M. Heller and Mr. L. C. Stenning: "Reference-Crystal-Controlled V.H.F. Equipments".

Society of Chemical Industry, Plastics Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. E. G. K. Pritchett: "Recent Advances in the Chemistry of the Phenol-Aldehyde Condensation".

Society of Dyers and Colourists, Northern Ireland Section (at the Queen's Hotel, Belfast), at 7.30 p.m.—Mr. G. Brearley and Mr. J. Starkie: "The Hydrosulphites—their Preparations, Properties and Textile Applications".

Thursday, January 15

Institution of Mining Engineers (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 11 a.m.—Fifty-fourth Annual General Meeting.

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. E. Lambert and Mr. J. C. Christie: "Standardization of Switchgear".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. O. N. Lawrence: "Gas Turbine Accessory Systems".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Mr. A. G. Fishburn: "The Place of Pharmaceutical Research in Medicine".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Symposium on "Leprosy" (to be opened by Dr. Ernest Muir).

Friday, January 16

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Film on "The Screen in relation to Engineering Training" (introduced by Mr. H. R. Hockley).

Institute of Navigation (at the Royal United Services Institution, Whitehall, London, S.W.1), at 5.30 p.m.—Squadron Leader R. H. Blackmore: "Grid Navigation and its Allied Problems".

University College London (at Gower Street, London, W.C.1), at 5.30 p.m.—Prof. C. A. Hart: "Modern Influences on the University Aspect of Professional Training in Surveying" (Inaugural Lecture).*

Institute of Physics, Electronics Group (joint meeting with the Manchester and District Branch, in the New Physics Theatre, The University, Oxford Road, Manchester), at 7 p.m.—Dr. J. G. Wilson: "The Cloud Chamber".

Paper Makers' Association (Technical Section), Northern Division (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. F. North: "Some Factors Affecting the Application of Dyestuffs to Paper".

Saturday, January 17

British Psychological Society (in the Physiology Theatre, University College London, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. Alastair Heron: "Adolescent Reactions towards the Idea of Education for Parenthood".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Principal of the Ministry of Supply School of Electronics, Malvern—The Chief Superintendent, T.R.E., Great Malvern, Worcs., quoting Ref. 5/138/JFA (January 17).

Assistant Agricultural Economist (Grade B)—The Registrar, The University, Bristol 8 (January 17).

Lecturers (2) in Mathematics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (January 24).

Lecturer in Child Health—The Registrar, The University, Manchester 13 (January 24).

Senior Lecturer in charge of the Department of Electrical Engineering under the Professor of Engineering—The Registrar, The University, Sheffield (January 31).

Principal Scientific Officer (physicist, preferably with good experience of military operational research), a Senior Scientific Officer (experimental physicist, preferably with good experience of the scientific investigation of the performance of military weapons and equipment), a Senior Scientific Officer (biologist or botanist or qualified in an associated science, with experience of military operational research and military training and of the scientific investigation of the performance of military equipment), a Senior Scientific Officer (mathematician with experience of military operational research), and a Senior Scientific Officer (mathematician with experience of the application of statistical methods to physical problems preferably in the field of weapon performance), at the Military Operational Research Unit, Byfleet—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2056 (January 31).

Cow and Gate Fellowship for research into problems associated with nutrition in infants and children—The Registrar, The University, Manchester 13 (January 31).

Divisional Manager of (*a*) the Animal Products Division, (*b*) the Agricultural Products Division, (*c*) the Minerals Division, (*d*) the Civil Engineering and Works Division, (*e*) the Factory Division, and (*f*) the Fisheries Division—The Director of Administration, Colonial Development Corporation, Dover House, Whitehall, London, S.W.1 (January 31).

Instructor in Poultry Husbandry and Poultry Manager at the College Farm—The Registrar, University College of Wales, Aberystwyth (February 1).

Director of the Marine Laboratory, Aberdeen; Principal Scientific Officers, Senior Scientific Officers, and Senior Experimental Officers, in the Ministry of Agriculture and Fisheries and the Scottish Home Department—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2088 (February 10).

Meteorologists in the East African Meteorological Service—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1 (February 21).

Professorship of Pathology and Bacteriology—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff (February 21).

Professor of Pure and Applied Mathematics in the Royal University of Malta—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (February 28).

Research Assistant for work on vitamins in relation to nutrition and allied microbiological investigations, and an Experimental Officer with experience in routine analysis of foodstuffs, blood and excreta—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (February 28).

Assistant Keeper to be responsible for the Zoological Collections in the Manchester Museum—The Registrar, The University, Manchester 13 (February 28).

Lecturer in Statistics in the United College, St. Andrews—The Secretary, The University, St. Andrews (February 28).

Assistant Lecturer in Geography—The Registrar, The University, Manchester 13 (March 31).

Senior Scientific Officer to the International Red Locust Control Service at Abercorn, Northern Rhodesia—The Director, International Red Locust Control Service, Abercorn, Northern Rhodesia (March 31).

Lecturer in the Physics Department—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Agricultural Zoologist in the Malayan Union—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

Lecturer in the Department of Mathematics—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

Lecturer in the Chemistry Department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Laboratory Assistants—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

Agricultural Chemist (Pyrethrum) by the Government of Kenya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.17954.

Fisheries Development Officer in Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

Senior Assistant in Physics—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1.

Director of the Canterbury Museum, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1.

Laboratory Technician (Grade B)—The House Governor and Secretary, Gordon Hospital, Vauxhall Bridge Road, London, S.W.1.

Technician in the Department of Physics—The Secretary, University College London, Gower Street, London, W.C.1, quoting Physics/1.

NATURE

No. 4081 SATURDAY, JANUARY 17, 1948 Vol. 161

CONTENTS

	Page
Imports of Scientific and Technical Books	75
Transmission in Nerves. By Prof. J. Z. Young, F.R.S.	76
A Study of Japanese Culture. By Peter Lawrence	77
Enzymes in Bacteria. By Dr. H. K. King	78
Chromosome Multiplication and Reduction in Somatic Tissues: Their Possible Relation to Differentiation, 'Reversion' and Sex. By Prof. C. Leonard Huskins	80
Theory of Electrokinetic Effects. By F. Booth	83
Obituaries:	
Dr. Charles Bolton, F.R.S. By Prof. H. P. Himsworth	86
Dr. Emily Berridge. By Dr. E. M. Blackwell	87
Dr. André Kling	87
Prof. J. Masson Gulland, F.R.S.	87
News and Views	88
Letters to the Editors:	
Audio-Frequency Radio Waves from the Sun.—Dr. Donald H. Menzel and Winfield W. Salisbury	91
Showers of Penetrating Particles.—Prof. G. Wataghin	91
Internal Waves in Certain Types of Density Distribution.—Dr. P. Groen	92
Electronic Waves and Thibaud's 'Particles'.—W. E. Benham	93
X-Ray Diffraction Rings from Deformed Solid Metal and Metal Powders.—Dr. W. A. Wood and W. A. Rachinger	93
A Simple Universal Model for Representing the Optic Orientation of Biaxial Crystals.—Dr. N. H. Hartshorne	94
Mode of Action of Acridine Antibacterials.—Dr. Adrien Albert and Reginald Goldacre	95
Arsenolysis and Phosphorolysis of the Amylose and Amylopectin Fractions of Starch.—Dr. Joseph Katz, Dr. W. Z. Hassid and Dr. Michael Doudoroff	96
Reaction of Boric Acid with Polysaccharides.—Dr. H. Deuel, H. Neukom and F. Weber	96
Constitution of Monazite.—Dr. A. W. Wylie	97
Structure of Urea.—Dr. J. O. Harris and A. H. Robson	98
Spread of Detonation in High Explosives.—Elwyn Jones and Dugald Mitchell	98
Chromosome Number of *Sesamum laciniatum* Klein.—Dr. S. Ramanujam and A. B. Joshi	99
Mustard-gas Mutation in *Aspergillus nidulans*.—Donald Hockenhull	100
A Vasodilator, Adrenolytic Substance in Aglomerular Fish Kidney.—Dr. Benjamin Jablons	100
Quantitative Relation Between Salt Accumulation and Salt Respiration in Plant Cells.—Dr. R. N. Robertson and Marjorie Wilkins	101
Aggression, a Component of Post-Epileptic Automatism in *Peromyscus*.—M. R. A. Chance	101
Absorption of Protein and Bacteria from Normal and Infected Joints.—Torbjörn Edlund	102
'Melarsen' and 'Melarsen Oxide'. By J. Williamson and Dr. E. M. Lourie	103
International Study of Rheology	104
Results of the Continuous Use of an Ammonium Phosphate Fertilizer on Rice in Lower Burma. By D. Rhind, O.B.E., and U Tin	105
Nutrition and Cancer. By Dr. E. Boyland	106
Survey of Radio Noise	107

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IMPORTS OF SCIENTIFIC AND TECHNICAL BOOKS

As one of the measures deemed necessary for the reduction of British expenditure overseas, and particularly for the conservation of 'dollar' resources, an announcement from the Board of Trade early last autumn re-introduced the system of licensing imports of books and other literature. Certain classes of books were completely excluded, and others, including scientific and technical books, were admitted up to a limiting money value. During the War, the licensing had, of course, been in operation; but there was the additional need at that time for extreme economy in the use of shipping space, which made restrictions almost inevitable.

Now that import licensing has again been in operation for some months, it is time to take stock of the position. From the first it was obvious that the restrictions, although directed against foreign books generally, would affect chiefly the supply of American publications, for these formed the greater proportion of the literature imported into Great Britain, especially in the fields of science and technology. This made the position particularly serious, for there was a shortage of such literature due to the difficulties of the war years. During that period, potential writers of scientific and engineering text-books in Britain were mostly occupied in work which claimed their whole time and attention, and much of it was done under conditions of secrecy which are only now being relaxed. Further, stocks of standard books had steadily diminished, and lack of labour and of maintenance in the printing works of the country, as well as shortage of paper, prevented—and still prevents—publishers from replenishing them. Thus new works were few and far between, and older books were only available from time to time and often in small numbers, a circumstance which in itself has led to higher costs of production through the increased proportion of overhead costs chargeable to each volume. With the lifting of war-time restrictions, a steady flow of American books into Britain began; they were welcome, in that many war-time developments of science and industry thus became known for the first time outside the small numbers of those who had been directly concerned in them.

The general terms of the restrictions, so far as they affect scientific and technical publications, were stated in an article in *Nature* of October 4, p. 448. Publishers in Britain are granted licences to import foreign books in bulk up to the value of 100 per cent of their pre-war imports; in applying for licences, titles of individual books and country of origin must be quoted.

The position of the individual who wishes to purchase a foreign book is, however, not so widely known. Under the present regulations and so far as American scientific and technical literature is concerned, anyone may place an order for books, journals and periodicals with publishers or their agents in the United States, provided the book or journal is imported as a single copy through the post. This permits monthly parts of scientific journals to be sent to individuals, libraries, etc., in Great Britain. Application for the necessary dollars for purchase money must be made to a bank, or for a money order at a post-office. The order for books, etc., can be sent directly to the United States by the purchaser, or on his behalf by a bookseller, provided the latter is willing to apply for the currency and to arrange for the book or journal to be sent by post directly to the address of the individual placing the order. Within the framework of the general policy of restricting imports of books, the licensing authorities are doing whatever they can to meet the needs of individual purchasers.

Hence the main difficulties at present met by the individual in Britain wishing to purchase American scientific and technical books or to subscribe for American learned periodicals are twofold: he has to make application for the necessary currency, and it is very unlikely that he will be able to examine a book before purchase. In any event, there is bound to be delay in supplying his need.

That an enormous reduction in British expenditure in the 'dollar' areas of the world is necessary will not be gainsaid. Books and periodicals have already made a contribution by the adoption of 'austerity' production methods, including poorer quality and thinner paper, smaller type, smaller margins, etc.; it is sufficient to turn back to a pre-war issue of *Nature* to realize at a glance some of the economies which have been made. The whole policy of restricting the flow of literature should be reconsidered in the light of world affairs.

From the long-term point of view, there never was a time when the free flow of information was so important for world peace and progress. In the turmoil following a great war, the interchange of literature can be a potent factor in promoting mutual understanding and tolerance; and it can prepare the way for the wider knowledge which can only come from the personal visits possible in more settled conditions. In this connexion, there is always the danger that a system of individual licences, although it may be devised solely with the view of controlling expenditure, may become in effect a form of censorship. Whatever the present intention, there seems little to prevent the over-zealous or the doctrinaire who may hold the reins of authority from discriminating against a particular book. This aspect relates particularly to historical and cultural literature, and its significance should not be overlooked at a time when rival political ideologies are threatening to divide the world more effectively than ever before. It is not so important in the field of technology, where the restriction is more likely to be imposed by the exporting country; but the very possibility that a form of censorship can grow out of a licensing system tends to arouse suspicion.

Turning now to the short-term view, there is a strong case for the removal of restrictions on the import into Britain of scientific and technical literature. particularly that from the United States. Publication of recent scientific and industrial developments has been lagging increasingly behind during the war years; and now, when the emphasis is on more and more production, and economy in man-power and processes, it is essential that the most up-to-date information should be available with as little delay as possible. In his presidential address to the Royal Society on December 1, Sir Robert Robinson quoted figures showing the serious time-lag in the publication of the Society's own papers; and he added that other societies were in worse case. The columns of "Letters to the Editors" in *Nature* reflect a similar delay. The President of the Board of Trade has undertaken to assist publications devoted exclusively to research by providing the paper required for prompt production of communications; though there will be difficulty in obtaining labour to enable them to make full use of this concession. Meanwhile, however, there is considerable material of significant value in books and periodicals, of American origin in particular, likely to be of immediate service for the progress of knowledge, in the drive for increased efficiency and in the training of students and technical workers.

It is often said that up-to-date literature is one of the most important tools of the research worker. This is an under-statement; new books and current periodicals are the life-blood of a progressive society. It is hard to believe that the potential value of the knowledge and experience incorporated in books has been weighed against the saving of dollars achieved by limiting imports of literature into Britain to 100 per cent by value—ignoring the substantial increase in prices—of pre-war imports, apart from such purchases as individuals may choose to make.

TRANSMISSION IN NERVES

Die Signalübermittlung im Nerven

By Prof. Alexander v. Muralt. (Lehrbücher und Monographien aus dem Gebiete der Exakten Wissenschaften, Band 14: Reihe der experimentellen Biologie, Band 3.) Pp. 354. (Basel: Verlag Birkhäuser, n.d.) 38.50 Schw. francs.

PROF. v. MURALT and his collaborators in Bern have taken up and developed the technique for the isolation of single frog's nerve fibres invented by the Japanese, Kato and Tasaki. As a result of optical and biochemical investigations of great technical ingenuity, he has developed theories about the mechanism of conduction in nerve which might be described as unorthodox. The basic unit of conduction is supposed to be the internode of medullated nerve fibres, and v. Muralt believes that each is separated from the next internode by a transverse membrane at the node of Ranvier. Unfortunately his pictures do not provide decisive evidence of the existence of transverse membranes crossing the entire axon at the node. The optical appearances which they show are well known to histologists and are usually considered as representing the abrupt end of the myelin layer. His belief in the existence of this membrane was strengthened by the observation that in dying fibres it was sometimes seen to be blown out in the direction of one segment or the other. But the figure demonstrating this effect is not convincing and would be taken by most to show a modified portion of myelin rather than a membrane across the axon. However, the exact details of the node of Ranvier and the nature of the structure called by Cajal the cementing disk still remain very obscure, and v. Muralt's provocative study will certainly stimulate further investigation.

It will be appreciated that if each section of the axon is separated from its neighbours by a complete membrane, all our basic ideas of the neuron as a unit would have to be abandoned; we should be left with each internode as a piece of protoplasm enclosed on all sides by a membrane but not containing a nucleus! It would take much evidence to persuade us of this; a 'membrane' allowing the passage of a 'trophic' influence only and hence dividing the cell into compartments would be a novelty. There is, however, no reason from study of nerve fibres with ordinary methods to suppose that the axon is divided in this way. Preparations fixed and stained in a great variety of ways show that the substance of the axon is continuous across the nodes; it is the myelin which is interrupted. Moreover, if the 'segmented' arrangement is essential for nerve conduction, what is the condition in non-myelinated nerves, large and small, in which we can be as near certain as we can of anything that there are no transverse membranes? Prof. v. Muralt does not ignore this problem, but his solution is to say that the unmedullated fibre is a limiting case in which the whole contents consist of material with "membrane properties". Surely when we speak of a membrane we refer to an entity which separates, and to speak of a fibre as all membrane is repugnant to sense. He admits that this theory "bedarf experimenteller Stutzung, um der sehr spekulativen character zu verlieren"; but will any amount of experiment suffice? His hypothesis is quite categorical that "das Aktionspotential entsteht durch Depolarisation der Quermembran des markhaltigen Nerven" (p. 254). The velocity of conduction is therefore determined by the distance apart of the membranes and the field intensity at them. Such a view is not inconsistent with some of the evidence about the action potential; but unfortunately Sanders and Whitteridge have recently shown that in regenerated nerves, where the nodes are all at small distances apart, the conduction velocity nevertheless increases with diameter as in normal nerves.

With all these doubts we can scarcely for the time being take the theory of the "Quermembran" as the basis for treatment of conduction in nerve. But it would be very unwise to reject v. Muralt's work because it is built around a doubtful hypothesis. The hypotheses are relatively unimportant; what he has done is to devise methods of very great beauty for the measurement of many of the physical and chemical changes which go on in a nerve fibre. Merely to list them is to show the astonishing range of his technical achievement. Included in this book are accounts of a direct current amplifier and methods of measuring the birefringence of nerve, and its X-ray diffraction patterns (unfortunately he does not give any indication whether he has found changes in birefringence of single axons during conduction). Other methods have allowed him to measure the minute chemical outputs of the nerve. Aneurin is estimated by several independent methods, including spectrographic methods and the polarograph, which makes use of the characteristic influences of dissolved substances on mercury-water interfaces. Acetylcholine and potassium are estimated by more conventional methods. He gives us in this book all too few of the actual results of these determinations, but combines his information into a theory of the "action substances" of a nerve. An action substance is any substance necessarily taking part in any particular reaction. Thence for nerve "jeder Stoff, der im Aktionszustand des Nerven gebildet oder verändert wird, und ein unentbehrliches Glied in der Kette der Aktionsreaktionen ist" (p. 272). Acetyl-choline is the first of these substances, and he believes it to be liberated in the activity of all parts of all nerves, including those not cholinergic. Aneurin is also liberated from all nerves and is the second action substance, potassium the third, and A_4, a substance related to aneurin and revealed by the 'polarograph' but not yet identified, is the fourth. An attempt is made to suggest how these four substances liberated from nerve during activity are related to the other changes known to occur. The resulting scheme is one of the most interesting parts of the book but, as the author realizes, speculative to a degree that makes discussion at this stage scarcely possible. It remains to be seen whether this approach to the "action substances" will prove profitable.

As if these physical and chemical considerations were not enough, v. Muralt has also included in his recent work a study of degeneration and regeneration of nerve, again using many methods. One of his most beautiful demonstrations is of the course of the decline in acetyl-choline content during nerve degeneration, beginning as early as the fifth hour and proceeding to zero. Aneurin concentration begins to fall a little later and proceeds only to 45 per cent of normal. Acting upon the presumption that a brain extract should stimulate nerve growth, much study was made of a "neuroregenerative growth-substance", *N R*, able to stimulate regeneration. Methods for estimating rates of regeneration by study of recovery after incision of the rabbit's cornea and after interruption of the phrenic nerve or of the nerves to the whiskers are suggested. Results are given here only for the cornea test; though suggestive they are not satisfactorily demonstrative of a stimulating effect, in view of a very large variability. It is not possible to discuss the possible nature of these substances until the method of extraction is published. It may be that the extracts produce an influence on regeneration of the cornea rather than on the rate of advance of new nerve fibres down the peripheral nerve trunks, no method of accelerating which is known.

This book is evidence of the very great activity of the Hallerianum in Bern during recent years. One is left reeling after such a feast of new techniques and new ideas, and we may hope that v. Muralt will be able to help us recover by astringent doses of further figures and discussions. J. Z. YOUNG

A STUDY OF JAPANESE CULTURE

The Chrysanthemum and the Sword

Patterns of Japanese Culture. By Ruth Benedict. Pp. vii + 324. (London: Secker and Warburg, Ltd., 1947.) 12*s*. 6*d*. net.

IN her recent book, "The Chrysanthemum and the Sword", Dr. Benedict deals with the Japanese along lines similar to, if not as clearly defined as, those in her earlier "Patterns of Culture". To quote Prof. Franz Boas, she "is concerned rather with the discovery of fundamental attitudes than with the functional relations of every cultural item". These fundamental attitudes, she believes, colour and condition the whole of Japanese outlook and behaviour.

The author reveals the following fundamental attitudes in the Japanese character: a strict love of social order involving unswerving loyalty to the Emperor and varying degrees of respect or discriminatory behaviour towards each member of society in accordance with his status; a habitual sense of shame coupled with a fear of ridicule and ostracism; a due regard for bodily pleasures, yet a great insistence on self-discipline and a belief in the superiority of the spirit over material power; and finally a complicated and rigid system of obligations and reciprocity. These obligations are the great sanction of Japanese culture; they range from duty to the Emperor, one's parents, family and ancestors to a proper respect for one's good name and reputation (*giri* to one's name). They are especially interesting in that they are eventually concerned with the rite of *seppuku* or *harakiri*.

So far, the work is an excellent general text-book study of Japanese psychology. It is clearly and, so far as one is able to judge, correctly elucidated and interpreted. For example, much of Dr. Benedict's analysis is borne out by Dr. Embree's field study of Suye Mura; and her elaborate description of the sanctions of obligation and reciprocity well explains the virtual pacifist reaction of the Japanese since August 1945. On the other hand, the book suffers from the author's self-confessed lack of first-hand experience in Japan. The system of mutual co-operation in the country districts, stressed so heavily by Dr. Embree, receives scant mention from Dr. Benedict. Its importance cannot be underrated, for refusal of co-operation is a very strong sanction in village life. Moreover, although the above listed fundamental attitudes may be widespread in the urban districts, one wonders how far they strictly apply to the Japanese peasant, "whose primary object", to quote Embree, "is to raise good rice and get along amicably with his neighbours". Such a man, like Falstaff, surely believes that the man who has honour is "he who died o' Wednesday"; and a punctilious observance of "*giri* to one's name" (often culminating in suicide) is something he acquires when he comes into contact with the Army or some other urbanized institution.

Finally, in analysing these fundamental attitudes, Dr. Benedict is rather prone to attribute them to the Japanese, but to minimize them in, or even exclude them from, the nations of the Western world; whereas they exist in both, perhaps emphasized to a different degree. For most of the traits given it would be by no means impossible to find parallels to them among the nations of Europe and even in the United States. It would be hypocritical to deny the existence of a shame complex (as opposed to a sense of guilt) in the West; and the Japanese belief in the superiority of the spirit over material power is reflected in many of our own maxims and proverbs.

It seems, therefore, that we may accept Dr. Benedict's analysis of Japanese fundamental attitudes as substantially true; but that we should be unwise to apply them on too wide a scale. Moreover, we must remember that the differences in outlook that she finds between the Japanese and ourselves are differences of degree rather than of kind.

PETER LAWRENCE

ENZYMES IN BACTERIA

The Chemical Activities of Bacteria

By Dr. Ernest F. Gale. Pp. iv+200. (London: University Tutorial Press, Ltd., 1947.) 8*s*. 6*d*.

IN an age long past, biochemistry was the science of food and waste products, the study, it was unkindly suggested, of the letter-box and the dustbin. The limitations of this approach to the chemistry of life were first discarded half a century ago, when intracellular metabolic enzymes were separated intact from the yeast cell. But though the microbiologist may claim that the science of enzymology (like the name) originated in his field, our knowledge of the cellular chemistry of bacteria lagged far behind the rapid progress made with yeast and animal tissues. Only during the last decade have the technical difficulties of extracting intracellular enzymes from the bacterial cell been overcome; at the same time, the usefulness of the washed suspension technique (employing intact cells) has been much enhanced by such tools as the deficient-culture technique and isotope methods. How rapidly the investigators of bacterial metabolism have made up the lost ground will amaze even those readers of Dr. Gale's book who are familiar with this field. But the intensive study of individual metabolic processes must not lead to neglect of the larger physiological system of which they are but the component parts. The bacterial cell is more than "a collection of enzymes surrounded by a semipermeable membrane".

One fundamental problem is kept continually before the reader, however. The reaction of the organism to its environment is peculiarly suitable for study among micro-organisms, since the environment may be precisely defined in simple chemical terms and the organism responds very rapidly, natural selection taking place within a community within a matter of hours. Dr. Gale himself has made extensive study of the relation between enzymic constitution and environment and the part this plays in the continued life of the organism in changing and perhaps unfavourable circumstances. But it is difficult always to avoid 'missing the wood for the trees'. Thus adenosinetriphosphate, once regarded simply as a 'phosphate-carrier', is now known to be the one essential product of perhaps the majority of catabolic processes. Text-books seldom give this vital point the emphasis it deserves, and the student may puzzle his way through the complex chemical cycles by which the bacterium produces its 'acid and gas' without fully realizing what it is all for. The specialist, of course, knows already: and it is essentially for the specialist that this book is written.

Dr. Gale has done a great service by collecting and critically examining much scattered material within a small space. He has achieved this by confining himself mainly to those topics (and they are many) on which he can claim to speak with acknowledged authority. Others are dealt with more briefly; but the reader is directed to authoritative reviews through a small number of carefully selected references. Duplication is thus avoided, but at the risk of giving the student an unbalanced view. Preliminary chapters make the book complete by introducing the non-bacteriological reader to the bacterial world (yeasts and moulds are not dealt with in this book), while a final chapter on the practical details of bacteriological technique invites him into a field peculiarly full of pitfalls for the unwary.

H. K. KING

Surveying for Young Engineers

By S. Wright Perrott. Pp. viii + 232. (London: Chapman and Hall, Ltd., 1946.) 10*s.* 6*d.* net.

THIS book is a revised and greatly enlarged edition of the author's "Surveying for Schools", originally published in 1930. It is designed to give practical assistance to the young and inexperienced surveyor. The author has thus wisely widened the scope of his earlier volume in order to provide a more complete exposition of the subject, while still concentrating upon the practical point of view in dealing with the field and office work. The text consists of twenty-eight chapters devoted to the practical methods employed in making surveys, an explanation of the necessary instruments, and the preparation of relevant plans. Some good advice is given on the important work of checking, and the book is excellently illustrated by drawings, maps and plates depicting some of the instruments to be used. No instrument, however, is described until its practical use has been fully explained. A useful index is included; but no exercises are provided since the course is intended mainly for practical field work. Formal mathematical treatment has also been avoided—the only form of calculation needed being simple arithmetic.

As the author points out, most of the text-books on the subject are academic productions, planned with a view to examination requirements; but the field is the right place in which to lay the foundation of surveying. Hence, the emphasis on practical outdoor work.

The book is well printed and got up, and should be of much use to those beginning the study of surveying.

Elements of Mechanism

By Peter Schwamb, Allyne L. Merrill and Walter H. James. Sixth edition, revised by Prof. Venton Levy Doughtie. Pp. xi + 428. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 4 dollars.

THIS somewhat unusual type of text-book originated in 1885 from printed notes used by Prof. Peter Schwamb at the Massachusetts Institute of Technology. In its present form, the book is in thirteen chapters dealing with motion, vectors, velocity, acceleration, linkages, transmission of motion by direct contact, cams, rolling contact, gears, trains of wheels, belts, ropes, chains, pulley blocks, screws, screw threads, pawls, escapements, etc. The whole course thus provides an authoritative book on the fundamental principles of kinematics applied to mechanical movements. In this edition, not only have recent data on the subject been added, but also laboratory problems emphasizing practical applications of theory are included for the first time.

As Prof. James points out in the preface to the fifth edition, "A study of the elements of mechanisms . . . is intended primarily to give the student familiarity with, and practice in thinking about, the application of the fundamental principles of kinematics in a specific field, namely, the field of mechanical movements".

The text is, in relevant sections, treated mathematically, frequent use being made of the simpler methods of the calculus, and is profusely illustrated both by clearly drawn diagrams and blocks lent by manufacturers. An index is provided; but no answers to the problems are given as solutions are expected to be done graphically. The whole course has been skilfully mapped out in an interesting manner and should be of much use to technical students.

F. G. W. BROWN

Hydraulic Measurements

A Manual for Engineers. By Prof. Herbert Addison. Second edition, revised and enlarged. Pp. xii + 327. (London: Chapman and Hall, Ltd., 1946.) 21*s.* net.

THE need for a second edition of this admirable manual within a relatively short time amply justifies the encomiums which were paid to the first edition on its publication in 1940. It was, in fact, an appropriate and even a necessary adjunct to the same author's "Text Book of Applied Hydraulics", and clearly it has been found helpful by a number of engineers and students engaged on problems connected with liquid flow. The opportunity has been taken to amplify the original text by adding some new paragraphs to improve the balance of the work, and at the same time to bring it up to date. These additions have been introduced in such a way as not to disturb the arrangement of the original material, which remains unaltered. Hydraulics is largely an empirical science, and the application of reliable standards of measurement is necessary to its satisfactory development. New methods, some of them indirect, as in the case of the Allen salt-velocity principle, are continually being evolved, and, among other recent improvements, the author notes the adoption of standardized forms of pipe inlet in the Annis suction pipe meter now being used in that type of differential head meter. The manual will be found enhanced in usefulness by its revision and extension.

B. C.

The Yale Collections

By Wilmarth S. Lewis. (Published on the Foundation established in Memory of Curtis Seaman Read of the Class of 1918 Yale College.) Pp. xv + 54 + 13 plates. (New Haven: Yale University Press; London: Oxford University Press, 1946.) 11*s.* 6*d.* net.

YALE was founded on a collection of books. This short survey of the collections of books, manuscripts, objects of art, natural history and anthropology which have come to Yale during the past two and a half centuries has been written to indicate their extent and variety, which are not generally known even in New Haven. If the library is the heart of a university, the other collections are the basic food of research. It is therefore sad to see that the author finds it necessary to justify the existence of "what many consider a frill". The survey briefly describes the history and contents of the library and its specialized collections, the art gallery, the Peabody Museum and the Anthropology Museum. It has space to mention only by name many other valuable collections and the splendid researches which have resulted from their study. The illustrations include an interesting photograph of a restoration of the first Yale College library as it was in 1742, with the actual books presented by Newton, Halley, Bishop Berkeley and others on the shelves.

The printing, paper and make-up of the volume are worthy of their subject, but the text contains a number of colloquialisms that jar on British ears.

L. HARRISON MATTHEWS

CHROMOSOME MULTIPLICATION AND REDUCTION IN SOMATIC TISSUES

THEIR POSSIBLE RELATION TO DIFFERENTIATION, 'REVERSION' AND SEX

By Prof. C. LEONARD HUSKINS
University of Wisconsin

CYTOLOGY, which began as a purely descriptive science, bifurcated early in this century into 'karyology' and 'experimental cytology'. By 1925 the karyologists had, as Schrader[1] points out, assembled a mass of data with far too few unifying concepts. These were furnished in the period 1925–35 by a closer union with genetics, in which John Belling and C. D. Darlington[2] played predominant parts, and cytogenetics became the most rapidly developing branch of cytology. When in 1942, as a Guggenheim Fellow, I attempted to write an advanced text-book I began with the assumption, then common to most cytogeneticists, that a synthesis was possible on the basis of generally accepted theories, with only minor modifications and adequate citation of exceptions. I ended with the opinion (cf. ref. 1) that some of the exceptions no longer 'proved the rule' but rather demanded basic revisions of the theories[3]. Of the new research approaches that seemed necessary, one promising line open to the cytologist appeared to lie in the union of cytogenetics with experimental cytology.

A beginning was made at McGill University in collaboration with Prof. George Scarth and a joint student, Herbert Stern[4,5]. The War, and at its end Scarth's retirement, deferred developments. A year ago it became possible to begin assembly of a research team at the University of Wisconsin, and a programme was initiated. Two features of it: (*a*) the determination of chromosome constitution in differentiated tissues, and (*b*) the experimental production of meiotic ('sexual') divisions in somatic tissues, have reached a stage at which the basic discoveries may be outlined and their possible significance discussed.

It is now well known to cytologists, though not yet taken into account by most biologists[6,7], that many animal and plant tissues are characteristically polyploid or polytene (any distinction between these is in part arbitrary, and in any event lacks significance for issues considered herein; both may, presently, be termed polysomaty or endopolyploidy). Geitler, who earlier did much of the best work on animal tissues, in 1940[8] recorded polysomaty in thirteen plant species and eleven tissues of these, including infected ones. He concluded, however, that no generalizations could be made regarding its significance since: (*a*) the data are too scattered, and (*b*) we know that differentiation can proceed either with increase in cell size, and therefore possible polysomaty, or by increase in cell number with all cells presumably remaining diploid. Since 1940 many new cases of polysomaty have been reported, including the very recent ones in flower-buds and succulent leaves by Geitler's students Lauber[9] and Jähnl[10]; but no possible rationale for their occurrence has been suggested other than our own[11]. White[12] sums up the situation in animals as follows: "The whole process of histological differentiation in insects seems to be intimately bound up with this phenomenon of endopolyploidy, each organ and tissue having its own characteristic degree of ploidy, some being entirely composed of one type of cell while others are mosaics of cells with different multiples of the fundamental diploid number. To what extent endopolyploidy occurs outside the Insecta is not known at present, but there are indications that it is fairly widespread in many groups of animals. In the vertebrates conditions are not favourable for counting the chromosomes in somatic resting nuclei, but measurements of nuclear volumes (Jacobj 1925–1935) suggest that in some mammalian tissues several size classes of nuclei exist, and it is possible that these correspond to different degrees of polyploidy."

TABLE 1

HETEROCHROMATIC BODIES IN RESTING NUCLEI OF *Rhœo discolor*

Mm. from tip	No. of nuclei	Mean No. hetero.	*S.D. M*	Variance
1	190	11·1	2·11	4·47
2	100	12·1	2·8	7·81
3	99	18·1	4·7	22·09
4	101	20·6	4·97	24·74
5	101	21·3	5·02	25·29

Differences of means: 1 : 2, not significant
1 : 3, not significant
1 : 4, $9{\cdot}5 \pm 4{\cdot}74$ $P = 0{\cdot}045$
1 : 5, $10{\cdot}2 \pm 4{\cdot}79$ $P = 0{\cdot}04–0{\cdot}03$

In 1946 we began, with a possible rationale in mind, an investigation of the extent of polysomaty in plant tissues commonly assumed to be diploid. Roots of *Rhœo* were chosen for a first test as these have, in their chromosomes, heterochromatic regions that can be stained in energic ('resting') nuclei. These first studies, with L. Steinitz[11], indicated that a very large proportion of differentiated cells behind the meristematic region are polysomatic (see Table 1). The test is, however, too indefinite and too subjective, particularly because the heterochromatic regions vary so much in size and fuse so readily. To count the actual chromosomes it is necessary to induce mitosis in cells that ordinarily would probably not divide again. It is, however, then necessary to avoid the induction of polysomaty by the treatment employed. Indole-3-acetic acid in dosages which we consider meet this latter requirement have enabled us to determine that 25–35 (maximum 75 in one root) per cent of the differentiated cells *that are induced to divide* in *Rhœo* roots are polysomatic. (The data of Table 1 indicate that, if all cells could be induced to divide, the proportion seen to be polyploid would be much higher.) We also found both statistical (Table 2) and direct (pairing with chiasma formation) evidence that reduction occurs from polyploidy to diploidy, as Berger[13] found in *Culex*, and we saw several haploid nuclei[11,14].

Repetition of the experiments, by Rhona Leonard, on barley gave similar results. At the same time, it was found by R. E. Duncan and J. G. Ross that the older nuclei of untreated maize endosperm are polytene[11]. The total data on polysomaty now make it clear that the axiom that all cells of a plant or animal body have the same chromosome and genic constitution is, quantitatively at least, invalid. In exceptional cases involving 'chromatin diminution' it has long been known that it may be invalid qualitatively, though the presumed absence of genes in heterochromatin complicates this issue. We have under way tests which may possibly help to determine whether, in a more sophisticated sense dependent on a concept of gene structure developed later herein, it lacks general validity.

TABLE 2

Treatment	No. of roots	Hours after treatment	Region	Chromosome number										Per cent polyploid
				n	$2n$				$4n$		$5n$	$6n$	$8n$	
				Chromatid number per chromosome										
				2	2	4	6	8	2	4	2	2	2	
Rhœo discolor	6	0–6	Meristem		22									0
Indole-acetic acid			Diff'd		28									0
20 p.p.m. 4 hours	8	7–12	Meristem		398									0
			Diff'd		72	15			3					20·0
	4	13–18	Meristem		114									0
			Diff'd		556	180			93	2			[illegible]	33·2
	3	19–21	Meristem		228									0
			Diff'd	2	349	175			69	8	2?			41·9
	4	22–24	Meristem		224									0
			Diff'd		243	35			46					25·0
Barley	2	0–3	Meristem		1									0
Indole-acetic acid			Diff'd		0									0
20 p.p.m. 4 hours	3	4–9	Meristem		167									0
			Diff'd		25	5			5					28·6
	4	10–15	Meristem		169									0
			Diff'd		47	20			1					30·9
	7	16–21	Meristem		420									0
			Diff'd		158	35	1	2	26	1			1	29·5
	2	22–28	Meristem		124									0
			Diff'd		70	10		3	6	1			2	23·9
40 p.p.m. 4 hours	3	21–28	Meristem		96									0
			Diff'd		82	12			4			2		18·0

Caspersson[15] found that at pachytene of meiosis when the paired chromosomes become microscopically four-partite there is a very high nucleic acid content. His conclusion "that nucleic acid plays a role in the synapsis or in the division of the chromonemata or in both" seems basically sound. His further conclusion[16] that thymonucleic acid has a role in gene reduplication is, however, based on the premature, if not completely inacceptable[17], identification of chromosome substance with gene and the view that gene reproduction and chromonema splitting coincide. This latter is one of the commonly accepted concepts of cytogenetics that has long seemed to require reconsideration. More than fifteen years ago Nebel, McClintock, Huskins and Smith and others (see ref. 18) showed cytologically that each chromatid in a meiotic tetrad is at least a double, if not a multiple structure, though it behaves as a unit in genetic segregation and usually, if not always as is commonly assumed[2], in its breakage and mutational response to X-radiation. Nebel[19] and I also had what we considered clear evidence of doubleness before pairing. Further, for more than twenty years many of the most cautious cytologists (see ref. 20) have held that the chromosomes of somatic divisions are double at anaphase and therefore contain twice as many strands as genetic evidence leads us to expect. (That the same opinion has also been held on faulty grounds is irrelevant.)

In meristematic cells of onion root-tips treated with sodium ribose nucleate (Swartz Lab. Inc. Sample *SN* 4509) by M. Kodani[21] in the course of his studies on the effects of nucleic acids and related compounds on the production of 'lampbrush' chromosomes, I recently found chromosome pairing and reduction divisions, similar in essential respects to those of the germ cells. It should be stressed that, as mentioned above, we had previously found several cases of reductional divisions in differentiated tissues in our indole-3-acetic treated materials, and with Caspersson's conclusions in mind I was looking for them in these slides. Otherwise, for the reasons given below, they would probably have been missed in the initial slides in which they occurred rather infrequently. By using 4 per cent sodium nucleate solution for 5–19 hours Kodani increased the number to several per cent of the total number of dividing cells and made it possible for us to make a detailed analysis.

The possibility that only chance association and distribution of chromosomes was involved has been eliminated by L. Steinitz in experiments on *Rhœo* roots. In them catenations of several chromosomes, instead of simple pairs, occur as in their germ cells. An 8 per cent solution for six hours has produced this effect in the majority of dividing nuclei.

Some of the pairing in onion roots is with chiasmata, some without. Further tests using structurally modified homologous chromosomes, which will bear on the chiasma-crossing-over relationship, are therefore under way.

From consideration of the cytological literature and our own, unpublished, data and especially since the recent evidence of somatic reduction in cotton[23], we conclude that our sodium nucleate treatments have only increased the frequency, by abnormal dosage with substances normally present, of a process that occurs naturally but infrequently without treatment. When pairing and reduction-type divisions occur in large numbers, as in our later experiments, they cannot long be missed. If they occur only occasionally, as in normal material, they would usually be missed by the cytologist for two reasons: (*a*) spindle formation and kinomere orientation on it are abnormal and the general appearance of the first reductional division is that of a cell squashed in preparation; (*b*) the second division is commonly abortive. When abortive, two nuclei are formed, each with the normal diploid chromosome number (instead of four with the haploid number as when they are not abortive), and in a structurally homozygous organism these two nuclei are indistinguishable, to the cytologist, from the products of a normal mitosis. In a genetically heterozygous organism, however, the result would be seen, as somatic segregation or 'crossing-over' for two homozygous cells, one with the two dominants and the other with the two recessive factors, can result. It is possible that many of the known cases of somatic segregation and/or crossing-over in *Drosophila*, other animals and plants occur in this way. The demonstration of this mechanism may further have significance for the phenomenon of 'saltation' in fungi lacking known sexual stages, and perhaps in bacteria[24].

Sometimes one of the two reduced nuclei divides before the other and before a cell wall is formed between them—as it often does in pollen mother-cell meiosis. This gives sixteen chromosomes at one end of the cell and eight at the other, and, of course, furnishes particularly convincing evidence that a true reduction division and not merely a random segregation of chromosomes has taken place.

The observations render more acceptable the oft-reported cases of chromosome pairing in tumours, particularly since a high nucleic acid content has been found in many tumours. In itself this may be quite distinct from any question of the *origin* of the tumours. However, in so far as the somatic cell mutation theory of cancer is acceptable, our observations indicate that such 'mutation' may well be somatic segregation in an organism heterozygous for a gene or genes that predispose to tumour susceptibility. The recent work of Greenstein[25] and Potter *et al.*[26] indicates that the changes involved are enzymatic in nature, as are the effects of many gene changes.

Sporadic cases of genome segregation, of which those in strawberries[27] and oats[28] are the most striking, also receive one highly plausible rationale from our observations. To get segregation of ancestral genomes from an allopolyploid it is theoretically necessary only to have pairing and segregation of homologous chromosomes in somatic tissue of the germ track prior to a normal meiosis in which there is pairing and segregation of the ancestral homœologues as in the hybrid diploid ancestor. Experiments are therefore being set up in which we shall attempt to abstract ancestral species from polyploids. This may have a bearing on the currently highly controversial[29] problem of 'relic' species.

The simple cytogenetic concept of the chromatid as a unitary string of genes seems to be entirely adequate for crossing-over and the Mendelian transmission of hereditary differences, though not as much so for the data on the production of such differences as is commonly supposed (cf. mosaics). Along with its corollary, the earlier concept of the gene as a unitary organic molecule, it has been a hindrance to thought on the gene as a physiological unit. It is now clear that the gene which acts as a unit in genetic segregation must in some sense be a multiple unit, since its microscopically visible habitat, the chromatid, is at least double. Current concepts of the protein molecule as made up of a number of identical lamellæ give us a model for the gene that seems to fit all present cytological and genetic data and open up the way for new theories of gene action. In particular they permit us to investigate the simplest of all possible hypotheses—and, as Muller[30] points out, one of the earliest—namely, that the gene acts as a physiological unit just as it does in inheritance by reproducing itself, or, more specifically, its platelets. (By using the term 'gene' to refer, for the present, either to a platelet or a multiplicity of platelets we are adding only one new concept to the several already subsumed under that term.) The axiom of chromosome and genic identity of all cells in a plant and animal body, which is now shown to be an incomplete and perhaps misleading concept, has previously prevented serious consideration of this hypothesis—see Wright[31], in which he points out that on the accepted theories of gene structure and identity of all cells a gene could reproduce itself only once between each nuclear division. This limitation as applied to platelets no longer holds. The discovery of nuclei with chromosome, and especially chromatid, numbers other than an exponential power of two (Table 2) may be of very great, though indirect, significance in this connexion. The next and most difficult step in the testing of this hypothesis is to determine whether all parts of a chromosome and all genes reproduce at the same rate. There is already much evidence that heterochromatin and 'differential regions' do not—included in this evidence is that of R. E. Duncan[32], who has further unpublished data that fall in line.

The concept we currently favour is that the gene, and its visible manifestation or habitat the chromatid segment or 'chromomere', must continuously be reproducing itself in all living tissues by the production of new platelets. Failure to do so would be one means of 'chromatin diminution'. Possibly this is what Goldschmidt has in mind[33] when he remarks that it occurs only in organisms with a limited cellular reproduction.

Wright[31] has pointed out that a mutation in one of the postulated lamellæ of a gene may (conceivably by "the same mechanism as involved in the duplication process") be restored rapidly or spread through them all. Gulick[17] considers this highly probable and adds that since genetic stability is founded on stability of chromosome organisation, natural selection will be expected to have ensured that restoration occurs in the majority of cases. The relative rarity of mosaicism is therefore expected even on the lamellar hypothesis of gene structure, while its occasional occurrence is thereby readily explained.

It may well be, of course, that polysomaty is not so direct an indication of the mode of gene action as the present hypothesis postulates. That it has *some* relation to the physiological activity of the gene now seems self-evident. Since the above data on higher plants, insects, and mammals were evaluated there have come to hand the papers of Subramaniam[34] claiming a relationship of "endopolyploidy" to enzymatic activity in yeasts and indicating its probable significance in the macronucleus of ciliates. It begins to look as if continued mitoses are essential to the preservation of diploidy. The significance of this possibility for theories on the isolation of the germ plasm are obvious.

To summarize the argument from the data on somatic reduction: A combination of four steps, each of which is now firmly established as occurring normally (and with higher frequency in experiments with normally occurring environmental substances or influences in unusual dosages but within a range consistent with viability), is sufficient to account, theoretically at least, for all the basic cytogenetic and evolutionary features of sex. They are, to state a hypothetical case for the purpose of exposition: (1) endomitosis (as an alternative to the nuclear fusion usually proposed) in a haploid organism giving rise to diploid tissue; (2) complementary mutations (it is, for the moment, irrelevant whether genic or chromosomal) in the two sets of chromosomes which render either one individually less efficient than the combination of both; (3) somatic reduction, with or without crossing-over; (4) fusion of reduced nuclei (or, in dikaryonts, of cells). These give us the cytogenetic essentials of sex without sexes or sexuality. All successive developments of sexuality may be viewed as adaptive mechanisms facilitating the orderly sequence of the reduction and fusion. On this simple view 'incompatibility' reactions are the evolutionary forerunner of ordinary sexuality, though reversion can, obviously, occur. The number of complementary heterothallic forms is unlimited ; the number of true sexes is limited to two because there must be very close association of many adaptive features. All the above issues have, of course, been considered by many writers and especially clearly by Darlington[36]. Beadle's[35] scheme has similarities but also fundamental differences ; he, further, accepts Darlington's conclusion that nuclear fusion and meiosis must have arisen simultaneously, which is not necessary in the above scheme. Our contribution, regardless of hypothetical significance, is the experimental production of the third, and previously most inexplicable, step, and from Stern's[5] work a suggested experimental technique for the production of fusion within a single organism. Our scheme has one advantage over others in that somatic reduction may in some cases (cf. ref. 22) have immediate selective value for the tissue involved and not only for the progeny[36].

To conclude, the occurrence of polysomaty and polyteny in differentiated tissues and of somatic reduction divisions equivalent to both complete and incomplete meiosis are established, and also the optical doubleness (if not the multi-strandedness) of the chromatid which is nevertheless the *unit* of Mendelian segregation. The speculations on the possible significance of the data are predominantly of the nature of working hypotheses which can, though to very varying degrees, be tested. Their validity, or lack of it, at this stage is therefore immaterial to their possible usefulness. Further obvious speculations on issues such as the relationship of the postulated platelets to 'plasmagenes', etc., are not indulged in since we see at present no way for the cytogeneticist to test them.

It must be emphasized that though I accept full and sole responsibility for all statements above, the work is that of a team in which I have the collaboration of three senior and seven junior associates. In the detailed publications to follow, authorship and accrediting will indicate the particular contributions of each in so far as this is possible with a team the members of which, to end on a cytological analogy, are, like cells, individual units at the level of differentiation, that is, in their special studies, and sub-units at the integrative level, that is, in the general programme. Financial support is provided by the Wisconsin Alumni Research Foundation and, through the award of one fellowship, by the National Research Council, Committee on Growth.

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THEORY OF ELECTROKINETIC EFFECTS

By F. BOOTH

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THE purpose of this article is to summarize the present position of the theory of electrokinetic phenomena and to present certain new mathematical results I have obtained, the details of which will be published later.

In electrokinetic phenomena we are concerned always with the electrical double layer at the boundary between an electrolyte and a solid. Two types of theoretical problem arise in considering the effects of this double layer, depending upon whether equilibrium, or non-equilibrium irreversible conditions (in the thermodynamic sense), prevail. An example of the first type of problem is the determination of the mechanical force between two solid particles at rest immersed in an electrolyte also at rest. This problem, of fundamental importance in colloid chemistry, has been solved successfully by Verwey[1] after many abortive attempts by other workers. The second type constitutes the subject matter of this article ; here dynamic rather than static conditions prevail, and we have to determine various consequences of the effect of the double layer on the flow of an electrolyte past a solid surface. These electrokinetic effects have, apart from their intrinsic interest, important industrial and biological applications[2]. The main electrokinetic phenomena are :

1. *Cataphoresis or electrophoresis* ; this is the motion of the particles in a suspension when an electric field is applied (Reuss, 1808).

2. *Electro-osmosis* ; this is the flow of a liquid through a capillary when an electric field is applied parallel to its axis. Closely related is the effect known as *electro-osmotic pressure* ; if the flow through a horizontal capillary is prevented, a difference of pressure develops between the ends when the field is applied (R. Porret, 1816).

3. *Streaming potentials* ; the potential set up between the ends of a capillary when an electrolyte is forced through it (Quincke, 1859).

4. *Sedimentation potentials*. A suspension of particles, if allowed to settle, sets up a vertical electric field (Dorn, 1878). A very similar effect is the difference of potential which develops between the nodes and antinodes set up by stationary sound waves in a suspension (see, for example, Hermans[3]).

5. *Electroviscous effect*; this is the increase of the effective viscosity of a solid suspension owing to the double layer on the particles.

Other effects may be suggested; for example, the double layer must influence the rate of diffusion of particles in suspension.

The classical theory of effects (1) to (4) is due to Helmholtz[4] and Smoluchowski[5]. For electro-osmosis they gave, for the mean velocity of flow,

$$\bar{v} \doteq \frac{E\varepsilon\zeta}{4\pi\eta}. \qquad (1)$$

Here E is the field-strength, ε the dielectric constant of the liquid, ζ the potential difference across the double layer, η the coefficient of viscosity. Smoluchowski's contribution was to insert ε in (1) and to show that the assumption for the capillary, of a uniform cross-section normal to E, could be discarded. Thus (1) holds for a closely packed powder with electrolyte filling the interstices. It is thus easily seen that the velocity U of cataphoresis will also be given by (1), U replacing $\bar{v}$, and ζ now being the electrokinetic potential of the particles. For, suppose we have a fixed but *isolated* particle; at a large distance the mean streaming velocity will be given by (1). But this system is equivalent to a *stationary* liquid and a *moving* particle.

The field set up in streaming potentials is

$$E = \frac{\varepsilon p\zeta}{4\pi\eta\sigma}, \qquad (2)$$

where p is the pressure gradient and σ the specific conductivity of the electrolyte. By an argument very similar to that we used to relate U to $\bar{v}$, equation (2) can be used to find the field set up in sedimentation. This is

$$E = \frac{1}{3}\,\frac{\varepsilon\zeta g\,(\Delta - \Delta')}{\pi\sigma\eta}, \qquad (2')$$

Δ being the particle density and Δ' the fluid density.

These formulæ only apply provided that the thickness of the double layer at each point of the interface is *small* compared with the radius of curvature at that point.

Although the Helmholtz–Smoluchowski formulæ have been extensively used for the analysis of experiments, they have undergone considerable criticism and modification in recent years. Let us first examine the phenomenon of cataphoresis; physically, this is the simplest effect but it is the most difficult one to treat mathematically. One obvious limitation of the Helmholtz–Smoluchowski theory is the restriction on the thickness of the double layer. This is not likely to be serious in effects (2) and (3), but evidently may not apply in cases (1), (4) and (5) for very small particles. For cataphoresis, Henry[6] obtained a formula which did not require this restriction on the thickness of the double layer. For non-conducting spherical particles he obtained

$$U = \frac{\varepsilon E\zeta}{6\pi\eta}\left[1 + \frac{1}{16}b^2 - \frac{5}{48}b^3 - \frac{1}{96}b^4 + \frac{1}{96}b^5 + \frac{1}{8}b^4 e^b\,E_i(b)\left(1 - \frac{b^2}{12}\right)\right], \qquad (3)$$

where $E_i(x) = \int_x^\infty \frac{e^{-u}}{u}du$, $b = \chi a$, a is the particle radius, and

$$\chi^2 = \frac{4\pi e^2}{\varepsilon kT}\sum_{i=1}^{s} n_i z_i^2.$$

The summation is over the s ionic species present in the electrolyte, n_i being the concentration, z_i the valency. Since χ^{-1} is a measure of the double layer thickness, b represents the ratio of the radius a to this thickness. The function in brackets tends to 3/2 for b large, and to 1 for b small; hence in the limit (3) agrees with Smoluchowski's formula.

Henry's treatment, however, contains a serious blemish, for in order to obtain (3), he had to assume that the charge distributions on the surface and in the electrolyte remain spherically symmetrical when the field is applied; this is certainly incorrect, since the ions will tend to fall behind the particle, causing excess of charge there and a deficit in front, as compared with the equilibrium charge density. This behaviour is known as the 'relaxation effect' in the theory of electrolytes.

Various attempts have been made to remedy this defect; one by Hermans[7] and another by Komagata[8] are valueless since they contain fundamental mistakes. More recently, Overbeek[9] and, independently, the present writer[10], have given generalizations of Henry's formula. I find a general expression for U in the form

$$U = \frac{EeQ}{6\pi\eta a}X_1(b) + \frac{E}{6\pi\eta}\sum_{r=2}^{\infty} Q^r e^{2r-1} a^{-r} (\varepsilon kT)^{1-r} \left[q_r X_r(b) + Y_r(b, q_\mu, t) + Z_r(b, q_\mu\, q_\mu^*, t)\right]. \qquad (4)$$

Qe denotes the total charge on the particle when at rest, q_μ the set $(q_2, \ldots q_r)$; q_μ^* the set $(q_3^*, \ldots q_r^*)$; also

$$q_r = \sum_{i=1}^{s} n_i z_i^{r+1} \Big/ \sum_{i=1}^{s} n_i z_i^2, \text{ and}$$

$$q_r^* = \varepsilon kT \sum_{i=1}^{s} n_i z_i^{r-1} w_i^{-1} \Big/ \pi\eta e^2 \sum_{i=1}^{s} n_i z_i^2,$$

where w_i is the ionic mobility of the ion of type i. The functions X_r, Y_r and Z_r are very complicated, although it can be shown that they all, except X_1, tend to zero as b tends to zero or to infinity; the X_r are functions of b only, but Y_r and Z_r may contain certain surface parameters which we have indicated by t in (4). The physical significance of the three terms in the square brackets is as follows: X_r represents a contribution to U due to the *symmetrical* part of the field around the particle. These terms, when r is greater than 1, do not appear in Henry's formula (which is identical with the first term of (4)) because he adopted the Debye–Hückel approximation, namely, that $\zeta e/kT \ll 1$; $\zeta e/kT$ may reach values of about 4, so that this approximation is not good. Y_r represents a contribution to U due to the distortion of the field, but *not* involving the ionic mobilities; that is, distortion not due to relaxation; Z_r is the contribution due to relaxation. So far, the expansion has been worked out as far as the Q^4 terms for *symmetrical* electrolytes (that is, electrolytes with equal numbers of positive and negative ions, or with $q_{2r} = 0$), though work is proceeding on the more difficult case of unsymmetrical electrolytes.

To obtain formula (4) it is first necessary to derive the spherically symmetrical part of the field. At distance r from the centre, the potential of this field is found to be

$$\psi_1 = \sum_{m=1}^{\infty} Q^m e^{2m-1} (\varepsilon a)^{-m} (-kT)^{1-m} \lambda_m(\chi r). \qquad (5)$$

The functions λ are obtained by transforming the differential equation for the potential into an integral equation. By analogy with (5) we write for the distortion of the potential of the ionic atmosphere

$$\varphi(r,\theta) = E \sum_{\nu=1}^{\infty} \sum_{n=0}^{\infty} Q^{\nu} e^{2\nu} (\varepsilon kT)^{-\nu} a^{1-\nu} \lambda_{\nu,n}(r) P_n(\cos\theta), \quad (6)$$

θ being the angle co-ordinate. Provided ψ_1 and φ are known, U can be calculated. Hence the problem is resolved into the determination of the functions $\lambda_{\nu,n}$. They are found from the equations of motion of the electrolyte and of the ions.

A serious difficulty for any theory of cataphoresis is to obtain satisfactory boundary conditions for the solid-liquid interface. We have no exact knowledge of the structure of the interface, and indeed it is from experiments like electrophoresis that we must derive information. Hence it is very desirable, if possible, to formulate basic assumptions on the surface state, in as broad a manner as possible, precluding specific mechanisms. It has been possible to derive (4) with the following simple assumptions about the interface:

(I) The thickness of the region in which the surface charge resides is small compared with the particle radius.

(II) The charge in this surface region is immobile.

(III) The surface charge density at any point is an explicit function of the ionic concentrations in the adjacent electrolyte and of the temperature only. (The surface parameters in (4) are partial derivatives of this function with respect to n_i.)

Assumption I is almost certainly true; II may be incorrect, but surface conductance is unimportant provided $\sigma_s \ll \sigma a$ (where σ_s is the surface conductance). Assumption III is more speculative but it seems very plausible; for example, in conjunction with assumption II, it would certainly be valid for a surface charge produced by adsorption of ions.

Overbeek expresses U in a series of powers of ζ (up to the third power). Using (5) to relate Q and ζ, his results should give formula (4) correct to Q^3; agreement seems fairly satisfactory although his method is rather different from ours. He employs, however, a more restrictive assumption than III above, namely, that the charge density on the surface is fixed; this cannot be strictly correct. Another basic assumption made by Henry is that the 'inertia terms' in the equations of motion of the electrolyte can be dropped. It can be shown that this is equivalent to assuming that U is proportional to the field strength E—a result often experimentally confirmed. A more exact formula for U [11], taking into account the inertia terms, is

$$U = \frac{EeQ}{6\pi\eta a} X_1(b) + \sum_{r=2}^{\infty} (EeQ)^r \eta^{-2r} [W_r(b) + O(Q)]. \quad (7)$$

The series of functions W_r, of which the first two members have been found, are, like X_r, Y_r and Z_r, very complicated. Oseen's linearized equations were used to deduce (7); in fact, the problem is closely related to a well-known problem of hydrodynamics—the determination of the drag on a sphere moving through a liquid. The most complete solution of this problem is due to Goldstein[12], and we have used his analysis extensively.

Another improvement of Henry's formula is to take into account the effect of surface conductance. For an insulating particle with a surface conductance σ_s, and with a thin double layer, we find[13] that the right-hand side of (3) should be multiplied by the factor $\sigma a(\sigma_s + \sigma a)^{-1}$, where σ is the ordinary bulk conductance of the electrolyte. The importance of the surface conductance effect evidently depends upon the relative magnitudes of σ and σ_s. Some experiments by Rutgers[14] suggest that the interface may possess very high surface conductance; hence surface conductance may be of great importance in interpreting the results of cataphoresis measurements. It is natural to inquire if a formula of type (4) might be given in this case. There are no additional mathematical difficulties, but unfortunately we require much more detailed assumptions than I–III for the conditions at the surface. For example, we should require the rate of 'condensation' of ions on to the surface and the rate of 'evaporation'.

Another problem under consideration is the determination of the rate of electrophoresis for solid particles in the form of ellipsoids. This should be of use in biological applications where spherical particles are not always available, for example, in the investigation of proteins.

We shall now consider the sedimentation potential. Smoluchowski's formula for the sedimentation potential, like his formula for electrophoresis, applies only to a *thin* double layer. I have extended this to the general case[15] by using methods similar to those for formula (4). As is to be expected, the removal of the condition $b \gg 1$ introduces a complicated function of b and of the surface parameters on the right-hand side of equation (3).

Finally, we come to the electroviscous effect. The first calculation of the effective viscosity η of a solid suspension of spheres in a liquid of viscosity η_0 was made by Einstein[16], who found

$$\eta = \eta_0 \left(1 + \frac{5}{2}\frac{v}{V}\right), \quad . \quad . \quad . \quad . \quad (8)$$

where v is the volume of solid, V of the suspension. This formula only applies for $v \ll V$. A better formula was given by Guth[17], who added the term $109v^2/14V^2$. Smoluchowski[18] in 1916 pointed out that a charge on the solid particles should increase the viscosity, and published without proof the following formula:

$$\eta = \eta_0 \left(1 + \frac{5}{2}\frac{v}{V}\left[1 + \frac{1}{\sigma\eta_0 a^2}\left(\frac{\zeta\varepsilon}{2\pi}\right)^2\right]\right). \quad (9)$$

Later, Krasny-Ergen[19] gave a proof; his equation being identical with (9) except for the multiplication of the last term by 1·5. Both formulæ only apply for a thin double layer. I have, however, succeeded in finding a formula for η, without this restriction[20]. The more general formula does not agree with equation (9), and I believe that Krasny-Ergen's treatment is incorrect. With this, we conclude our account of recent theoretical developments.

Much further work remains to be done, but at this stage it would seem that a thorough experimental check of theory would be more valuable than continued elaborations of the latter. The most useful procedure would be the determination of the electrokinetic potential ζ for a given surface and electrolyte by as many different methods as possible. The results would indicate if the theory required drastic or only minor modifications. In reading the literature, the impression is inescapable that in the past much effort has been wasted because experimentalists have confidently used formulæ without realizing their limitations, or at any rate without attempting to ascertain, so far as possible, whether basic assumptions for their validity were satisfied in their work.

Only when a theory is well tested can it be applied to new experimental data and conclusions drawn therefrom with a reasonable degree of certainty.

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OBITUARIES

Dr. Charles Bolton, F.R.S.

The death on December 6 of Charles Bolton, at the age of seventy-seven years, removes one more member of that distinguished band of clinicians who, during the opening years of the century, so successfully combined general consulting practice and fundamental research. The impulse to contribute to the knowledge of his subject was undoubtedly the result of his early contacts. When Bolton went to University College, London, the Medical School had not yet separated from its parent body, and the department at University College combined both clinical and pre-clinical subjects and housed all the laboratories. At that time the medical faculty comprised a galaxy of talent. Thane and Schafer were at the height of their powers, and were soon to be joined by Bayliss and Starling. On the clinical side were Ringer, Barlow, Rose Bradford, Victor Horsley and Sidney Martin. Coming into this atmosphere as he did, fresh from an apprenticeship in general practice, Bolton was, as he often told later, first astonished and bewildered, and then inspired. He never lost the scientific enthusiasm then aroused. Following medical qualification, he began investigations on the bacteriology of typhoid fever and the morbid anatomy of diphtheria. These attracted sufficient attention to gain for him, in 1903, the Grocers' Company research studentship, and so the opportunity for laboratory research. This he utilized so well that five years later he was appointed, on a part-time basis, first director of the new Graham Research Laboratories at his own Medical School. This post he held until 1914, when it was merged with the lectureship in pathology—which Bolton also held—in a single whole-time post to which the late Prof. A. E. Boycott was appointed. But Bolton continued to work part-time in the Graham Department until the outbreak of another war, in 1939, closed his Medical School and so brought to an end his researches. In the intervening quarter of a century Bolton had been a busy general consulting physician, in wide demand, and with no source of livelihood but his practice. Yet, throughout that time, at least one afternoon a week was reserved for research.

Bolton will be remembered chiefly for his work on two subjects: the formation of tissue fluids and œdema, and the production of peptic ulceration. His interest in œdema and ascites sprang directly from clinical observations and particularly those on a case of illness which, nowadays, would be diagnosed as constrictive pericarditis. At this time the teaching of his friend Ernest Starling, that the rate of formation of tissue fluid was determined by the balance of hydrostatic and osmotic pressures across the capillary membrane, was gaining acceptance. Bolton set himself to determine the factors concerned in ascites. Re-reading his work to-day, it is impressive to note how often Bolton's conclusions, once regarded as strange, have been vindicated by subsequent discoveries. By direct experiment he showed that increased venous pressure in itself could not account for the ascites, and he clearly stated: "The abnormal output of lymph leading to dropsy is primarily conditioned by the nutritive state of the capillary wall". Thirty years later, Landis reached the same conclusions from his demonstration of the deleterious effect of anoxia on capillary permeability. Again, the increased blood volume in cardiac failure had been discovered by Lorrain-Smith, and was then considered to be one of the causes of dropsy. Bolton grasped clearly that, under such abnormal conditions, fluid may be lost into one part of the body so that the remainder becomes dehydrated. He wrote: "The increase in blood volume must, therefore, be looked upon as a secondary phenomenon and due to an effort of the animal to make up its normal quantity of blood in the anæmic areas, and to replace the fluid lost as dropsy". Modern measurements of blood volume, cardiac output and tissue-fluid spaces would essentially confirm this conclusion, which seemed so strange when first enunciated.

Bolton's main contribution to our knowledge of peptic ulceration concerned the conditions necessary to produce acute ulceration. By injecting suspensions of one animal's gastric mucosa into another species, he was able to produce an anti-serum which, on intraperitoneal injection into the donor species, caused acute ulceration in the stomach. The interesting point then emerged that the gastro-toxic serum produced no visible effect on the gastric mucosa unless this were in contact with acid gastric juice. Neutralize the acid and no ulcers occurred; augment it directly, or by suitable feeding, and ulceration was increased. Clearly the gastrotoxin had produced a definite, if invisible, temporary damage to the gastric mucosa which deprived it of its natural resistance to acid. Bolton believed that such damage occurred in the course of disease, and so led to acute ulceration. With Cruveilhier he believed that chronic peptic ulcers originated as acute ulcers; but although he tried repeatedly, he could not prevent the healing of the acute ulcers he produced by gastrotoxins. By artificially delaying the emptying of the stomach, by augmenting acidity, he succeeded in delaying, but not in preventing, healing. It now seems probable that, if he had only maintained a consistent hyperacidity, he might have seen his acute ulcers become chronic. Nevertheless, he had clearly appreciated the importance of acidity in exaggerating and delaying the healing of gastric lesions; and it was on that basis that he formed his therapy of these illnesses.

Personally, Bolton was a massive Yorkshireman with a typical dry humour. He possessed a remarkable power of effortless concentration which rendered him cheerfully impervious to all distractions. Yet he was never unapproachable, and once his attention was captured he could be most helpful. To colleagues and students alike he was uniformly genial and unaffected. Undoubtedly Bolton was fortunate in the times in which he began his professional work, for seldom can conditions have been more favourable for the combination of clinical practice and research. The solid bases of descriptive medicine and morbid anatomy had been laid, and physiology had sufficiently advanced to become applicable to clinical problems. The methods of approach and the techniques required for clinical research differed little from those used in routine practice, and the extra knowledge necessary for research, at that stage in the development of medicine, was not yet so large as to demand the whole of a man's attention and time. The business of living was also easier, and consultants could afford time for other activities than practice. Such a coincidence of conditions could only be transient, and with its disappearance the combination of private consultant and research worker began to disappear, so that now it is hard to find an example, outside certain specialties. Yet, if our medical schools are not to become simply technical institutes, if something more than technology is required in the training of a physician, then effective steps to prevent the separation of medical research and practice must be taken.

It must again be made possible for men like Bolton to devote adequate time to investigating their subjects. Undoubtedly the conditions now required will be very different from those which sufficed in the spacious Edwardian days when he flourished; but the ideal which inspired Bolton is still there, and, given the opportunity, its devotees will fulfil it.

H. P. HIMSWORTH

Dr. Emily Berridge

DR. EMILY M. BERRIDGE, who died on October 8, in her seventy-sixth year, has slipped away from the world of science as unobtrusively as she lived in it. But live in it she did her whole life long, devoting her life to research from her youth, when she was encouraged by her father, himself an experimenter, and by her head-mistress, Miss Arnold of the Dulwich High School, to make science her career. In 1894 she went up to the Royal Holloway College as an entrance scholar in natural science, and it was here she began research work in botany (under Prof. Margaret Benson).

Dr. Berridge's published researches fall into two distinct groups. The early papers, studies on fossil plants, and on the groups Gnetales and Amentiferæ, published mainly in the *Annals of Botany* and the *New Phytologist* between 1905 and 1914, bear the mark of her early training in Dr. Benson's special field of botany. The later papers, studies in bacteriosis published in the *Annals of Applied Biology* between 1921 and 1930, recall her colleague Dr. Paine, in whose laboratory at the Imperial College of Science and Technology, London, she worked during these years. The explanation of this complete change in type of research is to be found in her war work, 1914–19, which was done with Dr. Ernest Glynn in the Thompson Yates Laboratory, University of Liverpool, on agglutination of dysentery bacteria and the preparation of serum.

Not only did Dr. Berridge carry out research herself but she also gave generously of her time, thought and money to young postgraduates just starting on research. The extent of her generosity will never be known, for her gifts were mostly made anonymously. She was shy and diffident about her own work and so truly humble that only those who worked with her knew how good it was; just as only those who served with her on research committees knew of the quick grasp of essentials, the sound judgment and the unassailable integrity of mind and purpose that she brought to the discussion of any problem.

E. M. BLACKWELL

Dr. André Kling

DR. ANDRÉ KLING died on August 8, 1947, at the age of seventy-five. Receiving his education and early training in Paris, he was appointed in 1911 director of its municipal laboratory. The frauds in food and wine, to restrain which the laboratory had been founded under Charles Girard, were now declining, but the First World War opened to the laboratory new fields of activity. The Explosives Service, initiated by Girard during the anarchist bomb panics, was now developed for the disposal of unexploded German missiles; and Kling's leadership was an example of personal courage no less than of professional ability. His experience and success in this field led to his appointment as scientific adviser to the French General Staff. Working in this capacity at the front line on explosives and war gases, he earned the Croix de Guerre and membership of the Legion of Honour.

After the War, Kling interested himself effectively in the internationalization of analytical methods and standards. During the nineteen-twenties he presided over the International Union of Chemistry's Commission on Pure Substances for Research, to which he presented a report which led to the inception in 1928, under his presidency, of a separate Commission of Analytical Chemistry. In France, he was a pioneer in the formation of the Société de Chimie Industrielle, in which he held office on various occasions.

In actual chemical work, the name of Kling is perhaps most readily associated with the analytical separation of the metals of Groups III and IV. He was also, however, the author of numerous papers on methods of food examination, and, outside the analytical field, on the high-temperature hydrogenation of aromatic compounds. This work, even after his official retirement, continued to the end of a life wholly dedicated to his profession.

Prof. J. Masson Gulland, F.R.S.

DR. JESSE P. GREENSTEIN, chief of the Biochemistry Section, U.S. Public Health Service, writes: "The loss of Prof. J. M. Gulland to the scientific world is deeply regretted by his colleagues in the United States who knew the man and admired his personality and achievements. Gulland was one of a group of distinguished foreign guests at the Cold Spring Harbor Symposium held in June 1947. He was easily the dominant figure at that conference, and the charm and ease of his manner, his gentle critical spirit, together with the scholarliness and incisiveness of his thinking, evoked general admiration and affection. Gulland's investigations in the field of the nucleic acids revealed a meticulous and sound approach, and were of great interest and still greater promise. It is indeed a sad misfortune that we should have lost him."

NEWS and VIEWS

British Association: Annual Meeting

Sir Henry Tizard was installed as president of the British Association at a meeting held at Burlington House on January 9, when the Committees of Sections met to draft the outlines of their programmes for the forthcoming annual meeting, to be held this year during September 8–15 at Brighton. Emphasis will be given to scientific subjects which have a bearing on the economic crisis; a preliminary programme will be issued in the beginning of April.

The officers of the Association for the present year are as follow: *President*, Sir Henry Tizard; *General Treasurer*, M. G. Bennett; *General Secretaries*, Dr. Edward Hindle and Sir Richard Southwell; *Presidents of Sections*, Sir Lawrence Bragg (Physics and Mathematics), Prof. John Read (Chemistry), Dr. A. E. Trueman (Geology), Prof. H. Graham Cannon (Zoology), Lord Rennell of Rodd (Geography), Sir Hubert D. Henderson (Economics), Wing-Comm. T. R. Cave-Browne-Cave (Engineering), R. U. Sayce (Anthropology and Archæology), Prof. H. Hartridge (Physiology), Prof. A. Rex Knight (Psychology), Prof. J. R. Matthews (Botany), W. O. Lester Smith (Education), Dr. G. Scott Robertson (Agriculture).

International Geological Congress

Sir John Anderson has accepted the office of honorary president of the General Organising Committee for the eighteenth session of the International Geological Congress, which is to be held in Great Britain this summer, and will welcome the delegates and members at the first meeting of the General Assembly. Prof. H. H. Read, president of the Geological Society of London, has succeeded the late Sir Thomas Holland as president of the General Organising Committee and president-designate of the Congress. More than a thousand geologists from countries overseas are expected to attend the Congress; the total attendance, including British geologists, is likely to approach two thousand. Twenty-eight Governments and about 160 universities and scientific institutions have already accepted invitations to be represented by official delegates. The meetings of the Congress will be held during the period August 25–September 1 in the Royal Albert Hall and the lecture theatres of the Royal Geographical Society and the Imperial College of Science and Technology. Sir Edward Bailey and Prof. O. T. Jones will deliver special addresses on the structural history of Britain.

The list of subjects to be discussed at the sectional meetings of the Congress is as follows: (A) problems of geochemistry; (B) metasomatic processes in metamorphism; (C) rhythm in sedimentation; (D) geological results of applied geophysics; (E) geology of petroleum; (F) geology, paragenesis and reserves of the ores of lead and zinc; (G) geology of sea and ocean floors; (H) Pliocene – Pleistocene boundary; (J) faunal and floral facies and zonal correlation; (K) correlation of continental vertebrate-bearing rocks; (L) earth movements and organic evolution; (M) other subjects. In addition, problems of African geology will be considered at open meetings of the Association des Services Géologiques Africains; and selected palæontological topics will be discussed by the International Palæontological Union. A series of meetings on the mineralogy and geology of clays will be organised in conjunction with the Clay Minerals Group of the Mineralogical Society. In addition to the thirty-two geological excursions previously announced, five more excursions are being organised; two of these will visit East Anglia, one will visit Jersey, and two others will demonstrate the general geology of Scotland, and the hydrogeology of England and Wales. There will also be a series of day and half-day geological excursions. Full details of the excursion programme and of other arrangements for the Congress can be obtained from the General Secretaries, 18th Session International Geological Congress, Geological Survey and Museum, Exhibition Road, London, S.W.7.

International Congress of Anthropological and Ethnological Sciences

The third session of the International Congress of Anthropological and Ethnological Sciences (which met in London in 1934 and Copenhagen in 1938) is to be held under royal patronage at Brussels-Tervueren, during August 15–23, 1948. The president will be Prof. Ed. De Jonghe (University of Louvain); secretary, Prof. Frans M. Albrechts (University of Ghent, director of the Museum of the Belgian Congo); treasurer, Prof. Fr. Twiesselmann (University of Brussels, curator of the Royal Museum of Natural History). The subscription for full members is £2 2s.; for associates 200 Belgian francs. The Congress will meet in twenty-four sections, covering all branches of anthropological and ethnological research. Communications must be sent in typewritten synopsis, of not more than 200 words, to the Secretary before June 1; the full text and illustrations before July 1. Provision will be made for films and sound-records. There will be several exhibitions in connexion with the Congress; and excursions during August 24–28. Accommodation may be reserved either in the 'Cité Estudiantine' of the University of Brussels at 165 Belgian francs a day; or in hotels through Wagon-Lits-Cook, 17 Place de Brouckère, Brussels; approximate cost, room 100–200 Belgian francs; meals, 75–125 Belgian francs. Formal dress will not be required for any of the functions. The Organising Committee will endeavour to obtain currency facilities and reduced fares. Correspondence should be addressed to the Secretary, Musée du Congo Belge, Tervueren.

Embryology of Monsters

A recent issue of *Ciba Symposia*, a journal produced by a pharmaceutical firm, contains two informative articles on monstrosities in embryological development. The first, by Dr. Hamburger, professor of zoology in Washington University, St. Louis, is a general account of natural and experimentally induced maldevelopments. The second, by Dr. Wolfgang Born, of the Department of Fine Arts of Louisiana State University, traces the course of monstrosities, real and imaginary, as they appear in painting, sculpture and mythology. It is interesting that Dr. Born is a son of the Gustav Born who was one of the founders of experimental embryology, and one of whose main discoveries was that two halves of a divided amphibian embryo will fuse together if they are kept in apposition. It is widely believed that this finding was one of those brilliant outcomes of an accidental observation. In the course of Born's studies on regeneration, some tadpoles were halved just after hatching. To enable him to distinguish individual larvæ on which he was working, he left a part of the skin of the back intact after having halved the bodies. To his surprise he found next day that the halved larval bodies the dorsal skin of which had been left intact had re-united and healed together.

This observation led Born to the fundamental discovery that it is possible to join together as a chimæra the half of an embryo of one amphibian species with that of another. This fact provides the basis for the many transplantation and grafting experiments out of which much of experimental embryology as we know it to-day has developed. The centenary of Gustav Born's birth takes place in 1951, and it is to be hoped that the occasion will be properly celebrated by the publication of a commemorative volume tracing the story of his work and its subsequent development. The present issue of *Ciba Symposia* is a reminder of his very great contributions to experimental embryology, and of the widespread interest which the subject of monstrosities has always aroused.

Simultaneous Recording of Related Oscillograph Traces

DURING the War, the frequent need in such fields as ballistics, and the study of mechanical shock and vibration, to obtain information about the temporal variation of quantities, and in particular the interrelationship of these variations, led to a considerable use of the cathode ray oscillograph and moving-film technique. The methods of obtaining several records at once so as to permit a study of this interrelationship included the use of double-beam oscilloscopes, electronic switches for beam splitting, ganged cameras, and the photographing of a number of screens on the same film. Messrs. Cossor designed a unit comprising a 70-mm. film camera facing the screens of two double-beam tubes, and provision was made for ganging three such instruments together. The problem became more difficult, however, when it was desired to record some fifteen traces on the same film, as it was obviously impracticable to photograph fifteen oscilloscopes in line and still retain reasonable trace amplitude. To meet such a requirement, Messrs. Avimo Ltd., Taunton, have produced a series of units, employing up to fifteen 1½-in. cathode ray tubes photographed through mirrors on 70-mm. film or paper. The apparatus is robust and portable, and has a range of film speeds of 1–50 in./sec. The optical reduction factor is 2·5, and a microscope is provided to allow observation of the traces during recording. Of particular importance is the provision of adjustments to permit the alignment of the tubes so that each deflexion shall be normal to the film motion and all the deflexions shall be colinear.

Rubber Developments

Rubber Developments is a new illustrated quarterly, issued gratis by the British Rubber Development Board, Market Buildings, Mark Lane, London, E.C.3. The primary purpose of the journal is to direct attention to fresh or extended applications of the use of rubber, and it is addressed more to the potential user than to the manufacturer of rubber. The first number, consisting of 40 pages, contains articles on the rehabilitation of rubber estates in Malaya, liquid latex, engineering with rubber, and 'Positex', as well as other features. It is interesting to note that there are now six pamphlets available describing 'Positex' and its applications to woollens, cotton, linen and other yarns, and felts, and also its use as a textile printing paste. The British Rubber Development Board is a non-profit-making organisation, deriving its funds from a cess on raw rubber exported from the British production areas. The Board works in association with corresponding units in France and Holland, the work being co-ordinated on an international basis by the International Rubber Development Committee, the area allocated to the British Board comprising the British Empire and the United States.

Unasylva: A Forestry and Forest Products Review

THE first number of *Unasylva*, a new, illustrated, bi-monthly magazine of forestry and forest products, published by the Food and Agriculture Organisation of the United Nations, is dated July–August, 1947. Editions are being issued both in English and French, and a Spanish edition is planned for the near future. The aim of the journal is to shed light on all problems connected with forestry, to compare the methods used in different countries and to present the opinions of experts in the various fields. It is realized that the nations working together through the Food and Agriculture Organisation cannot hope to achieve their main objectives if due regard is not paid to the vast forests of the world. Conservation of those that perform useful social or protective functions is essential; their soils must be used wisely if productivity is to be maintained, and improved methods of processing and utilizing forest products need to be found. In the first number, Sir John Boyd Orr, director-general of the Organisation, contributes a foreword, while articles relating to the disappearance of the tropical forests of Africa, forest utilization, and the growth of the world's forests appear under the sub-heading "Problems". In the section dealing with "National Situations" are papers on timber shortage or timber abundance in the United States, and forest and forest products research in Canada, while a further part is devoted to a description of the scope and framework of the Forestry Division of the Food and Agriculture Organisation. Distributing agents for the new magazine are being selected for various countries and areas. Meanwhile, orders are being taken by the Documents Office, FAO, 2000 Massachusetts Avenue, N.W., Washington 6, D.C., U.S.A.

Physical Chemistry at the Mellon Institute

A DEPARTMENT of Research in Physical Chemistry has been established at the Mellon Institute of Industrial Research, University of Pittsburgh, to conduct fundamental investigations in its domain for professional and public benefit. Since its beginning, the Mellon Institute has recognized the need of fundamental scientific research as a background and source of stimulus for investigations in applied science. The Institute has therefore supported extensively disinterested investigations planned within the organisation and focused on the study of more basic problems than those usually pursued in researches in applied science or technology. This new Department of Research in Physical Chemistry will supplement the Institute's work in pure science, carried on since 1911 and formally organised under the Department of Research in Pure Chemistry in 1926 and the Department of Research in Chemical Physics in 1946. The Department of Research in Pure Chemistry specializes in the organic, biological and pharmaceutical fields. As investigations in pure science are completed, the results are published and widely disseminated. Dr. John R. Bowman, who has been appointed head of the Department of Research in Physical Chemistry, has distinguished himself in applied mathematics, particularly as employed in the analysis of chemical engineering problems, and in petroleum chemistry, especially in his comprehensive original work on distillation. He was born in New York, in 1910, and educated at the University of Pittsburgh and at the California Institute of Technology. Since 1935 he has been at the Mellon Institute, on the multiple fellowship of the Gulf Research and Development Co.

Public Libraries in Germany

H. SCHURER'S paper "Public Libraries in Germany", published as No. 5 in the German Educational Reconstruction Series (15 James Street, London, W.C.2), gives a readable account of the development of the public library system in Germany and of the two schools of thought, neither favouring open access to the shelves, which influenced that development down to the Nazi regime; it also deals with the part which the system could play in the educational reconstruction of Germany. The ideas of Walter Hofmann and his school in making book selection the decisive intellectual task of library service, with all its implied demands on the library staff, are set forth in some detail and should be of considerable interest to those engaged in library work in Britain, whether in the public library service, in the universities or in industry and commerce. The special characteristics of the tradition of German librarianship are of international significance, and a chapter in L. R. Wilson and M. F. Tauber's book on the university library suggests that that tradition has already made its influence felt in the United States as a positive contribution in library service. As regards the immediate future in Germany, apart from the restoration of damaged buildings and the recovery of lost stocks, Mr. Schurer considers that the main task will be the negative one of undoing most of the work of the Nazis, including the elimination of Nazi literature from book collections, removal of ardent Nazis from responsible positions, the preparation of new readers' guides and the training of library workers. Furthermore, he considers that the principle of open access must now be adopted, and he looks to a steady increase in the number of readers and to a healthy development of local and regional efforts rather than national or centralized efforts.

Glasgow Art Gallery and Museum

COMMENDABLE enterprise in making the natural history department attractive to visitors has been shown recently by the Glasgow Art Gallery and Museum. Despite special difficulties caused by enemy action during the War, considerable material has been salvaged and displayed as a series of habitat groups in an Animal Court at the Museum. The first and second arches contain representative samples of African and Indian animals, and the others in preparation will display animals of Australia and the Scottish Highlands. To accompany each display the Museum is publishing a series of attractive booklets in which each animal typified is described and illustrated. "Animals of Africa" and "Animals of India" are already available.

Medical Sub-Section of the Library Association

THE first ordinary meeting of the newly formed Medical Sub-Section of the Library Association was held at the National Institute for Medical Research on January 2. In welcoming the seventy or more members and guests, Dr. C. R. Harington, director of the Institute, spoke of the increasingly important part played by library services in the modern medical world and of the invaluable aid that specially trained librarians could give to those engaged in medical practice and research. Dr. G. Popjak gave an illuminating talk on recent developments in nuclear physics and their medical applications; his exposition of the manufacture of radioactive isotopes was much appreciated. Miss Ethel Wigmore, librarian to the Medical Research Council and a member of the Committee of the Medical Sub-Section, then described the work of the Library of the Institute, and this was followed by a conducted tour. The members were especially interested in the system of indexing current periodical literature pending the issue of the *Quarterly Cumulative Index Medicus*, and in the very comprehensive subject-index to the large collection of reprints.

Institution of Electrical Engineers: Awards

THE triennial award of the Coopers Hill War Memorial Prize and Medal, which fell in 1946 to the Institution of Electrical Engineers, has been made by the Council to Mr. E. C. Cherry, for his paper on "Analogies between the Vibration of Elastic Membranes and Electro-Magnetic Fields in Guides and Cavities".

No award having been made in 1946 of the Page Prize for the best thesis in lieu of the Associate Membership Examination of the Institution, the Council has awarded two Page Prizes for 1947: one to Mr. D. T. Hollingsworth for his thesis entitled "An Account of the Development of the Accessories for a Cable with the Dielectric under Pressure"; and the other to Mr. M. K. Taylor for his thesis entitled "The Transmission of Voice Frequencies by Height Modulated Pulses of Constant Recurrence".

Announcements

APPLICATIONS are invited for research fellowships, normally of the value of £600 per annum, founded by Imperial Chemical Industries, Ltd., tenable in the University of Cambridge and available for research in physics, chemistry, biochemistry, engineering, metallurgy, pharmacology, chemotherapy, or related subjects. Applications should be received not later than April 30. Regulations governing the award of the Fellowships may be obtained from the Secretary of the Board of Research Studies, The Old Schools, Cambridge, to whom all applications should be addressed.

A PRELIMINARY announcement under the title "Photostat Copies of German Scientific and Technical Papers" appeared in *Nature* of September 27, 1947, p. 427. It has now proved possible to reduce the cost of this service and a revised charge of 6*d*. per page, irrespective of number, is now being made.

ERRATUM.—Mr. A. B. Wardrop and Dr. R. D. Preston write: "In our recent article entitled "Organisation of the Cell Walls of Tracheids and Wood Fibres" in *Nature* of December 27, p. 911, we inadvertently allowed the same mistake to occur in three places. The legends to the abscissæ of Figs. 3 and 4 should read 'Angle of section to *transverse* plane' and the word 'increasing' (p. 912, line 8) should read 'decreasing'."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Audio-Frequency Radio Waves from the Sun

The recent discovery of solar radio noise, in the range 30–1,000 megacycles, raises the question whether lower frequencies may not also exist. Variable magnetic fields exist on the sun and probably in the stars as well. Small and rapid pulsations of spot fields may well occur, even though detection of the variations, by studies of the Zeeman effect, will prove difficult. Nevertheless, we may expect that these changing fields will produce electromagnetic radiations the maximum wave-lengths of which are comparable to stellar dimensions. Such low-frequency radiation will escape from the sun in the presence of a steady magnetic field, like those found in sunspots.

Partial absorption of such waves in the solar atmosphere may produce the observed high excitation of chromosphere, prominences and corona. In the earth's atmosphere, similar absorption may be responsible for the luminosity of the night sky and, possibly, also for the aurora polaris. The concentration of the latter in a zone near the magnetic poles may arise from the tendency of accelerated ions to spiral around the lines of magnetic force.

To explain the observed terrestrial effects as the action of solar electromagnetic waves, we require voltages of the order of 0·01–1·00 volts per cm. We postulate the existence of frequencies in the range of from 1 to, say, 500 cycles per sec., though the extent of the range is unimportant for our argument. These long waves will be diffracted around the earth and hence may well cause effects on the dark, as well as on the sunlit, hemisphere. With these assumptions, one readily calculates that an amplitude of at most several gauss, with the appropriate frequency, in the field of a spot can produce the desired radiation.

The total energies involved in the radiation are roughly equivalent to that from an area of normal photosphere about equal to that of a spot. Hence, we further suggest that the emission of radio energy provides a simple mechanism for cooling the spot.

The long-wave emission may account for many ionospheric phenomena, such as sporadic *E*. The waves will cause any 'seed' ionization to spread—a sort of multiplier effect. Some phases of ionospheric storms may also be explained as due to heating of the layers by the absorbed radiation. The waves will have a similar action on meteor trails, the growth and persistence of which are difficult to explain in terms of the meteor itself. The voltages and wave-lengths are sufficient to produce, in regions of low density, high-energy particles, like the softer components of cosmic rays. We suggest that the phenomenon here discussed may be the source of cosmic rays. We suppose that the harder components arise in stars the magnetic variations of which are much more intense than for the sun.

The suggestions made above demand experimental verification. As a first step in the study, we have constructed a large loop antenna, connected to a tunable audio amplifier. With this device, we have detected the existence of variations of the order of magnitude herein suggested, and of frequencies from 25 cycles (the lowest limit of the amplifier) to about 400 cycles.

Further experiments are in progress to determine whether we can attribute the effects to electromagnetic waves of solar origin, or whether we must assign them to micropulsations of the earth's magnetic field.

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WINFIELD W. SALISBURY
Collins Radio Company,
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Showers of Penetrating Particles

The intensity of several 'components' of the cosmic radiation varies with atmospheric depth more rapidly than the intensity of the so-called total radiation (curves of Pfotzer and Millican): for example, showers of penetrating particles measured with a counter arrangement vary according to an exponential law $e^{-x/d}$, where x is the atmospheric depth in gm./cm.^{2} and $d \sim 100$ gm./cm.^{2} [1]. The cross-section for the collision of a primary shower-producing particle with a nucleus in air is of the order $2 \cdot 5 \times 10^{-25}$ cm.^{2}. Neutrons, protons, multiple nuclear disintegrations, large bursts and slow mesons show similar rapid decrease with increasing depth.

The present remarks will chiefly refer to the showers of penetrating particles. Some of them contain at least four particles each penetrating 20 cm. lead, as we have observed by means of eight-fold coincidences between eight counters arranged in four telescopes scattered on an area of 4 m.^{2}. Each counter was surrounded on all sides by 10 cm. lead. The frequency of these showers in S. Paulo (altitude 800 m.) was 3×10^{-4} min.$^{-1}$. Examination of experimental data on the density of particles in such showers, the existence of penetrating particles in extensive showers and the variation of meson intensity and spectral distribution at high altitudes (and at great depths) leads us to the following conclusions: the majority of mesons are produced in groups (in collisions of primary protons or secondary protons and neutrons with nuclei), with a multiplicity increasing with energy in accordance with the scheme suggested by us earlier[2].

Here we limit ourselves to the discussion of one argument. There is a striking difference between the slow variation with atmospheric depth of the frequency of single penetrating particles (chiefly mesons) as measured by a telescope (curves of Schein, Jesse, Wollan and of Ehmert), and the rapid exponential variation with depth of the frequency of penetrating showers measured by us[1]. Obviously, a telescope indicates the arrival of every meson the trajectory of which lies inside the solid angle defined by the counters. The collision process which gives rise to these mesons can take place at great altitudes above the telescope (for example, at 20 km. above), provided their life-time is long enough and their energy is not too low. Thus the telescope measures the integral intensity of mesons produced inside the solid angle defined by the telescope, whereas the large-angle arrangement of 4-fold or 8-fold coincidences used by us can only register bunches of particles created locally at distances of not more than a few hundred metres above the arrangement. Indeed, if, for example, the centre of the shower is located at 10 km. height above the arrangement, the angular spread of the penetrating particles will give rise to an average distance between the points of arrival of two mesons on a horizontal plane (at 10 km. below the centre) greater than the distance between the telescopes of our arrangement, and no coincidence will be registered. Thus the exponential variation with atmospheric depth in our experience refers to penetrating showers produced locally.

The rapid increase of the number of slow mesons and neutrons with altitude leads us to associate these particles with local penetrating showers of low energy. The high-energy, long-lived mesons, observed at sea-level and underground, are probably produced also in groups, giving rise to extensive penetrating showers. The cross-section for these processes must be of the same order of magnitude or even greater than the value found by us for local penetrating showers. In all these collisions, energetic secondary nucleons can arise and thus the formation of cascades of nucleons and mesons must be expected.

G. Wataghin

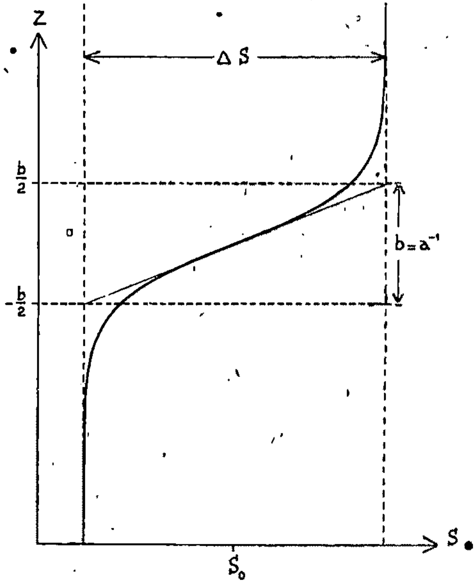
Department of Physics,
University of S. Paulo,
São Paulo. Sept. 23.

[1] *Phys. Rev.*, **71**, 453 (1947). The radiation producing these showers does not show east–west asymmetry at the altitude of S. Paulo, as was shown by P. Saraiva and G. Wataghin.

[2] "Symposium sobre raios cosmicos", *Acad. Bras. Sci.* (1941).

Internal Waves in Certain Types of Density Distribution

Dealing theoretically with internal gravitational waves in vertically inhomogeneous incompressible fluids, many authors have assumed discontinuities, at certain levels, either in the density or in its first derivative with respect to the vertical co-ordinate, z. Fjeldstad, on the other hand, by using numerical integration, gave an approximate solution of the problem for long waves in certain general, continuous density distributions between a free surface and a rigid bottom.



DENSITY DISTRIBUTION REPRESENTED BY A GRAPH OF THE SPECIFIC VOLUME S (THE ABSCISSA) AGAINST THE VERTICAL CO-ORDINATE z (THE ORDINATE)

It has now proved possible to deal with certain continuous density distributions analytically and find complete solutions which are not restricted to the longer wave-lengths.

The density distribution is of the general type shown in the accompanying graph; the relative variation of density is supposed to be small. The fluid is supposed to be incompressible and to be at rest in the non-perturbed state, whereas, in the perturbed state, an internal wave is propagated in the x-direction.

The perturbation is supposed to be small. If we describe the simple harmonic wave motion by means of a stream function

$$\varphi(x,z,t) = \varphi(z) \exp i(mx - nt),$$

it appears that $\varphi(z)$ may be found with, in general, sufficient accuracy as a solution of the equation

$$\frac{d^2\varphi}{dz^2} + \left(\frac{gdS/dz}{c^2 S_0} - m^2\right) \varphi = 0, \qquad (1)$$

where $S(z)$ is the specific volume in the unperturbed state, S_0 is the mean specific volume, $c = n/m =$ velocity of propagation.

As an analytical representation of $S(z)$ we have chosen $S = S_0 + \frac{1}{2} \Delta S \tanh (2z/b)$, where ΔS is the total variation of the specific volume, b is the thickness of the transition layer (see graph). The differential equation (1) then becomes

$$\frac{d^2\varphi}{dz^2} + \left(\frac{g \Delta S}{bc^2 S_0 (\cosh (2z/b))^2} - m^2\right) \varphi = 0. \qquad (2)$$

If the fluid extends to infinity both upwards and downwards, we have as boundary conditions, that φ must remain finite or become zero, when $z \rightarrow \pm \infty$. This is an eigen-value problem.

The differential equation (2) can be solved by means of certain transformations, the solutions being expressed in terms of hypergeometric series. The eigen-values of m, in terms of c, are given by

$$bm = \sqrt{1 + \frac{bg \Delta S}{c^2 S_0}} - (2k + 1), \; k = 0, 1, 2, 3, 4$$

. . ., etc., m being positive.

This yields relations between the wave-length $L = 2\pi\lambda$ and the period $T = 2\pi\tau$, which may conveniently be described by

$$\frac{g \Delta S}{b S_0} \tau^2 = k(k + 1) \left(\frac{2\lambda}{b}\right)^2 + (2k + 1) \left(\frac{2\lambda}{b}\right) + 1.$$

When $\lambda \rightarrow 0$, the period approaches a minimum value for all modes (namely, for all values of k):

$$T_{\min} = 2\pi \sqrt{\frac{bS_0}{g \Delta S}} = 2\pi \sqrt{\frac{S_0}{g(dS/dz)_{\max}}}.$$

It appears that any solution $\varphi_k(z)$ has k zeros for finite values of z; for $z \rightarrow \pm \infty$ it tends to zero exponentially.

It is easy to extend the theory to the case of a rotating fluid (the atmosphere or the ocean on the rotating earth). In this case, the same relation as exists between τ and λ in the previous (non-rotating) case now exists between τ and $\lambda\sqrt{1 - (2\omega_z\tau)^2}$, ω_z being the angular velocity of rotation around the vertical axis.

Further details will be given shortly in a paper by the author in the *Mededelingen en Verhandelingen van het Koninklijk Nederlands Meteorologisch Instituut*, de Bilt, Netherlands.

P. Groen

Koninklijk Nederlands Meteorologisch Instituut,
de Bilt. Sept. 4.

Electronic Waves and Thibaud's 'Particles'

An inadvertent omission from my earlier communication[1] of the universal constant $(-e/c)$, which should multiply the right of equation (5), and, therefore, both sides of equations (11) and (12), involves that the predicted rate of energy loss by electronic wave radiation is now some 14·4 times as large. Writing $v_r = v \cos \theta$, the corrected formula (12) now reads

$$(-ec)\,\frac{\overline{A}_r}{r} = \frac{e^4}{2mc^2} \cdot \frac{v \cos \theta}{r^3} \cdot \psi\psi^* \doteqdot$$

$$(3{\cdot}24)10^{-31}\,\frac{v \cos \theta}{r^3} \cdot \psi\psi^* \quad . \quad . \quad . \quad (12a)$$

The radiation is now seen to depend on an even power of the charge, and so can be of negative sign only for values of θ which make cos θ negative. An element of an electron beam is seen to radiate nothing in its equatorial plane, a maximum in the forward direction, and a negative maximum in the backward direction.

This fact, coupled with the smallness of the numeric in (12a), suggests the conclusion that electrons accompanied by the assumed spherical electronic waves (of low and substantially uniform group velocity) would not lose observable energy in transit. Indeed, integration of (12a) over all possible values of θ gives zero for a cylindrical beam, neglecting complications due to the effects of beam-forming or beam-receiving electrodes. For an expanding beam a small net rate of loss, and for a converging beam a small net rate of absorption of energy are predicted; but for electrons and all heavier particles the effect is negligible, frequently even when the restriction to nearly uniform motion is waived.

If, however, extremely light particles should come in for consideration, these conclusions might well be reversed in respect of such particles. In this connexion we must give careful attention to the beautiful researches of Jean Thibaud[2], in which he seems to establish the mass of the neutrino at $10^{-11}\,m_0$, where m_0 is the rest mass of an electron. In addition, the neutrino is, according to Thibaud, endowed with a charge, small compared with that of an electron. The term 'electrino' is suggested to cover the particle; but since Thibaud finds both positive and negative neutrinos, we should obviously need 'positrinos' as well. From the preliminary values quoted, it would appear that the radiation-rate divided by the kinetic energy of Thibaud's particles may be up to ten thousand times the corresponding ratio for electrons. For such particles moving in a non-uniform electric field, it is conceivable that this brings the radiation loss to an observable order of magnitude.

At all events, Thibaud[2] finds his particles are liable to gain or lose energy when traversing zones of intense gradient: ". . . the particle appears to suffer appreciable loss of energy per unit length of path—loss due doubtless to a radiation which is no longer negligible as for an electron".

W. E. Benham

17 Sandyford Place,
Glasgow, C.3.
Oct. 4.

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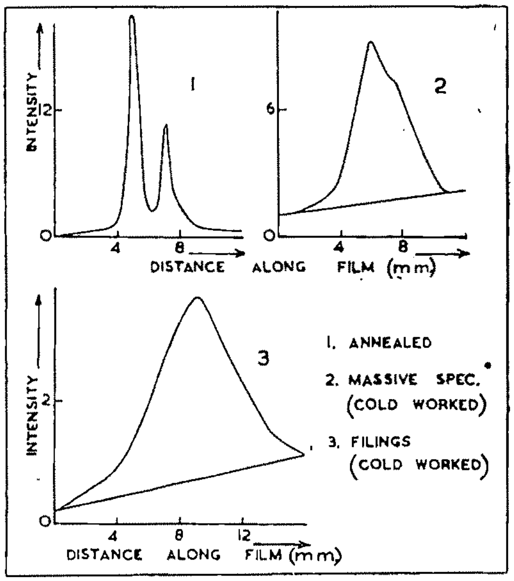
[1] *Nature*, **160**, 160 (1947).

[2] *C.R. Acad. Sci. Paris*, **224**, 739 (1947) (*et aliunde*).

X-Ray Diffraction Rings from Deformed Solid Metal and Metal Powders

The changes in crystalline texture of metals subjected to plastic deformation can be studied by following the increase in diffusion of the X-ray reflexions from the atomic planes. The correct procedure should be always to obtain the reflexions direct from the metal in the normal solid state. But for convenience much work has been based on the circular camera technique, where the test specimen has to be in the form of powder. The metal has been reduced to powder by filing, and measurements made of the breadth and intensity of the X-ray reflexions from the filings. These values have been compared with the breadth and intensity of the reflexions after the filings have been annealed and the effect of deformation thereby removed. The difference has been taken to represent the effect of the cold plastic deformation produced by the action of filing. Then it has been assumed that the same differences would exist between the annealed and plastically deformed state in the solid metal; also that the theoretical conclusions would be applicable directly to interpretation of the structural changes produced by plastic deformation of the solid metal.

We have considered it worth while examining these assumptions by experiment. The results are interesting and may serve to direct attention to a factor which does not appear to have been recognized in previous work.



We have compared the diffraction rings from solid metal, in the form of flat tensile specimens of iron, with the diffraction rings of filings taken from the same specimens. The tensile specimens were plastically deformed by stretching to increasing extents in order that a measurement might be made of the characteristic maximum diffraction broadening which, it has been shown, is reached after progressive deformation, and which has a specific value for a particular metal[1]. This maximum line-broadening was then compared with the breadth of the diffraction rings from the filings. For this purpose the filings were formed into a flat layer of powder, so that they might be examined by X-rays under exactly the same conditions as the flat tensile specimens.

The tests showed that the diffraction rings from the filings in all cases were broader to a striking extent than the maximum broadening obtained from the deformed solid specimens. The effect is illustrated by the accompanying microphotometer traces, obtained by traversing the typical (310) diffraction ring given by cobalt $K\alpha$ radiation. Fig. 1 is from the annealed strain-free metal, and shows the sharply resolved α_1- and α_2-components of the diffraction ring. Fig. 2 shows the broadening of the ring when a tensile specimen is extended by the amount giving the maximum diffusion; at this stage the α_1- and α_2-components are just discernible in the original photograph. Fig. 3 shows the much broader ring obtained from filings; the α_1- and α_2-components have diffused into a single halo, and, in fact, measurements indicated that the line-width was approximately twice the maximum obtainable from the solid metal. The filings referred to in Fig. 3 were taken from an annealed test specimen and represent the least deformation introduced by the action of filing. Filings taken from the plastically deformed specimens tended to give rings which were even broader. The above comparison proves, therefore, that the physical condition of the filings cannot be taken as representative of the condition of the plastically deformed solid metal, as it has been in the past.

We think the explanation will follow from recent observations on the stress-strain curves for the atomic lattice. This work, carried out on metals in the normal solid state, has shown that homogeneous plastic deformation leaves the iron lattice with permanent strains which are directional[2]. Thus after a tensile test-piece has been extended in tension the lattice spacings perpendicular to the axis remain with a residual compression, while spacings parallel to the axis exhibit an expansion, and spacings at intermediate inclinations vary in a regular manner between the two extremes. The diameter of a diffraction ring from such a specimen, since diameter depends on spacing, varies according to the angle between the reflecting planes and the axis of the specimen. This variation does not affect the inherent diffusion of the diffraction ring, because only one direction relative to the axis is photographed at one time; thus the ring can have an enlarged diameter or a contracted diameter, but not a range of diameters. If, however, the metal is reduced to filings, then the lattice expansions and contractions will be oriented at random in the powder. The diffraction ring in a photograph from the filings will be the resultant of rings varying in diameter between the extremes which correspond to the most expanded and most contracted values. Therefore the ring will possess an abnormal and adventitious diffusion in which the inherent broadening characteristic of deformation of the solid metal will be lost.

This view could be tested by measurements of the mean diameter of the diffraction rings from the solid specimen and from the filings. The broad back-reflexion ring from a stretched tensile test-piece photographed with the incident X-ray beam at right angles to the specimen showed an increase over the same ring from the undeformed material; this corresponded to a directional increase in the lattice spacing parallel to the axis, which would be expected from the above-mentioned work. The broader ring from the deformed filings, however, showed no change compared with the annealed material. This confirmed the view that the deformed filings contained a mixture of tensions and compressions oriented at random in a manner which is foreign to the deformed metal in the solid state.

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W. A. RACHINGER

Baillieu Laboratory,
University of Melbourne.

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[1] Wood, W. A., *Proc. Roy. Soc.*, A, **172**, 231 (1939).

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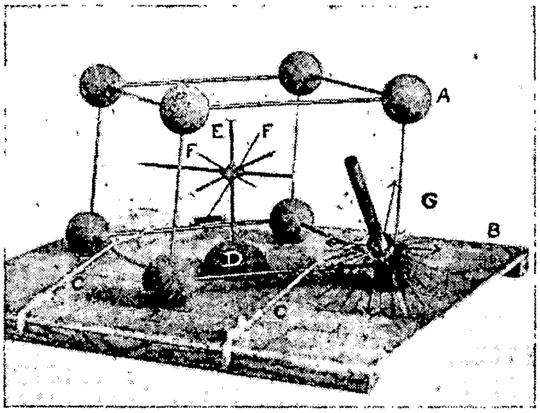
A Simple Universal Model for Representing the Optic Orientation of Biaxial Crystals

IN dealing with crystals of low symmetry, a model showing the orientation of the indicatrix axes with respect to the external form helps greatly in visualizing the optical characters which will be presented by sections parallel to different faces. I have found the model described below extremely useful for this purpose, both in the study of new material and as an aid to the appreciation of published optical data. It is readily constructed from simple materials and can be adjusted to represent the optic orientation in any biaxial crystal to a degree of approximation which depends mainly on the data available.



The external form of the crystal is represented by the framework *A* (see figure), which is built up from cork balls and finely pointed brass rods, the correct angles being secured by comparison against paper templates. It usually suffices to show only the principal faces developed, for it is the sections parallel to these faces which are likely to be of most interest. The approximate inclination of secondary faces with respect to the indicatrix axes can be judged by holding a sheet of mica against the framework in the appropriate position. Only a few sets of rods are needed to build up a wide variety of models, convenient lengths being 4, 6, 8 and 10 in. The framework is secured by spring-tensioned cords *C* to the plywood baseboard *B*, in the centre of which is glued one half of a large cork ball *D*, serving as support for the indicatrix axes *E*. Each axis carries at one end a small disk marked with the appropriate symbol, while the other end is prolonged and finely pointed. By thrusting one or other of these pointed ends into *D*, the axes can be erected in any orientation with respect to the framework *A*. Two thin wires *F*, pivoted on β, represent the optic axes and can be set at any angle.

The case shown in the figure is that of the monoclinic $K_2SO_4,MgSO_4,6H_2O$ with {001} and {110}, and will serve to illustrate the use of the model. The axial plane is (010), $2V$ is 48° (+), and X is almost normal to (001), so that sections parallel to this face give a nearly centred obtuse bisectrix figure, as is immediately apparent from the model. The emergence of the optic axes, and thus the type of interference figure, on a {110} face may be made out very clearly by shifting the framework (while preserving the correct orientation with the aid of the squares marked on the baseboard) so that the axes project through the face. The extinction directions on the face may be determined by means of the sighting protractor G. This consists of a thin glass plate marked with two double arrows at right angles, and thinner radial lines at intervals of 10°. At the centre of the plate and at right angles to it is cemented a short length of thin brass tubing. The model is supported on the floor by means of a stand and clamp, with the face in question horizontal and uppermost. A thick sheet of mica is laid across the face, and on top of this is placed the protractor, which is then moved until, on looking from above, the origin of the indicatrix axes is seen to be in line with the axis of the brass tube and the double arrows bisect the projected angles between the optic axes. By the law of Biot and Fresnel the arrows then represent the extinction directions on the face. With a carefully constructed model this method gives the correct extinction angle to within about 5°. A rougher but more convenient method is simply to view the optic axes through the face, along a direction normal to it as nearly as can be judged, and find the positions at which a rod laid across the face bisects the projected angles between these axes.

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Mode of Action of Acridine Antibacterials

Two years ago, it was shown[1] that, in a series of 107 acridines, marked antibacterial activity was, for the most part, confined to those substances which exist mainly in the form of cation at pH 7·3. Apparent exceptions to this rule have since been examined more closely and some important gaps in the series closed.

1-Hydroxyacridine, which possesses antibacterial activity greatly in excess of what could be predicted from its feeble ionization, has been shown to owe this biological effect to an entirely different chemical property, namely, to its ability to combine with metabolically important trace metals. This has opened up a fruitful field of investigation, with the result that antibacterial properties ascribable to this metal-chelating effect have been demonstrated in several other heterocyclic series that bear a hydroxyl-group *ana* to a ring-nitrogen[2].

The enhanced activity of 5-amino-1-hydroxyacridine is a further example of this phenomenon, but two of its isomerides seemed to form exceptions to the cationic rule. Using an approximate correction to derive the pK_a value in water from the pK_a value as determined in 50 per cent alcohol, it appeared that 5-amino-2-(and -3-)hydroxyacridines were sufficiently well ionized (71 and 98 per cent respectively) to command a greater antibacterial activity than was actually found. Re-examination of all four hydroxy derivatives of 5-aminoacridine has shown, rather surprisingly, that they produce a high proportion of zwitterions at pH 7·3, an effect not previously reported for simple phenolic amines. The use of a Hilger absorptiometer has permitted determination of the pK_a values directly in water[3], thus dispensing with the correction which is inapplicable when zwitterionic species are present. The corrected figures are given in the accompanying table (Nos. 22–25; the numbering of the previous paper[1] is retained for ease of reference). It is seen that the new values fall into line with those obtained from the other acridines and add further support to the correlations already found.

The synthesis of 1 : 5- and 4 : 5-diaminoacridines (Nos. 2*a* and 4*a*) completes the set of amino-derivatives of the important antibacterial, 5-aminoacridine. These showed antibacterial activity of the intensity expected from their high degree of ionization.

The inclusion of 2-dimethylaminoacridine (47*a*) provides the first tertiary mono-aminoacridine for the series. The lowered response to Gram-negative organisms (compared with the corresponding primary amine) forms the third example of such an effect in this series (the others being 2 : 8-*bis*dimethylaminoacridine and 2-dimethylamino-7-aminoacridine). This suggests that hydrogen bonding may make a contribution to the action of the primary amines on these bacteria.

No.	-acridine	Highest dilution completely inhibiting growth after 48 hr. at 37° C. (Medium : 10 per cent serum broth, pH 7·3)					Sum of inhibitory indices	pK_a in water at 20° C.	Per cent ionized as cation at pH 7·3
		Cl. welchii	*Strept. pyog.*	*Staph. aur.*	*B. coli*	*Proteus*			
2*a*	1 : 5-Diamino-	5	5	4	4	4	22	9·3	99
4*a*	4 : 5-Diamino-	5	5	3	3	2	18	11·0	100
22	5-Amino-1-hydroxy-	5	5	3	3	3	19	7·1	39
23	5-Amino-2-hydroxy-	2	4	0	0	0	6	6·6	17
24	5-Amino-3-hydroxy-	4	6	2	0	0	12	7·7	72
25	5-Amino-4-hydroxy-	3	3	1	0	0	7	5·6	2
47*a*	2-Dimethyl-amino-	5	5	3	2	0	15	8·3	91

Key to dilutions : 0 signifies growth at 1 : 5,000 ; 1 signifies inhibition at 1 : 5,000 ; 2 signifies inhibition at 1 : 10,000 ; 3 signifies inhibition at 1 : 20,000 ; 4 signifies inhibition at 1 : 40,000 ; 5 signifies inhibition at 1 : 80,000 ; 6 signifies inhibition at 1 : 160,000.

We thank Prof. S. D. Rubbo for the bacteriological testing and Mr. J. N. Phillips for experimental assistance.

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Arsenolysis and Phosphorolysis of the Amylose and Amylopectin Fractions of Starch

Doudoroff, Barker and Hassid[1] showed that the addition of arsenate to sucrose phosphorylase from *Pseudomonas saccharophila* catalyses the decomposition of sucrose to glucose and fructose, the reaction being:

$$\text{sucrose} + H_2O \xrightarrow[\text{arsenate}]{\text{sucrose phosphorylase}} \text{glucose} + \text{fructose}.$$

We have found that the addition of inorganic arsenate to potato phosphorylase will also cause the liberation of glucose from starch according to the reaction:

$$\text{starch} + H_2O \xrightarrow[\text{arsenate}]{\text{potato phosphorylase}} \text{glucose}.$$

Apparently an intermediate glucose-1-arsenate is formed which does not accumulate but is decomposed rapidly to glucose and arsenate.

However, there is a distinct difference in the limit to which arsenolysis of amylose and of amylopectin proceeds when potato phosphorylase is used. Whereas amylose is practically completely decomposed to glucose by this enzyme in the presence of arsenate, amylopectin is degraded in this process only to approximately 54 per cent (see table).

Likewise, it has been observed that potato phosphorylase acts towards amylose and amylopectin in a similar manner in the process of phosphorolysis. Under conditions in which the amount of amylose is insufficient to allow equilibrium to be reached between glucose-1-phosphate and inorganic phosphate, the amylose is almost completely phosphorolysed to glucose-1-phosphate, but only about 57 per cent of the amylopectin is converted to this ester.

It is interesting to note that such behaviour is characteristic also of β-amylase[2]. In the well-known hydrolytic reaction, amylose is broken down by β-amylase almost completely to maltose, while amylopectin is degraded by this enzyme only to the extent of about 55 per cent. It can therefore be postulated that, like β-amylase, potato phosphorylase acts upon the branched amylopectin through the process of arsenolysis or phosphorolysis, attacking the non-reducing ends, splitting off successive terminal glucose fragments (β-amylase splits off maltose), until it encounters an obstruction. The obstruction is considered to be a modified structure, which is a 1,6-glucosidic linkage at or near the point of branching. With amylose, which has an unbranched structure and therefore no such linkages, arsenolysis or phosphorolysis continues until the whole molecule is degraded. This difference in behaviour of potato phosphorylase towards the amylose and amylopectin components of starch constitutes further evidence that the former component is linear while the latter is branched.

PHOSPHOROLYSIS AND ARSENOLYSIS OF AMYLOSE AND AMYLOPECTIN

Enzyme digest for phosphorolysis consists of 0·05 *M* sodium phosphate and 0·05 *M* sodium maleate buffers at *p*H 6·65, 2 ml. potato phosphorylase preparation. Total volume of digest, 8 ml. Incubation at 30°.

Enzyme digest for arsenolysis consists of 0·05 *M* sodium arsenate and 0·05 maleate buffers at *p*H 6·65, 6 ml. of potato phosphorylase (different preparation than used above). Total volume of digest, 36 ml. Incubation at 30°.

Substrate	Starch added (mgm./ml.)	Starch phosphorolysed (as percentage of total glucose esterified, ± 3) after		Starch arsenolysed (as percentage of total glucose esterified, ± 3) after	
		4½ hr.	7 hr.	12 hr.	24 hr.
Potato amylose	1·0	102	100	88	89†
,,	2·0	66	65*	85	88†
,,	4·0	35	35*	—	—
Potato amylopectin	0·5	56	60		
,,	1·0	57	58	51	54
,,	2·0			48	53
Tapioca amylopectin	0·5	56	58		
,,	1·0	55	56		

* Starch incompletely phosphorolysed because equilibrium between glucose-1-phosphate and inorganic phosphate had been reached. Excess of starch does not affect the equilibrium.

† The fact that the reaction does not go to completion is probably due to the small amount of retrogradation of amylose that occurs during the experiment.

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Reaction of Boric Acid with Polysaccharides

MANY polyhydroxy compounds of low molecular weight are known to form complexes with boric acid in aqueous solutions, as numerous investigations (Böeseken *et al.*) have shown. These complexes are much more easily obtained from cyclic glycols possessing the *cis* configuration than from the *trans* isomers. One boric acid molecule may react with either one or two 1,2-glycol molecules; in the latter case a 'boron spirane' is formed.

No systematic and theoretical investigations concerning boric acid – polysaccharide compounds have been published. Irany[1] studied the effect of boric acid on various substances of high molecular weight in the absence of water. Cross-linking was observed especially in substances in which the macromolecules carried non-adjacent hydroxyl groups. The Pharmacopœia Helvetica V mentions the incompatibility of borax with gum arabic (gel formation). The gelification of aqueous solutions of *Ceratonia siliqua* mucilage by borax has been observed repeatedly[2].

It is to be expected that polysaccharides characterized by adjacent hydroxyl groups in the *cis* configuration will form boron spiranes in the presence of water. If chain molecules are employed, this reaction should lead to the formation of three-dimensional networks (gelification). Experiments with numerous polysaccharides of known composition[3] have shown that only those substances possessing the postulated configuration tend to form chelate esters: mannan from tubers of *Orchis morio*, mono-glycol ester of alginic acid (polymannuronic acid) and galacto-mannans from the endosperm of *Ceratonia siliqua* and *Trigonella fœnum græcum*. Aqueous solutions containing even less than 0·3 per cent polysaccharide are transformed into jellies by the addition of borax, provided that the degree of polymerization of the chain molecules is sufficiently high. Because of its more spherical macromolecules and its low content of rhamnose[4], gum arabic, even at extremely high concentrations, possesses only a small tendency to jellify. Aqueous solutions of the methyl and mono-glycol ester of pectic acid (polygalacturonic acid) do not jellify when borax is added. However, cross-linking takes place, if the monoglycerol ester which carries the required diol group is used.

All the above-mentioned jellies are not formed under acidic conditions. The gels are liquefied by treatment with compounds of low molecular weight which are known to form complexes with boric acid (for example, mannitol, fructose, glycerol, but not sucrose). Their mechanical properties (ropiness, plasticity) can be explained on the assumption that the cross-linkages are not fixed but perpetually destroyed and rebuilt.

It is of interest to note Lopatkin's observation[5] on the agglutination of *B. Shiga-Kruse* by boric acid. This micro-organism produces a polysaccharide which contains rhamnose[6]. Certainly many other mucilages found in animals, plants and micro-organisms will react with borax in a similar manner to the above-mentioned substances. The reaction described might prove to be valuable to macromolecular chemistry and bacteriology. Adjacent hydroxyl groups in the *cis* configuration can thus be identified.

These investigations will be published in full elsewhere.

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Constitution of Monazite

X-RAY examination of monazite has been carried out by Hadding[1], Gliszczynski[2] and Parrish[3], and the space group and crystal class uniquely determined. According to Goldschmidt[4], the thorium which is usually present is 'captured' during crystallization of the phosphate from its parent magma because of its favourable ionic size. To compensate for the increased cationic charge of the thorium ion, the resulting lattice must possess a defect structure in which some of the sets of equivalent cationic positions are only partially occupied. The quantity of thorium which can be tolerated in such a structure is not known, but monazites the thoria content of which varies from nil to at least 18 per cent (approximately 0·2 atoms per atom of rare earth element) have been reported[3,5].

While there is agreement about the gross structure of the mineral, the role of certain minor constituents, particularly silica, has not been satisfactorily explained[5]. Many components reported in monazite analyses are undoubtedly due to the presence of a considerable proportion of extraneous heavy minerals which, because of high specific gravity or other factors, have not been removed from the sample. This is the case with much of the iron, tin, chromium, titanium, and probably zirconium in samples of alluvial or littoral origin. Petrographic examination reveals that even single crystals of monazite are seldom free from inclusions of foreign substances. Microscopical observations reveal a much greater degree of homogeneity, however, in some fine-grained monazites obtained from beach sands, natural processes having effectively separated the grains from associated minerals.

The proportion of inclusions in such material is scarcely sufficient to account for the percentage of impurities given by chemical analysis of the sand, even after allowance has been made for the small quantity of extraneous material (insoluble in sulphuric acid) which remains in the sand after repeated magnetic and other separations. It is not unreasonable, therefore, to suppose that some at least of the 'impurities' occupy positions in the lattice of the mineral, for example, silica (usually present to the extent of about 0·5–1 per cent), lime (about 0·2 per cent), urania (about 0·2 per cent UO_2), and other oxides in smaller amounts. Thus calcium and tetravalent uranium, like thorium, could be easily accommodated because of favourable ionic size[4,6].

Marshall[7] has commented on the replacement of silicon by phosphorus in certain silicate structures. A similar replacement appears to occur in certain varieties of zircon rich in phosphorus[8]. The reverse phenomenon is observed in the apatite minerals wilkeite[9] and ellestadite[10], and in the mineral abukumalite, for which Shin Hata[11] has found the ratio Si/P to be 4. The replacement of silicon by phosphorus arises from the comparable size and regular tetrahedral structure of the groups SiO_4 and PO_4[6,12,13]. The possibility arises, therefore, that silica in monazite is present in the phosphate lattice to the extent of about 1 silicon atom for 23 phosphorus atoms. A defect structure with some unoccupied anionic positions would compensate for the increased charge of the phosphorus ion. Conceptions such as these would account both for the variable quantities of thorium and silicon in the lattice and for the variable thorium to silicon ratio observed, thus overcoming the difficulties of the earlier theory of solid solution of thorium silicate in rare earth phosphate, a theory which was shown to be untenable because it demanded constancy of the thorium to silicon ratio.

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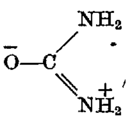
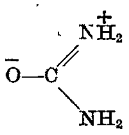
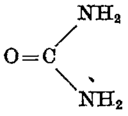
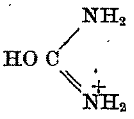
Structure of Urea

Considerable evidence[1] has been presented for the polar structures I and II as important contributory forms of urea in aqueous solution and in the solid state. This view has been criticized by Bell, Gillespie and Taylor[2] on the grounds of electrometric titration data. The observation that buffering of urea solutions can only be detected at low *p*H values has been interpreted by these authors to mean that urea is a weak monacid base having the uncharged structure III. This result, however, would appear to be compatible with the polar structure of the molecule.

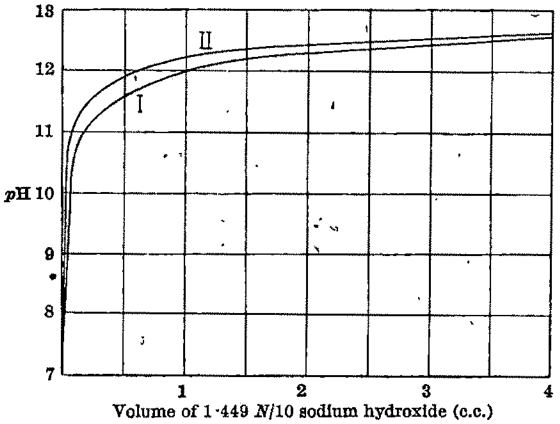

I


II


III


IV

Either resonance structure I or II may be regarded as a substituted amidine in which the normal basic strength of this group has been considerably increased by the strong anionoidal characteristic of the attached O^- ($+I$; $+T$). This amidine ion would impart strong acid properties to the hydroxyl group of structure IV, of which urea may be regarded as the acid ion. The acid titration of urea may then be regarded as the back titration of a strong acid ($K > 10^{-1}$), and the alkaline titration as the back titration of a strongly basic substituted amidine, of such strength that buffering is absent in aqueous sodium hydroxide (cf. Bjerrum[3] on the titration data of amino-acids).



I, 10 c.c. $N/100$ benzamidine hydrochloride; II, 10 c.c. water

In support of this view the titration of benzamidine hydrochloride with sodium hydroxide (see graph), in which the O^- of urea may be regarded as having been replaced by the less anionoidal phenyl radical, shows slight buffering. The dissociation constant as computed from these data is of the order of $K_{20} = 10^{-2 \cdot 3}$.

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Spread of Detonation in High Explosives

In a recent communication[1], W. C. F. Shepherd makes the interesting observation that in the initial stages of detonation in a cylindrical cartridge of high explosive initiated with a detonator, a phase, referred to as the pre-detonation phase, is often noticeable during which the rate of propagation of the reaction is much lower than the stable value finally established. Moreover, "with progressively stronger initiators, the extent of the pre-detonation phase was correspondingly reduced and the rate of propagation during this phase was increased until, finally, there was no perceptible delay in the inception of detonation".

Having had occasion to study this phenomenon, we can confirm that, in certain high explosives, the detonation set up by a detonator may be of a lower order than that which eventually develops. In such cases, there is an initial unstable phase during which the reaction accelerates more or less rapidly until a point is reached at which the rate of detonation changes abruptly to a much higher value. This phenomenon is fairly common among liquid and gelatinous explosives and is illustrated in photographs Nos. 2, 7 and 10 of a previous paper by one of the present writers[2]. It is not generally known, however, that this effect can be produced in granular solid explosives like crystalline or granulated T.N.T. or tetryl, and that, under suitable conditions, such explosives exhibit the property, usually attributed only to liquid and gelatinous explosives, of being able to propagate detonation at two distinct velocities.

Fig. 1

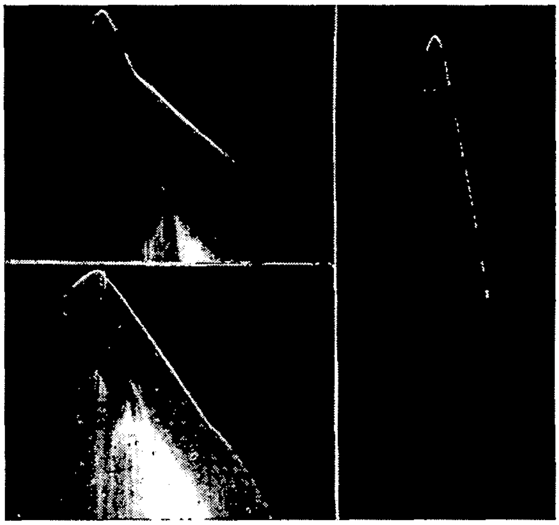

Fig. 3 Fig. 2

The photograph reproduced in Fig. 1 illustrates the case where the initial regime is unstable and, after travelling a certain distance, changes abruptly to the higher detonation level. This record, which is almost identical with that of Shepherd, was obtained with a 1-in. diameter cartridge of granulated tetryl, size 20–30 B.S.S., cartridged at a density of 0·94 gm./c.c. and initiated with a No. 6 A.S.A. detonator. As Shepherd points out, the length of the initial phase varies with the strength of the initiator and can be eliminated altogether by using a sufficiently powerful initiator. Another interesting feature is that it also depends on the grist of the explosive, the density of packing, and the diameter of the cartridge. With high-density compressed cartridges, as used by W. Weibull[3], the high-velocity regime is usually set up immediately, even with detonator initiation. On the other hand, with low-density packing, as used by Shepherd, the low-velocity regime may be initiated first. In the latter case, by using a sufficiently narrow cartridge, or, alternatively, a sufficiently coarse grist of explosive, the low-order detonation can be made to travel throughout the full length of the cartridge (at least a metre) at a rate which is both uniform and repeatable. It appears, therefore, that the explosive has a specific and stable 'low' velocity of detonation under these conditions. On the other hand, if a sufficiently powerful initiator is used, the same cartridge propagates detonation at a greatly enhanced speed, the rate of detonation being again uniform and repeatable.

Figs. 2 and 3 illustrate this point and show the 'low' and 'high' velocities of detonation in identical cartridges of granular solid explosive. The explosive in this case was flake T.N.T., size 20–30 B.S.S., cartridged at a density of 1·0 gm./c.c., the diameter of the cartridge being 1 3/16 in. The cartridge in Fig. 2 was initiated with a No. 6 A.S.A. detonator and gave a velocity of detonation of 1,120 m./sec.; that in Fig. 3 was initiated with a 12·5 gm. tetryl pellet and gave a velocity of detonation of 3,660 m./sec. The length of the cartridge in each case was 10 in., but tests with cartridges up to 1 metre in length showed no indication of any significant change in velocity of detonation with distance along the cartridge.

It is interesting to note that the low-velocity detonation appears to be characterized by incomplete decomposition of the explosive in the sense that some of the original explosive remains chemically unchanged. Visual evidence of this is to be found in the fact that the cloud formed on detonating T.N.T. or tetryl in the open appears white when detonation occurs at the low velocity and black when the high velocity is operative. It will also be seen from the photographs, especially Fig. 1 where the transition point is represented, that the luminosity is much more intense in the high-velocity region than in the low. The presence of undecomposed explosive in the residue remaining after a shot has also been confirmed by chemical tests; and it is remarkable that, even with a sensitive explosive like nitroglycerine, a considerable proportion of the explosive may be scattered without decomposing if the cartridge is below a certain diameter and is initiated with a detonator below a certain strength.

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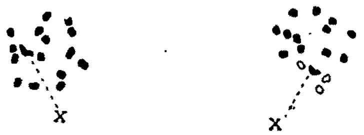
Chromosome Number of *Sesamum laciniatum* Klein

Sesamum laciniatum is a wild species which is reported to occur with another wild species, *S. prostratum* Retz., in south India[1]. The two species resemble each other closely in their morphological characters except for the fact that the leaves of *S. laciniatum* are more deeply pinnatifid than those of *S. prostratum*. Besides these two wild species, the only other representative of this genus in India is *S. orientale* L. (= *S. indicum* D.C.), which is the common cultivated *til*.

Cytogenetical studies on *S. orientale* and *S. prostratum* have been in progress in this laboratory for some years past[2,3,4]. Attempts were made to collect seeds of *S. laciniatum* for the inclusion of this species in the studies in progress, and some were obtained in November 1945 through the courtesy of one of the postgraduate students of this Division, Mr. Syed Murtaza Hasan, who collected them from plants growing in the vicinity of Hyderabad (Deccan). More seed of this species was also obtained later from plants growing in the Coimbatore district in South India.

Fig. 1



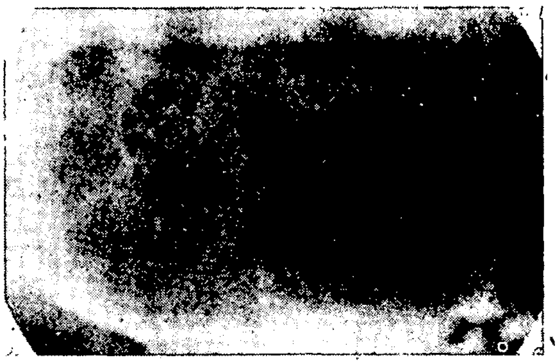


Fig. 2

The seeds were germinated after removing their tough seed coats, and a few plants were raised to maturity and identified as belonging to the species *S. laciniatum*. Aceto-orcein preparations of pollen mother cells were examined for chromosome number. It was noticed in a large number of cells, at metaphase II, that the chromosomes were distributed as 16 + 16 at the two poles (Figs. 1 and 2). The somatic chromosome number of this species was also determined in the root-tip cells as 32 (Fig. 3). It is not surprising that the chromosome number of this species is the same as that of *S. prostratum*, namely, $2n = 32$, considering its close similarity to the latter in morphological characters and distribution in Nature. One peculiarity was, however, noticed in that almost invariably, at second meiotic metaphase, one chromosome in each group of daughter chromosomes was very much less stained than the others and also showed very much less condensation (Fig.

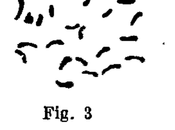


Fig. 3

1, *x*). Further studies on this species are in progress.

It may be mentioned in this connexion that recently Raghavan and Krishnamurthy[5] have reported the chromosome number of this species as $2n = 28$.

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Mustard-gas Mutation in *Aspergillus nidulans*

THE production of 'biochemical mutants' of fungi by means of ultra-violet or X-radiation has been reported by Beadle and Tatum[1,2] (*Neurospora* spp.), Fries[3,4,5,6] (*Ophiostoma* spp.) and Pontecorvo[7] (*Aspergillus* and *Penicillium* spp.). Following the use of mustard-gas (β,β′-dichlorodiethyl sulphide) in producing mutations in the vinegar fly (*Drosophila melanogaster*) by Auerbach and Robson[8], this reagent has been used by Horowitz *et al.*[9] to produce mutations in *Neurospora* spp. A method for isolating strains of *Aspergillus nidulans* deficient for a specific amino-acid, cystine, from a mixture of mutants produced by mustard-gas, is now described. These special mutants grow normally in presence of cystine but are unable to grow with sulphate as sole sulphur source.

A dark green 'conidial' strain of the mould, called *A*69 by Dr. Yuill who kindly supplied it, was found by Dr. Pontecorvo to be particularly suitable for the production of X-ray mutants. Seven-day cultures on 10 cm. Petri dishes of maltwort-agar were each exposed to the vapour from three drops of mustard-gas on a 3·5 cm. Whatman No. 1 paper ; ⅜-in. disks of mycelium were removed. Those in which the viable count had dropped to about 3,000 (on cystine-containing medium) were used for isolation of mutants. Spore-suspension from a disk was incubated for 16 hr. in a thin layer of liquid cystineless medium (sulphate as source of sulphur). The suspension was then filtered through glass wool to remove a greater part of the already germinated spores, that is, those capable of using sulphate. By this means the number of viable spores were reduced 10–15 times. The technique is an adaptation of one used by Fries[10]. The resultant suspension was plated on cystine-containing medium.

At this stage in various experiments there have been noted morphological mutants of many types ; for example, white, yellow, yellow-green and cinnamon 'conidial' types, many white and one purple 'mycelial' types, 'perithecial' types and pigment producers. In the experiment quoted, 68 different morphologues (mostly white types) appeared from 640 viable spores. A control test on non-exposed material gave two morphologues out of 1,480. Dr. Pontecorvo has made similar observations on X-ray mutations.

Material from each colony was inoculated on to solid cystineless medium. Those inoculations which only grew a few spidery threads were tested on cystineless and cystine-containing media. Those giving no growth or only a few spidery threads on the former were checked against both media again. Four such isolates were obtained.

To date, thirteen such mutants have been obtained. Some of these tested by Dr. Pontecorvo form 'balanced' heterokaryons with some of his mutants deficient for certain amino-acids.

Full details of media, methods and observations on the exact nature of the biochemical deficiencies will be published elsewhere.

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A Vasodilator, Adrenolytic Substance in Aglomerular Fish Kidney

EXPERIMENTS were performed on aglomerular fish kidneys to establish the presence or absence of vaso-active substances. This communication deals with the presence of an adrenolytic, vasodilator substance in extracts of the aglomerular kidneys of the toadfish (*Opsanus tau*). The material extracted was tested for its vasodilator properties on the peripheral blood vessels and capillaries of the frog (*Rana pipiens*), and also for its adrenolytic ability, that is, ability to neutralize and protect against the vasoconstrictor effect of epinephrine.

Material and Methods. Toadfish (*Opsanus tau*), a marine fish which is a normal inhabitant of the deep waters of the Atlantic coast, were obtained by seining in Buzzards Bay off Woods Hole, Mass., and brought to the Marine Biological Laboratory. The fish were kept in aquaria supplied with a continuous stream of sea water and treated as indicated below. The fish were removed from the aquarium and placed in a solution of sea water containing 5–7·5 per cent of ether, C.P. Some fish were anæsthetized by being placed in a bucket containing cracked ice. The fish used varied in size from 8 to 10 in. in length. When anæsthetized, they were placed in a holder ventral side uppermost, and the abdomen opened by a V-shaped incision, commencing above the anal aperture, and extending anteriorly along both sides up to the pectoral fins. The kidneys were dissected free and weighed. Immediately after weighing, they were ground with sand and acid alcohol (95 per cent ethyl alcohol to which 0·1 per cent concentrated sulphuric acid had been added ; *p*H approximately 3·5). After being thoroughly homogenized, enough acid alcohol was added to make the final volume approximately 4 ml. for each gram of kidney. Material and solvent were then placed in a shaker, shaken for twelve hours and treated further according to the method previously published[1,2].

The final product was dissolved in distilled water in an amount in which 1·0 ml. represented the equivalent of material obtained from 1·0 gm. of toadfish kidney. In preliminary chemical tests, it was found to be protein-free (sulphosalicylic acid test), negative with the biuret test, *p*H 4·5–5·0.

The vasodilator effect was studied in the web of medium-sized frogs (*Rana pipiens*). Frogs were pithed and the circulation in the web was observed with a low-power microscope. In the control studies of ten frogs, the diameter of the capillaries was 12–15 microns. The amount of epinephrine injected sufficient to bring the circulation in the web to a standstill was determined by injecting increasing doses beginning with 10 gamma of stock solution (1 : 100,000). 1 ml. of toadfish kidney extract prepared as indicated above was then injected into the lateral lymph sac, and the effect on the capillary vessels, a-v anastomoses, arterioles and venules observed. After the effect was fully established, amounts of epinephrine equal to that required to arrest the circulation were then injected, as well as multiple dosages (2–10 times the amount). In the ten frogs thus studied, all showed a definite increase in the diameter of the capillaries to 20–30 microns following the injection of toadfish kidney extract. In nine out of ten frogs there was complete protection against subsequent administration of epinephrine in doses varying from 100 to 500 gamma (1 : 10,000–1 : 2,000).

Similar results have been reported with an extract obtained from mammalian kidneys, named 'tubulin'[3].

Extracts of toadfish liver similarly prepared failed to produce vasodilation or neutralize or protect against epinephrine in similar dilutions.

A more extensive report of these studies will be published in the near future.

I wish to express my thanks to Dr. Charles Packard, director of the Marine Biological Laboratory, Woods Hole, Mass., for the material and laboratory facilities made available for these studies.

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Quantitative Relation Between Salt Accumulation and Salt Respiration in Plant Cells

LUNDEGÅRDH[1,2] has shown how the salt or anion respiration could provide a mechanism of accumulation by transporting anions into the cell. This hypothesis postulates a mechanism whereby anions are transported by an electron carrier (probably cytochrome) in the direction opposite to electrons, and whereby cations exchange for hydrogen ions; both electrons and hydrogen ions enter into the formation of water in the respiratory process. Both ions of a salt are accumulated.

If the Lundegårdh hypothesis is valid, the maximum rate of accumulation should occur when each electron leaving via the oxidase system is exchanged with an anion from the external solution. In this respiration all the molecular oxygen concerned in the process is combined to form water, and each molecule of oxygen therefore requires four electrons and four hydrogen ions. The maximum rate of salt accumulation should therefore be 4 gm. mol. monovalent salt accumulated per gm. mol. oxygen utilized, or,

$$\frac{\text{salt accumulation}}{\text{salt respiration}} = 4.$$

This quantitative relationship is not shown in Lundegårdh's results[3]; but experiments with carrot tissue indicate that, under appropriate conditions, the ratio approaches the theoretical value.

In all experiments, the salt respiration-rate has been taken as the difference between the rate in water and rate in salt solution, which, in well-washed carrot tissue, is equivalent to the cyanide-sensitive respiration[4]. The rate of accumulation, taken over the few hours immediately after the initial equilibration[5], is at its maximum. The results of experiments with various batches of carrots are given in the accompanying table.

Concentration of potassium chloride	No. of observations	Mean of ratio $\frac{\text{Accumulation-rate}}{\text{Respiration-rate}}$
0·00063 *M.*	2	0·44 ± 0·16
0·00125	2	1·60 ± 0·73
0·0025	1	2·09
0·005	6	2·26 ± 0·41
0·01	19	2·88 ± 0·84
0·02	16	2·78 ± 0·62
0·03	4	3·00 ± 0·23
0·04	6	3·17 ± 0·79
0·05	8	3·39 ± 0·70
0·06	4	3·38 ± 0·37

At the higher concentrations the ratios approach the hypothetical value. Both salt accumulation and salt respiration-rates increase asymptotically with increasing concentration, but the salt respiration-rate approximates to the asymptote at lower concentrations than does the salt accumulation-rate. This accounts for the significantly lower ratios observed at low concentrations. Results of the same order of magnitude have been obtained with other halides on carrot tissue, and with beet tissue[6] and barley roots[7].

Comparison of these with other relevant data in the literature indicates that: (1) low concentrations give low ratios; this probably accounts for the low ratios calculated from Lundegårdh's results with low concentrations of salt on wheat roots; (2) at higher concentrations when neither accumulation nor salt respiration is limited, the ratio approaches that required by the theory of ion transport by an electron carrier.

This work will be published in full elsewhere. We wish to express our thanks to Prof. J. S. Turner and Dr. J. R. Vickery.

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Aggression, a Component of Post-Epileptic Automatism in *Peromyscus*

CONVULSIVE seizures of rodents have been described in rats[1-4] and in *Peromyscus*[5]. Although various types of convulsive seizures exist, the epileptic form is common to all the strains of animals in which a seizure can be precipitated by specific sounds (audiogenic), and is also induced by other methods. This type has the following general form: a period of disorientated running is succeeded by a clonic phase or by clonic-tonic convulsions, terminating either in a spastic state, catalepsy or exhaustion.

Our studies on a strain of epileptic *Peromyscus* (*maniculatus-artemesiæ*, received from Dr. L. R. Dice, Ann Arbor, Michigan) have revealed a new component of the behaviour in the post-convulsive phase. While convulsing two litter-mate animals together in the same enclosure, the animal which recovered first from the fit made a savage attack on the other, biting and holding it with the fore-paws.

Typically we have observed 'bouncing' convulsions lead to a prostrate clonic phase during and after which the jaws of the mouse are constantly in motion, and it may sometimes bite its own feet. The animal recovers while still undergoing clonic movements, and then runs and hops round the cage with retroverted head. In this phase it will follow and attack other mice or attack models and occasionally attempts to bite the floor. Sometimes the attacks are interrupted by clonic movements which loosen its hold on the attacked object. Otherwise it may crawl over the model, attacking it in many places, or make repeated sallies at the same model. Finally, it halts, shaking with ears extended, hairs on the back erect and with its head and tail raised.

Referring to the latter part of the 'bouncing' fits, Watson[5] says, "After 5 to 20 seconds of clonic convulsions most of the mice in this condition will take hold of the cotton which surrounds the tin enclosure in which they are tested; they hang along the cotton with their feet or teeth for several minutes until they are able to walk away". This attitude, we suggest, is really an attack. Hamilton[2], describing the post-convulsive symptoms of his rats, mentions that "After the convulsive attack the animal relapses into a 'coma' which may last from a few seconds to as long as thirty minutes. If it is of short duration the animal usually is subsequently hypersensitive, squealing, jumping and biting violently when touched," and "During the later stages of the coma the animal may make aimless head movements from side to side or chew on objects that reach his mouth, such as sawdust, other rats, his own paws and frequently his tail, which because of a characteristic sitting position is readily accessible".

This behaviour is in many respects the same as that discovered by us, except that the 'coma' prevents the animal from making an assault. Apparently, observers working with *Peromyscus* have missed this component of the fits because they have only reported observations on solitary animals. Later work on a number of animals of both sexes has confirmed our original observation, the aggression, occurring towards the end of a 'bouncing' clonic convulsion with marked regularity in young animals. Not only do they make attacks on cage mates which are not attacked between fits, but they chase and attack other mice. The attacks are also made on models and in the presence of a number of different models, such as a stuffed *Peromyscus* pelt, a cotton-wool roll and a 'Plasticine' model; the wool- and fur-covered models are attacked preferentially. The aggression is, therefore, part of a co-ordinated phase of behaviour and is thus an automatism. This suggests that the hopping and running of the mice in this phase are also automatic phenomena, due to a "return of activity to the lower centres" before the derangement of the neural mechanism has been restored to normal[6].

In view of the close similarity of audiogenic convulsions in *Peromyscus* and rats, it would be interesting to know if post-convulsive aggression occurs in any of the different strains of rats subject to this type of abnormal behaviour.

As aggression is a component of post-ictal automatisms in man[6], the discovery of an aggression in the behaviour of *Peromyscus* following audiogenic seizures adds a further point to the evidence suggesting a close similarity between this type of abnormal behaviour in rodents and epilepsy in man.

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Absorption of Protein and Bacteria from Normal and Infected Joints

KNEE joints of rabbits were infected by intra-articular injection of staphylococci. In some cases a diluted solution of a standardized staphylococcus filtrate was used instead. The absorption of protein from the joint cavity was tested by means of 5·5 gm. per cent solution of human hæmoglobin in isotonic saline containing 10 mgm. per cent of calcium. Living radioactive bacteria used in absorption tests were prepared by growing *Mycobacterium phlei* on a Sauton substrate containing radiophosphorus.

The following observations were made. During the first hour of infection, the absorption of hæmoglobin is increased above normal. Two to three hours after infection, the rate of absorption of hæmoglobin is temporarily decreased below normal. The decrease lasts only a few hours. Heparinization of the animals prevents this decrease of absorption; instead, an increased absorption of hæmoglobin, as great as during the first hour after infection, prevails for several hours. The absorption of radioactive bacteria injected one hour after the infection is greatly reduced whether heparin is given or not. In joints inflamed by means of a diluted culture filtrate, the absorption of hæmoglobin is increased far above normal. This increase is partly prevented by large doses of desoxycorticosteroneacetate. Desoxycorticosteroneacetate, however, has no effect on the absorption of hæmoglobin from normal joint cavities.

The results confirm previous statements by Menkin[1] that in staphylococcus inflammation the absorption of colloids is partly blocked by fibrin clots. The formation of these clots is prevented by heparin. The fact that the absorption of radioactive bacteria is blocked in spite of heparin shows that this block has a different origin. Control experiments on benzene-poisoned animals are in progress in order to investigate if the partly blocked absorption of bacteria depends on leucocytic action.

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'MELARSEN' AND 'MELARSEN OXIDE'

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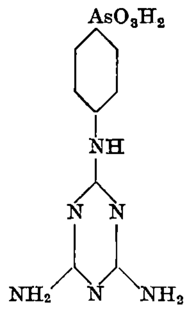
Activity Against Tryparsamide-Resistant Trypanosomes

THE melaminyl arsonate, 'Melarsen', that is, the di-sodium salt of 4-melaminylphenylarsonic acid [I], and the corresponding arsenoxide, 'Melarsen oxide' [II], have been suggested for the therapy of *T. gambiense* sleeping sickness[1,2,3]. The most recent published statement on field trials of the latter compound is by Van Hoof[4], who mentions that it is effective against cases of tryparsamide-resistant sleeping sickness. There seems, however, to have been no publication, as yet, of any trials in laboratory infections which might give solid support to the expectation of efficacy in such cases. We have therefore tested the point by comparing the action of 'Melarsen oxide' on our laboratory strain of *T. rhodesiense* and on its tryparsamide-resistant offshoot. (*T. rhodesiense* is not normally sensitive to tryparsamide and other arsenicals, but in the course of many years of mouse-passage our strain has acquired a high degree of sensitivity, and tests against laboratory infections of this strain have proved to be a reliable screening method for the selection of compounds for use against *T. gambiense* infections in man.)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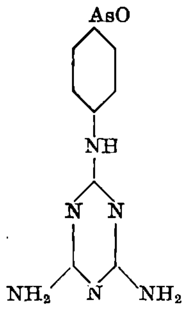
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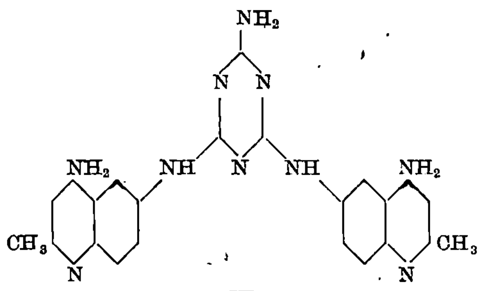
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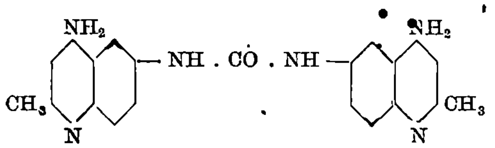
IV

Mice were treated on the second day after intraperitoneal inoculation of 2×10^4 trypanosomes, when the blood contained about 1 to 10 parasites per microscope field (⅙th obj.). 'Mapharside', 3-amino-4-hydroxyphenylarsenoxide, was used instead of tryparsamide to confirm that the tryparsamide-resistant offshoot had retained its resistance unimpaired since this character was acquired eighteen years ago[5].

TABLE 1. EFFECTS OF 'MAPHARSIDE' AND 'MELARSEN OXIDE' ON INFECTIONS OF THE PARENT STRAIN AND TRYPARSAMIDE-RESISTANT OFF-SHOOT OF *T. rhodesiense* IN MICE

Drug	Trypanosome strain	Dose (intraperitoneal), mgm./20 gm.				
		0·2	0·1	0·025	0·015	0·01
'Mapharside'	Parent	4 4C	5 5C	10 1C 9R	33 1C 29R 3N	15 8R 7N
	Resistant	8 8N	5 5N			
		0·05	0·025	0·01	0·005	0·0025
'Melarsen oxide'	Parent	4 4C	4 3C 1R	4 4C	17 8C 9R	19 1C 15R 3N
	Resistant	4 4C	4 4C	4 3C 1R	4 3C 1R	4 2R 2N

Results shown as follows:
4 1C 1R 2N = 4 mice treated; 1 cured (blood permanently cleared of trypanosomes), 1 relapsed (blood temporarily cleared), and 2 not affected (blood not cleared).

Table 1 shows that (*a*) the tryparsamide-resistant offshoot has retained a full measure of resistance, and (*b*) 'Melarsen oxide' is equally as efficacious against the resistant as against the parent strain.

'Melarsen' also was shown, by similar tests, to be equally effective against both strains.

Interference by 'Surfen C'

The commonly used term 'arsenic-resistance', in reference to trypanosomes resistant to aromatic arsenicals such as tryparsamide, 'Atoxyl', 'Mapharside', etc., has long been recognized as a misnomer, since it is the non-arsenical substituted phenyl radical rather than the mere presence of arsenic which may determine whether or not a compound is active against so-called 'arsenic-resistant' trypanosomes. Thus, it has been known since the time of Ehrlich that 'Atoxyl'-resistant trypanosomes are sensitive to arsenophenylglycine and to other aromatic arsenicals containing an acetic acid or carboxyl substituent[6,5,7]. This feature has again been given prominence by Eagle's introduction of γ-(*p*-arsenosophenyl)butyric acid, active against tryparsamide-resistant trypanosomes[8]. King and Strangeways[7] suggested that such carboxyl-substituted arsenoxides differ from others in their mode of fixation on, or entry into, the trypanosome cell, while the ultimate lethal mechanism (presumably an inactivation of essential —SH groups) is the same for all types of arsenoxide. We have provided further circumstantial support for this view in arguments depending on the finding that *p*-aminobenzoic acid interferes with the trypanocidal action of Eagle's compound but not with that of 'Mapharside', while glutathione interferes with the action of both[9].

With the demonstration of 'Melarsen oxide' as a representative of a further class of arsenoxide active against tryparsamide-resistant trypanosomes, it became of interest to find out whether suitable interference experiments might provide similar circumstantial evidence for the view that this type of arsenoxide also differs from others in its mode of fixation on the trypanosome cell, but not in the essential mechanism of its lethal effect.

The obvious type of compound in which to seek for the property of selective interference with 'Melarsen oxide' would be a substance containing the melamine nucleus. Such a compound is 'Surfen C', bis(2-methyl-4-amino-6-quinolyl)melamine [III], which is itself a chemotherapeutic agent of significant activity against *T. congolense* and *T. brucei*[10]. It also exercises some action on our strain of *T. rhodesiense*. In the experiments below, mice were infected with the parent strain of *T. rhodesiense* and treated under the standard conditions of timing and degree of infection mentioned above; in these circumstances more than 24 hours elapse before the blood becomes free of trypanosomes after treatment with 'Surfen C' even in maximal doses.

Table 2 gives the results of a number of interference experiments and shows that while *p*-aminobenzoic acid interferes selectively with Eagle's compound, 'Surfen C' interferes similarly with 'Melarsen oxide'.

TABLE 2. SELECTIVE INTERFERENCE: *p*-AMINOBENZOIC ACID AGAINST γ-(*p*-ARSENOSOPHENYL)BUTYRIC ACID (EAGLE'S COMPOUND), AND 'SURFEN C' AGAINST 'MELARSEN OXIDE'

Treated with (intraperitoneally)	Main treatment preceded 5 min. by		
	—	*p*-Aminobenzoic acid (70 mgm./20 gm.)	'Surfen C' (4 mgm./20 gm.)
'Mapharside' 0·015 mgm./20 gm.*	cl	cl	cl
Eagle's compound 0·015 mgm./20 gm.*	cl	n	cl
'Melarsen oxide' 0·003 mgm./20 gm.*	cl	cl	n

Each cell of the table represents results of treating at least eight mice.

*ED$_{95}$, that is, dose causing temporary disappearance of trypanosomes from the blood in 95 per cent of mice (estimated by probit analysis of numerous trials).

cl = blood cleared of trypanosomes in 24 hours.

n = blood not cleared of trypanosomes in 24 hours.

Other tests showed that glutathione interferes equally with the action of 'Melarsen oxide' and of the other arsenoxides. If, then, glutathione interference be accepted as evidence that the essential mechanism of lethal action is by interference with —SH constituents of the parasite cell[11], we may conclude that 'Melarsen oxide' (like Eagle's compound) shares this mode of action with other arsenoxides, but that it differs in its fixation on, or route of entry into, the trypanosome, this fixation or route being selectively blocked by 'Surfen C'.

It is reasonable to suppose that it is the melamine nucleus of 'Surfen C' which determines the selective nature of its interference with 'Melarsen oxide'. If this were so, then no such selective interference should be exercised by 'Surfen' [IV], which differs from 'Surfen C' by having a carbamide instead of a melamine linkage between the two quinoline systems[10]. This anticipation was substantiated by interference experiments in respect of 'Surfen' and the three arsenoxides. It was found, however, by examining the blood at hourly intervals within eight hours of treatment, that instead of complete absence of any interference with the three arsenicals (as found in similar tests of 'Surfen C' with 'Mapharside' and Eagle's compound, respectively), 'Surfen' does exercise some degree of interference with each of the three arsenicals. The significance of this non-specific interference will be elaborated elsewhere, but meanwhile it is established that the interference of 'Surfen C' operates selectively against 'Melarsen oxide', and presumably depends on the presence of the melamine system in both compounds*.

The facts, therefore, warrant the view that while the ultimate lethal mechanism of 'Melarsen oxide' is the same as that of other arsenoxides (by inactivation of —SH groups, perhaps of the pyruvate oxidase system[12]), it has a radically different means of fixation on, or entry into, the trypanosome cell, and it is this difference which may underlie the fact that it is active against trypanosomes resistant to the more usual type of arsenical. We have recently reached a similar conclusion in connexion with antimalarials. Representatives of the earlier pyrimidine prototypes of 'Paludrine', such as 3349 [13], are active against 'Paludrine'-resistant *P. gallinaceum*, and we have connected this finding with the conception that the pyrimidine precursors of 'Paludrine' share with the latter a common (but unknown) ultimate mode of lethal action on the malaria parasite, while differing in their mechanisms of attachment to, or entry into, the parasite cell[14].

This work was supported by grants from the Medical Research Council. We are obliged to Messrs. Parke Davis and Co. for supplies of 'Melarsen' and 'Melarsen oxide'.

* *Note added in proof.* This supposition has been further supported by finding that melamine itself interferes with the therapeutic action of 'Melarsen oxide', but not of 'Mapharside' or Eagle's compound.

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INTERNATIONAL STUDY OF RHEOLOGY

International Joint Committee on Rheology

IN December 1945 the International Council of Scientific Unions instituted a Joint Committee on Rheology, with representatives of the International Unions for Physics, Chemistry, Biological Sciences, and Geodesy and Geophysics, to which afterwards was added the International Union for Theoretical and Applied Mechanics. The International Union of Physics will act as 'mother union' for this Committee.

The Committee held its first meeting during September 8–9, 1947, in London. It was decided that its terms of reference should be to co-ordinate research and to investigate problems concerning the deformation and the flow of matter, and the following were nominated as officers for the year 1947–48: *Chairman*, Dr. Th. von Karman, Pasadena, Cal.; *Vice-chairman*, Mme. A. Dobry-Duclaux, Paris; *Secretary*, Dr. J. M. Burgers (van Houtenstraat 1, Delft, Holland); *Committee*, P. Eggleton, H. Eyring, A. Frey-Wyssling, G. van Iterson, jun., G. W. Scott Blair, R. Signer and Sir Geoffrey Taylor. The Committee intends to act as a central body for establishing contact between scientific men and societies engaged upon work in rheology. For this purpose it has chosen the following subjects for its initial activities: nomenclature; abstracting work in rheology; standards of high viscosity. A report on the nomenclature of deformations, prepared in Holland during the War under the auspices of the Committee for the Study of Viscosity and Plasticity of the Royal Netherlands Academy of Sciences (Amsterdam), was considered at the meeting. This report, after modification as a result of discussion, will be submitted both to the members of the Committee and to co-operating societies and groups, with an invitation to send in criticisms and, if desired, new proposals.

As regards abstracting work in rheology, a report will be prepared on what is already being done in this subject, and contact will be established with the United Nations Educational, Scientific and Cultural Organisation. Finally, information will be collected on materials suitable as standards of viscosity of the order of 10^6 poise and more.

International Rheological Congress

An International Rheological Congress will be organised by a Dutch committee, to be held in Scheveningen (near The Hague), during September 21–25, 1948. The Joint Committee intends to hold a meeting during this Congress, at which the information gathered can be discussed and eventually brought before the Congress. The provisional programme includes the following topics: recent developments in the theory of viscosity; nomenclature; fundamental experimental methods; solutions of macromolecular substances; Russian work on rheology; relations between stress and strain in complicated systems; abnormal substances and abnormal phenomena of flow; psycho-physical aspects of rheology; rheological problems in biology; rheology in industry.

An agreement has been reached with the Elsevier Publishing Company, Inc., of Amsterdam, to publish the Proceedings of the Congress in book form. Preprints of all papers will be forwarded to participants at least a month in advance of the Congress. Remarks in discussion will be included in the final edition of the Proceedings. Those intending to present papers should communicate with the principal secretary, Dr. R. Houwink, Rubber-Stichting, Julianalaan 134, Delft, Holland. Manuscripts must be received before May 1, 1948. A maximum of 3,000 words, formulæ and diagrams included, should not be exceeded, and the organising committee must, in consequence of present restrictions, reserve the right to cut down papers.

It is proposed that in the sectional meetings every speaker will give only a short account of his paper or mention the most important points, so that ample time will be available for discussion. The time to be allotted to each paper, inclusive of discussion, will be at most thirty minutes, but may perhaps have to be reduced if many papers are presented.

Due to generous support from Dutch industry and from some Dutch scientific societies, it will be possible to fix the Congress fee for participants at approximately f. 10 (£1), which it is hoped will also cover the cost of the preprints. It does not, however, include the price of the final edition of the Proceedings, which can be fixed only when all papers have been received. The organising committee will assist in obtaining accommodation at Schevingen.

The members of the organising committee are: J. M. Burgers (*Chairman*), R. Houwink (*Principal Secretary*), H. Kramers, A. J. Staverman, R. N. J. Saal, A. van Rossem, H. C. den Daas.

RESULTS OF THE CONTINUOUS USE OF AN AMMONIUM PHOSPHATE FERTILIZER ON RICE IN LOWER BURMA

By D. RHIND, O.B.E., and U TIN
Dept. of Agriculture, Burma

CULTIVATORS in parts of the Irrawaddy delta complained that after a few years use of an ammonium phosphate fertilizer on rice lands, they had continually to increase the dose in order to obtain the same response. An experiment was devised to test this opinion[1,2].

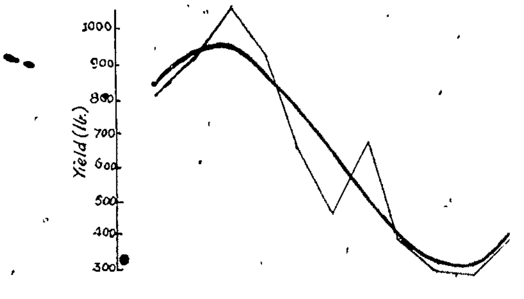
A proprietory ammonium phosphate fertilizer, the one complained of, was applied repeatedly for eleven years to a series of plots replicated five times on Myaungmya Farm in the Irrawaddy delta. The experiment continued from 1930 until 1940 inclusive, when it was interrupted by the War. The soil is a recent, acid alluvium; the rainfall averaged 93·14 in. a year during the period of the experiment; the variety of rice was the pure line *Ngasein* C14–8. The soil analysis is given in Table 1.

TABLE 1. MYAUNGMYA FARM SOIL

Insoluble residue	68·82		
Soluble silica	0·01	Stones, gravel and fine gravel	nil
Ferric oxide (Fe_2O_3)	6·06		
Alumina (Al_2O_3)	10·95	Coarse sand	1·1
Lime (CaO)	0·15	Fine sand	8·4
Magnesia (MgO)	0·63	Silt	24·6
Potash (K_2O)	0·25	Fine silt	54·7
Soda (Na_2O)	0·14	Clay	11·5
Sulphuric acid (SO_3)	0·15		
Phosphoric acid (P_2O_5)	0·01		
Carbon dioxide	0·08		
Organic matter-combined water	8·16		
Moisture lost at 100° C.	4·55		
Manganese oxide (Mn_3O_4)	0·04		
Organic carbon	1·85		
Organic nitrogen	0·15		
Available P_2O_5	0·0016		
Available potash	0·0137		
*p*H	5·3		

The fertilizer contained 18·20 per cent of nitrogen and 18·43 per cent of P_2O_5, and was applied at the rate of 100 lb. per acre shortly before transplanting. Cultivation methods were those normal to the area, seedlings being raised in unmanured nurseries and transplanted. Rice in the Irrawaddy delta is grown continuously without rotation as a single monsoon crop.

In every year the yields of the manured plots were significantly higher than the unmanured, and this is the normal effect of ammonium phosphate fertilizers on soils of this type. The point which the following analysis brings out, and which is important, is that after the first few years there was a decline in the response to the fertilizer, though at the end of the experiment there was still a significant increment over the unmanured plots.



DIFFERENCES IN YIELD OF PADDY GRAINS OF TREATED AND UNTREATED SOILS, 1930–40 (IN LB.); THIRD DEGREE POLYNOMIAL. SMOOTH CURVE, CALCULATED; STRAIGHT LINES, OBSERVED.

A polynomial of the third degree (see graph) has been fitted to the variability of the differences between the yields per acre of the treated and untreated plots. The calculated differences agree well with those found (Table 2).

TABLE 2. CALCULATED AND ACTUAL DIFFERENCES IN YIELD OF PADDY PER ACRE OF MANURED AND UNMANURED PLOTS. MYAUNGMYA FARM

Year	Actual differences over control in lb. per acre	Calculated differences over control in lb. per acre
1930	808	833·8
1931	908	932·4
1932	1062	939·7
1933	928	878·4
1934	647	771·2
1935	470	640·7
1936	695	509·7
1937	413	400·6
1938	332	336·4
1939	321	339·5
1940	431	432·6

The total variance contributed by the variation in differences in yield from year to year has been analysed into (1) the amount due to average rate of deterioration, (2) slow changes other than steady deterioration, and (3) annual causes. The smoothed curve shows the actual course and extent of the slow changes in mean differences in yields. The analysis of variance is given in Table 3.

TABLE 3. ANALYSIS OF VARIANCE

Sources of variation	Degrees of freedom	Sum of squares	Mean variance	*F*
Deterioration	1	498491·06	498491·06	35·52
Slow changes	2	88108·66	44054·38	3·139
Annual fluctuation	7	98228·46	14032·64	

The variation due to deterioration (represented by a linear function) is significant, but that due to slow changes is not reliably greater than the residual variance. The secular changes in yield differences examined are given in Table 4. The measures x_2', x_3', and x_4' of the component of change can be compared with the residual *S.D.*

TABLE 4. SECULAR CHANGES IN YIELD DIFFERENCES

Component	lb. per acre
Mean difference	+ 637·7
x_2'	− 706·0
x_3'	− 8·8
x_4'	+ 296·7
S.D.	± 118·4

The linear regression coefficient is − 67·3 ± 13·7 lb. per acre per year.

After an initial rise in the first three years, the yield differences significantly decreased during the remainder of the period of eleven years when the fertilizer was repeatedly applied. We refrain from speculation on the causes of this result. The cultivators were justified in their complaint. There is clearly need for caution before advocating the prolonged use of artificials without thorough tests in the field, and for further investigation into the causes of the present results. Conclusions based on incomplete results as reported in the Myaungmya Farm Reports from 1931 to 1941 are erroneous.

[1] Ann. Rept. Dept. Agric. Burma, 1941–42 and 1942–43, 2.

[2] Agric. Dept. Burma, Myaungmya Farm Reports, 1931 to 1941.

NUTRITION AND CANCER

A SYMPOSIUM arranged by the New York Academy of Sciences and held in December 1946 on "Nutrition in Relation to Cancer" covered a wide field and included a number of interesting articles which have now been published*. The paper by Dr. E. L. Tatum on chemically induced mutations and their bearing on carcinogenesis deals mainly with mutations induced in *Neurospora* and *Escherichia coli*, where the mutations have made the organisms more exacting in their nutritional requirements. Dr. W. J. Robbins, dealing with the botanical contributions to the cancer problem, suggests that the autonomous growth of plant tumours induced by *Phytomonas tumefaciens* is due to their ability to produce indoleacetic acid. In discussing the nutrition of tissue cultures, Dr. P. R. White indicates that if mammalian cells could be grown in controlled synthetic media, then the nutritional techniques used in the study of mutations in *Neurospora* could be applied to cancer tissue and carcinogenesis. This might give more insight into the relation of carcinogenesis and mutations involving changes in nutritional requirements.

The induction of cancer in animals is often greatly affected by diet. Dr. A. Tannenbaum describes how the restriction of the calorific intake of animals reduces the incidence of spontaneous mammary tumours, lung adenomas, hepatomas, sarcomas, and skin tumours, in mice treated with 3 : 4-benzpyrene. Restriction of calorific intake, however, has little effect on growth of established cancer. Perhaps the most interesting results of the effect of diet on carcinogenesis are seen in the experiments on hepatoma induction with azo dyes. Such experiments, carried out at Wisconsin, are described by Dr. J. A. Miller, and results obtained at the Memorial Hospital by Dr. C. J. Kensler. A high content of riboflavin in the liver reduces the chance of tumour development. Treatment with carcinogenic azo dyes tends to reduce the riboflavin content of the liver; but the carcinogenic action can be neutralized by adding riboflavin to the diet. Dr. J. White, Dr. F. R. White and Dr. G. B. Mider find that the incidence of leukæmia in mice treated with methylcholanthrene is not reduced if the dietary lysine or tryptophane is reduced to levels which prevent growth. On the other hand, reduction of the cystine intake to such a level did reduce the incidence of leukæmia in mice treated with methylcholanthrene.

Two independent groups of workers in the United States have produced tumours in rats by feeding choline-deficient diets. Dr. R. W. Engel, Dr. D. H. Copeland and Dr. W. D. Salmon of Alabama describe pathological changes including cancers which were seen in the lungs, liver, subcutaneous tissue, pancreas

* "Nutrition in Relation to Cancer", by Charles Glen King, John J. Bittner, D. H. Copeland, R. W. Engel, C. J. Kensler, George W. Kidder, G. Burroughs Mider, J. A. Miller, Harold P. Morris, William J. Robbins, W. D. Salmon, Albert Tannenbaum, E. L. Tatum, Florence R. White, Julius White and Philip R. White, *Ann. New York Acad. Sci.*, 49, Art. 1, 1–140.

and bladder in fourteen out of eighteen rats maintained on such low choline diets for five to eleven months.

Although it may seem disappointing that after so much study of cancer the fundamental cause or nature of it is unknown, the papers referred to above show advances. The carcinogenic process can often be influenced by diet, which means that the process can be resolved into separate parts, and this must help in the understanding of the process. Many of the speakers at the symposium compared carcinogenesis to mutations. Both cancer and mutations can be induced in living organisms by similar agents. The hypothesis that cancer is a somatic mutation relates carcinogenesis to other biological changes and the stability of the nuclear and cytoplasmic genes.

E. Boyland

SURVEY OF RADIO NOISE

It has long been appreciated that satisfactory radio communication depends upon the establishment at the receiving station of a minimum strength of signal above the prevailing noise. During the War, it became clear that the study of atmospheric noise-level and the limitation which it imposes on signal reception has received far less attention in recent years than the study of radio wave propagation. In 1943, the Radio Research Board, in co-operation with British inter-Service organisations, considered that it was desirable to supplement our existing knowledge of the nature, origin and prevalence of atmospherics, with particular reference to their effect on radio reception in various parts of the world. It was recognized that this would involve the carrying out of a long-term programme of research in order to place our knowledge on a satisfactory basis in relation to other advances in radio reception technique. Before embarking upon such long-term research, the Board recommended that a survey of existing knowledge in this field should be made as soon as possible; and it is in consequence of this recommendation that Radio Research Special Report No. 15, entitled "Survey of Existing Information and Data on Radio Noise over the Frequency Range 1–30 Mc./s.", has recently been published by the Department of Scientific and Industrial Research (London: H.M. Stationery Office. 3*s.* net).

This report has been prepared in the Radio Division of the National Physical Laboratory by Dr. H. A. Thomas and Mr. R. E. Burgess. Some 180 published papers on the subject were examined, together with data and measurements made available by certain commercial and government organisations operating radio services in Great Britain. The report covers radio noise of all types, whether of atmospheric, cosmic or man-made origin; but the scope of the work has been limited to radio frequencies between 1 and 30 Mc./s. (wave-lengths 10–300 metres), since most of the medium- and long-distance communication and broadcasting is conducted within this range, and the efficiency of such services is determined and even severely limited by the strength of the noise prevailing at the receiving station.

In most circumstances, atmospheric noise is the main factor limiting long-distance reception and communication; all thunderstorms, with their accompanying lightning flashes, within a range of several thousand miles are potential sources of disturbance. The most prominent centres of such storms are the large land areas, and particularly those in the tropics such as Africa and America during their local summer seasons, although these storm centres can drift out over the oceans to considerable distances. In each locality the thunderstorm activity varies with the season and during the day, and it is usually greatest under summer conditions and during the local afternoon. But the radio waves originating in a lightning flash can travel to great distances and may cause considerable disturbance at a receiving point where the above conditions do not apply.

The report deals also with the measurement of the strength of noise and its direction of arrival, and it is in these fields that active research is now in progress with the view both of obtaining a better understanding of the origin and nature of radio noise of all types, and also of developing techniques of limiting or mitigating the effects of these disturbances to radio communication. Such investigations are now being started in various parts of the world, and this report provides a good foundation as a comprehensive presentation of existing knowledge.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 19

ROYAL PHYSICAL SOCIETY OF EDINBURGH (at the Royal Scottish Geographical Society, Synod Hall, Castle Terrace, Edinburgh), at 5.15 p.m.—Dr. James Davidson: "Biology and the Detection of Crime".

CHEMICAL SOCIETY, SOUTH WALES SECTION (joint meeting with the UNIVERSITY COLLEGE OF SWANSEA STUDENTS' CHEMICAL SOCIETY, at University College, Swansea), at 6 p.m.—Dr. Philipp Gross: "The Physical Chemistry of some Vacuum Metallurgical Processes".

INSTITUTE OF WELDING, NORTH LONDON BRANCH (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Mr. S. M. Reisser: "The Welding of Bridges and Buildings".

Tuesday, January 20

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. A. T. Newboult: "Reconstruction in Malaya".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Physical Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. S. J. Rowland: "Recent Studies in the Composition of Milk".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. John M. Mogey: "The Community in Ulster".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. H. Harris: "Sex Limitation in Human Genetics".*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Symposium of Papers on "Winter Conditions and the Civil Engineer". (Mr. Stanley Mehew: "Roads"; Mr. W. K. Wallace: "Railways"; Mr. H. J. B. Manzoni: "Municipal"; Mr. Ben Howorth: "Drainage and Inland Navigation"; Prof. D. Brunt, F.R.S.: "Meteorology".)

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "To What Extent does Distortion Really Matter in the Transmission of Speech and Music?" (to be opened by Mr. P. P. Eckersley).

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. C. H. Desch, F.R.S.: "Abrasion, Erosion and Corrosion".

INSTITUTION OF THE RUBBER INDUSTRY (at Caxton Hall, Caxton Street, London, S.W.1).—"Industrial Design in the Rubber Industry".

Wednesday, January 21

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5 p.m.—Annual Meeting; Dr. R. J. Ludford: "Relation between Cellular Structure and Functional Activity" (Presidential Address).

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. T. Norris: "The Lightning Strength of Power Transformers".

BRITISH INSTITUTION OF RADIO ENGINEERS, SCOTTISH SECTION (at the Heriot-Watt College, Edinburgh), at 6.30 p.m.—Mr. W. D. Oliphant: "Acceleration of Sub-Atomic Particles".

Royal Institute of Chemistry, London and South-Eastern Counties Section (at the Wellcome Research Institution, 183 Euston Road, London, N.W.1), at 6.30 p.m.—Dr. H. N. Linstead: "Science and Parliament".

Society of Dyers and Colourists, Midlands Section (at the King's Head Hotel, Loughborough), at 7 p.m.—Mr. G. C. Grundy: "Non-Textile Uses of Dyestuffs".

Chemical Society, Eire Section (joint meeting with the Irish Chemical Association, in the Department of Chemistry, Trinity College, Dublin).—Prof. Wesley Cocker: "Santonin".

Thursday, January 22

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

London Mathematical Society (at University College, Gower Street, London, W.C.1), at 5 p.m.—Mr. A. D. Booth: "Recent Developments in Electronic Computing".

Mineralogical Society (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.15 p.m.—Scientific Papers.

Institution of Electrical Engineers, Installations Section (at Savoy Place. Victoria Embankment, London, W.C.2), at 5.30 p.m. —Mr. B. Feldbauer: "The Design of Contactors with regard to their Industrial Application".

Chemical Society, Nottingham Section (in the Chemistry Lecture Theatre, University College, Nottingham), at 6 p.m.—Prof. Brynmor Jones: "Some Aspects of Aromatic Substitution".

Society of Dyers and Colourists, West Riding Section (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Prof. J. B. Speakman: "The Formation of Polymers in Wool".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Chemical Society, Edinburgh Section (joint meeting with the Local Sections of the Royal Institute of Chemistry and the Society of Chemical Industry, at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. H. T. Openshaw: "Some Recent Developments in Alkaloid Chemistry".

Friday, January 23

Mineralogical Society, Clay Minerals Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 10 a.m.—Discussion on "Clay Minerals as Catalysts".

Chemical Society, Southampton Section (joint meeting with the Southampton University College Chemical Society, in the Physics Lecture Theatre, University College, Southampton), at 5 p.m.—Prof. E. C. Dodds, F.R.S.: "Synthetic Organic Chemistry in relation to Biology".

University College London (in the Department of Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. E. Ashworth Underwood: "The Heritage of Medicine" (further lectures on January 30, February 6, 13, 20 and 27).*

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. T. A. Crowe: "Gas Turbine and Marine Propulsion" (Thomas Lowe Gray Lecture).

Manchester Statistical Society, Statistical Methods Study Group (in the Society of Architects' Room, Textile Institute, 16 St. Mary's Parsonage, Manchester), at 5.45 p.m.—Mr. J. R. Jarmain: "Density Standards in Assessing Housing Needs".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Growing Points in Science" (to be opened by Prof. J. S. Mitchell and Dr. K. Weissenberg).

Saturday, January 24

Biochemical Society (at the British Postgraduate Medical School, Ducane Road, London, W.12), at 11 a.m.—Scientific Papers and Demonstrations.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Director of a new Vegetable Research Station—The Chairman, Organising Committee, Vegetable Research Station, Ministry of Agriculture, Block 4, Bickenhall Mansions, Baker Street, London, W.1 (January 24).

Senior Lecturer in Physics and Electronic Engineering at the Ministry of Supply School of Electronics—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs., quoting 5/138/JFA (January 24).

Engineer in the Audio Frequency Section of the Research Department in London, Engineers (2) in the Field Strength Section of the Research Department at Oxford, and Senior and Junior Engineers in the Designs Department in London—The Engineering Establishment Officer, B.B.C., Broadcasting House, London, W.1 (January 24).

Senior Lecturer in Aerodynamics, a Senior Lecturer in Mathematics, a Responsible Lecturer in Electrical Engineering, a Lecturer in Mechanical Engineering, a Lecturer in Production Engineering, and a Teacher of Engineering Drawing, —The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (January 24).

Research Physicist—The Director, Institute for Industrial Research and Standards, 45 St. Stephen's Green, Dublin (January 24).

Power Station Chemist—The Borough Electrical Engineer and Manager, Halifax Electricity Department, 19–23 Northgate, Halifax (January 26).

Soil Conservation Officers in the Soil Conservation Branch of the Irrigation Department, Southern Rhodesia—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (January 31).

Senior Lecturer or Lecturer in the Department of Physiology —The Registrar, The University, Sheffield (February 7).

Lecturer in Chemistry at Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (February 21).

Chair of Pathology in the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (February 21).

Chair of Mathematics at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 24).

Readership in Bacteriology at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 26).

Senior Professional Officer in the Tobacco Branch of the Division of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (February 27).

Assistant Keeper (Class II) in the Departments of (*a*) Physics and Geophysics, (*b*) Chemistry, Astronomy and Optics, (*c*) Industrial Engineering, (*d*) Air and Water Transport, (*e*) Science Library—The Director and Secretary, Science Museum, South Kensington, London, S.W.7, endorsed 'Assistant Keeper' (February 28).

Lecturer in Geography at Raffles College, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (February 28).

Chair of Agriculture in the University of Ceylon—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (February 28).

Senior Lecturer in Mechanical Engineering, a Senior Lecturer in Aeronautical Engineering, a Senior Lecturer in Civil Engineering, a Lecturer in Electrical Engineering, and a Lecturer in Mechanical Engineering, at Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (March 1).

Lecturer in Pharmacology at Makerere College, Uganda—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (March 25).

I.C.I. Research Fellowships in Bacteriology, Biochemistry, Chemical Engineering, Chemistry, Chemistry of Leather Manufacture, Chemotherapy, Colloid Science, Colour Chemistry and Dyeing, Engineering (Civil, Electrical or Mechanical), Fuel and Refractories, Metallurgy, Pharmacology, Physics, Textile Industries (Protein Chemistry)—The Registrar, The University, Leeds 2 (April 30).

Senior Lecturer in General Bacteriology in the University of Sydney—The Secretary Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Sydney, May 1).

Technician (Grade B) in the Pathological Laboratory—The House Governor and Secretary, Queen Mary's Hospital for the East End, Stratford, London, E.15.

Experienced Biochemical Technician for the Department of Physiology—The Professor of Physiology, Medical School, King's College, Newcastle-upon-Tyne.

Chemists and Assistants for the development of methods of combating the corrosion of iron and steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Corrosion'.

Field Zoologist in Kenya to undertake work in connexion with a survey of tsetse distribution in the Colony—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

Junior Laboratory Technician with experience of simple histological techniques—The Secretary, Marie Curie Hospital, 66 Fitzjohn's Avenue, Hampstead, London, N.W.3.

Research Chemist—The Director of Research, British Leather Manufacturers' Research Association, 1–6 Nelson Square, London, S.E.1.

Senior Post in the Metallurgical Department—The Director, Tin Research Institute, Fraser Road, Greenford, Middx.

Graduate in Physics or Engineering to undertake experimental work in connexion with small heating equipment—The Assistant Secretary, British Coal Utilisation Research Association, 13 Grosvenor Gardens, London, S.W.1.

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NATURE

No. 4082 SATURDAY, JANUARY 24, 1948 Vol. 161

CONTENTS

Page
Democracy in Industry 109
Methodology in Ethnography. By Dr. A. I. Richards 111
The War Effort of a Great Engineering Organisation. By Sir Arthur Fleming, C.B.E. 113
Co-operation Between Medical and Agricultural Physiology . . 113
Grammar School Science. By W. L. Sumner 114
The Theory of Primary Calcification in Bone. By Dr. Marcel J. Dallemagne 115
The West African Cacao Research Institute. By O. J. Voelcker . . 117
Exhibition of Indian Art. By Prof. J. H. Hutton, C.I.E. . . . 119
Obituaries :
  Prof. E. C. C. Baly, C.B.E., F.R.S. By Prof. R. A. Morton . . 120
  Sir Robert Greig. By Dr. W. G. Ogg 120
  Mr. H. W. Pugsley. By Dr. J. Ramsbottom, O.B.E. . . . 121
  Prof. B. Bavink 122
News and Views 122
Letters to the Editors :
  Pre-erythrocytic Stage in Mammalian Malaria Parasites.—Prof. H. E. Shortt and P. C. C. Garnham 126
  Action of Nitrogen Trichloride on Proteins : Production of Toxic Derivative.—H. R. Bentley, Dr. R. G. Booth, E. N. Greer, J. G. Heathcote, Dr. J. B. Hutchinson and Dr. T. Moran, C.B.E. 126
  Enzymic Conversion of Amylose into Amylopectin.—Dr. S. Peat, Dr. E. J. Bourne and S. A. Barker 127
  Adenosinetriphosphate in Glutamine Synthesis.—W. H. Elliott . 128
  Glutamine-synthesizing System of *Staphylococcus aureus* : its Inhibition by Crystal Violet and Methionine-sulphoxide.—W. H. Elliott and Dr. E. F. Gale 129
  Use of Solubility Curves at Varying *p*H and Constant Ionic Strength for the Precipitation and Crystallization of Proteins.—A. Distèche 130
  Reaction between Catalase and Hydrogen Peroxide.—R. Lemberg and E. C. Foulkes 131
  Synthetic Polyglutamic Acid.—W. E. Hanby, S. G. Waley and J. Watson 132
  Dielectric Relaxation of Molecules Containing Rotating Polar Groups.—Prof. A. Budó 133
  Emission of Enhanced Microwave Solar Radiation.—R. G. Giovanelli 133
  Solar Radio Emissions and Sunspots.—I. L. Thomsen ; M. Ryle . 134
  Structure of Calcium Fluoride Films Evaporated on Polished Glass Surfaces.—J. Bannon and C. E. Curnow 136
  Active Regulation of Chloride in *Metapenaeus monoceros* Fabricius.—N. Kesava Panikkar and R. Viswanathan 137
  Development of Cestodes *in vitro* : Production of Fertile Eggs ; Cultivation of Plerocercoid Fragments.—Dr. J. D. Smyth . . 138
  Threshold Value of Carbon Dioxide Concentration in Photosynthesis of Foliage Leaves.—Dr. E. K. Gabrielsen 138
  Extermination of *Aedes aegypti* in Khartoum.—R. Kirk . . . 139
Limitation of Bacteria by Micro-Predators in Soil. By Dr. F. J. Anscombe and Dr. B. N. Singh 140
Research and Development in British Colonial Territories . . 141
Use of Equivalent Metric Values in Scientific Papers 144
Science Masters' Association : Annual Meeting 144
Meteorology and the Propagation of Radio Waves. By Dr. R. L. Smith-Rose 145
Release of Information on Atomic Energy 146
Forestry in Trinidad and Tobago 147

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DEMOCRACY IN INDUSTRY

ALTHOUGH the importance of mobility of labour as part of the price to be paid for social security and the condition of full employment which Government action, irrespective of party, will now be expected to maintain has been emphasized repeatedly since Lord Beveridge first formulated his proposals in the report of 1944, the implications are still far from being appreciated in many quarters. They are not even fully recognized by the Government, as is indicated in Mr. Isaacs' introduction of the Control of Employment Order ; and the way in which that Order has been received further demonstrates the same fact in other sections of the community. Even in the support which the Prime Minister and Sir Stafford Cripps have given to the reinstatement and extension of the practice of joint consultation in industry, which proved so successful during the War, there is little indication that the extent to which one of the major driving forces of industry has been weakened and is disappearing is fully realized. Nor does current discussion on incentives take adequate account of the fact that, while fear is happily disappearing as a goad to work, no positive enthusiasm is taking its place.

This, however, is the point at which discussion of incentives in industry, industrial efficiency and management are linked up with those larger questions of the relation of industry to the State which are being raised simultaneously by the changes in industrial organisation witnessed in the establishment of the National Coal Board and the nationalization of transport. Notable attempts are being made to deal constructively with these questions : Mr. W. D. Brown's paper on "Principles of Organisation" and Col. L. Urwick's on "Morale", both contributed to the Manchester College of Technology's series of Monographs on Higher Management, like an earlier one of Mr. G. G. Renold's on "The Employer and the Social Fabric", are recent examples, while the same questions are dealt with from a rather different point of view by C. Reaveley and J. Winnington in a recent book, "Democracy and Industry".*

Miss Reaveley and Mr. Winnington, as so frequently happens, are stronger in delineating the weaknesses and faults of the old system of industrial competition than in their positive suggestions for its replacement ; but they have much to say about the effects of competitive mass production on personality, that should be taken into account by all concerned to build up an efficient system of co-operation whether within industry itself or in society as a whole. They paint a black picture of conditions in industry, but one which is generally accurate, even if some statements are rather too sweeping. A factory may be a totalitarian institution ; but it is not necessarily so, as they suggest. Again, factory life does often corrode the nobility of reason, but there is no inherent reason why it should.

What stands out most clearly from this study is the futility and impracticability of considering factory and industrial life apart from that of the society.

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* Democrac[illegible] Industry. By C. Reaveley and J. Winnington. Pp. 176. (Lo[illegible]atto and Windus, 1947.) 16s.

which the factory and industry exist primarily to serve. Unless the relations between industry and the community are satisfactory, we cannot hope to get that sense of purpose on which Miss Reaveley and Mr. Winnington rightly lay such stress, and their book is to be welcomed for the clear way in which the relations between industry and the democratic State are displayed. They point out frankly the danger of an industrial position in which conditions of employment steadily atrophy the very qualities on which freedom and democracy depend, and it was time that someone emphasized that the process goes on whatever political party is in power.

Democracy makes large demands on the moral and spiritual, as well as on the intellectual, ability of a people, and no system of education will be adequate to develop and preserve such qualities if conditions of employment are such as to inhibit or discourage their use. That is the real danger springing from the sense of frustration, however caused, on which the authors of this book dwell at length, and we must take steps to counter it effectively, just as we must meet the danger inherent in propaganda and train and encourage men to exercise critical judgment and individuality.

There is a further danger of which rather less specific warning is given. The difficulty is due in part to the powerful institutions which we have inherited from the past. But those institutions cannot be destroyed without stripping ourselves of our greatest strength. In so far as they are archaic, they endanger development and no longer fully serve the needs of society; but they are also the focus of social cohesion and the legacy of the wisdom of our fathers. Rightly understood, they can be adapted to the needs of to-day without sacrificing their funded strength, and the real test of our democracy is its capacity to use the institutions it has inherited to foster spiritual freedom and creativeness. It is a moral as well as an economic problem, and the intensity of the drive for efficient production must not be allowed to encourage practices which destroy the purpose and freedom of those who do the work.

Without discussing the more profound economic changes which may be needed, Miss Reaveley and Mr. Winnington suggest three immediate steps which should help to diminish the clash between the present industrial system and democracy. In line with the trend of Mr. W. B. D. Brown's suggested principles governing the economic and social aspects of organisation and industrial justice, they suggest first that juster methods of dismissal should be inaugurated on a wide scale, and summary and unjust dismissal no longer be used as a means of spurring production. Urgent inquiry is necessary into the efficacy of the methods that have already been tried with some success. Secondly, they insist on the importance of training of management, and particularly the training of foremen, and of the lower supervisory grades; though equally they stress the necessity of such training as well as technical training for the works manager. That aspect is already receiving fairly general attention, even if some time must elapse before full effect can be given to [illegible] policy as was advocated in the report of the Urwick Committee. Its importance has been stressed in most of the reports of the 'working parties' of the Board of Trade; but more attention might be given by the Government to the promotion of conditions which make efficient management easier. The question of incentives for management, too, requires more attention than it has yet received, and Miss Reaveley and Mr. Winnington make an important point in directing attention to the value of the support of a strong professional ethical tradition, and the way in which specific training for management can help to develop such a tradition. Further, they rightly emphasize that Government cannot well demand higher standards of industrial management without itself setting the example of a high standard of management in its own departments.

Elsewhere Miss Reaveley and Mr. Winnington are disposed to overlook the importance of the technical man, and they nowhere show evidence that they realize how essential is his contribution if we are to ensure that the processes and operations of industry are directed to objectives which are materially worth while, and as such can be satisfying and supply the worker with a sense of social purpose or professional pride or craftsmanship. But they have an eye for detail which can count; such as the value of the contribution from women who bring to their work in the factory their house-pride, the weakness of adult education in relation to industrial workers, and the way in which the factory can be hostile to the purpose of the home as well as to the qualities on the exercise of which the continuance of democracy depends. Their third proposal, for the wider and wiser use of joint consultation, is a plea for experiment in this direction so as not only to secure the greater interest and closer co-operation of the worker, but also to develop those qualities of responsibility which democratic citizenship needs. They suggest, too, that we need to explore afresh the problem of recreation and the use of leisure, that we need fresh creative experiment in social activity, a modern tradition of community life, with the restriction of working hours and a different type of education that are involved in a community life which the industrial or agricultural worker is physically able to share.

Mr. W. D. Brown, in the paper referred to at the beginning of this article, suggests that the major malaise of industry is lack of participation on the part of many, and that we should seek both to wean executive authority from its authoritarian attitude and to demonstrate to workers that the objectives of an industrial undertaking are sufficiently useful in the social sense, and sufficiently in their own interests in a national sense, to justify their participation. The formal committees which are set up in industry may well be regarded as class-rooms for the development of spontaneous joint consultation and participation, and Mr. Brown indicates principles of consultation which may help to avoid some of the pitfalls which the joint production committees have encountered. These principles should certainly be carefully considered by all those concerned to implement the plans for the re-establishment and extension of joint consultation in industry which the Government regards as so important a means of increasing production.

Industry undoubtedly requires the full development of the consciousness of a common aim or purpose before it can give of its best; and joint consultation should promote this consciousness. It is even more important than the tapping of the constructive ideas and practical experience of the men in immediate contact with the daily problems of an industrial firm in its factories or workshops, on which the system of joint consultation is intended to assist management to draw. Indeed, that contact will not be complete and spontaneous and fruitful unless the sense of common purpose is first developed. We have to remove the obstacles in the minds of men which, as Mr. David Lilienthal has observed, are the real barriers to effective co-operation and the utilization of our mechanical resources without detriment to human personality.

This is why, as Col. Urwick insists, morale and the general assumption of individual responsibility for some share in the national task is the fundamental problem, and why it is imperative that, while shedding the idea of domination which has been associated with industrial management in the past, we should develop the idea and capacity of leadership, about the nature and exercise of which our war-time experience has taught us so much. Leadership respects personality and encourages initiative, and it is not too much to say that Britain's recovery from the present economic crisis depends on the extent to which, not merely in industry but also in Government institutions and the public corporations, we can replace the climate and tradition of domination by one of co-operation, with true leadership summoning forth the initiative and enthusiasm of the individuals who follow. Indeed, one of our dangers is that we may make the mistake of believing that changes in organisation in the field of government, such as nationalization of industry or transport or in the means of co-operation such as the production committees, may in themselves develop leadership.

Organisation may contribute much, but how much depends on the men who use it; the ultimate problem is that of the men whose capacity for leadership at all levels is the means of creating morale. No one concerned with the conduct of industry, on the technical, the administrative or the trade union side, can ponder too deeply on the meaning of some of our war-time experience; the points of particular importance have been expounded by, for example, Field-Marshal Montgomery, General Slim, Mr. Bernard Fergusson in his book "The Wild Green Earth" and Col. Urwick in his analysis of the lessons of Stalag XIB. In matters of training and tradition, the encouragement of initiative and the development of an effective substitute for the satisfaction of craftsmanship, the fostering of a sense of social as well as of industrial purpose and of personal responsibility, there is still much to be done and to be learnt; Mr. Fergusson's appeal for the lessons of the Burma campaign to be applied to our industrial and social life is as impressive as General Slim's stress on the spiritual and intellectual foundations of morale. We are only at the beginning of the development of real scientific management, and it should be noted that Col. Urwick, like other observers, does not fail to point out how comparatively weak industry has been from this point of view in the lower levels of supervisory staff.

There is indeed much in Col. Urwick's paper that is stimulating to the industrial scientist and to all those who hold positions of administrative responsibility in industry. Valuable as will be the contribution that the wider provision of courses of training in management will make, we do not need to wait on that for the constructive thinking and the application of experience learnt, sometimes at bitter cost, in other fields. The task of building morale, like that of fostering co-operation, is one that can be undertaken by all men and women of goodwill engaged in industry whether on the management side or on that of the trade unions. It must be undertaken without preconceived ideas, by those willing to experiment but able to respect the individuality and personality of others even when they hold differing views. These are necessary conditions for a fruitful issue from the new plans of the Government for joint consultation in industry; but if the task is undertaken in this way, we may well find that not only has industry greatly increased its efficiency and productivity, but also that simultaneously industry has been knit more closely to the purpose and traditions of the State in which it functions, and that the clash between the purposes and ideals of the home and of democracy and those of industry has at last been eliminated. There can be no doubt that the newly established Committee on Industrial Productivity, and in particular its sub-committee, under the chairmanship of Sir George Schuster, on human factors affecting industrial productivity, should be able to make important contributions to that end; but its work will only reach full fruition when all engaged in industry give their full support, and when Government policy and administration no longer obscure the declared objectives.

METHODOLOGY IN ETHNOGRAPHY

The Dynamics of Clanship among the Tallensi

Being the First Part of an Analysis of the Social Structure of a Trans-Volta Tribe. By Dr. Meyer Fortes. (Published for the International African Institute.) Pp. xx+270+16 plates. (London, New York and Toronto: Oxford University Press, 1945.) 30*s*. net.

THIS is a book of considerable interest, both as an account of a little-known area in the northern territories of the Gold Coast and as an example of some present-day trends in social anthropology. The Tallensi are a primitive agricultural people about 350,000 strong who inhabit the densely populated area between the White and the Red Volta. They are as 'backward' as any in the Gold Coast, and Fortes' previously published material shows their low level of diet and the annual periods of starvation or, at any rate, privation, to which they are liable[1].

Taleland has no fixed boundaries and no central machinery of government. Its population is mixed owing to the constant introduction into Tale country of kindred, but not entirely similar, ethnic groups. Fortes is concerned to discover how these clans or sub-clans of varied origins are integrated to form the group commonly known as the Tallensi. He believes that this integration is achieved by a common pattern of kinship which binds the separate elements together as effectively as political machinery, and which makes it possible for alien groups to be incorporated by a fiction of common descent. An ancestral cult and the joint performance of annual rites to an earth goddess enforce the unity of the different groups by constantly expressing it. Fortes uses the kinship terminology recently employed by Evans-Pritchard in the latter's description of the social structure of the Nuer of the Anglo-Egyptian Sudan[2], and he develops it in an elaborate and very systematic way. Words such as 'kinsmen' or 'clan', which have inevitably been used in a variety of different ways, are discarded or re-defined, and the author substitutes a series of more precise terms which reflect the origin of the different descent groups in a constant process of fission from a common stock. Such groups are classified as minimal, major, or maximal 'lineages', and primary or secondary segments, to indicate the type of fission which has taken place, and the rules of seniority within the group.

The system of relationships which governs human behaviour in this small and very primitive society is expressed in diagrams, geometrical figures, and metaphors derived from the mechanical and biological sciences, such as planes of cleavage, parallelograms of balanced structure, fusion, fission and segmentation. This treatment of ethnographical material raises interesting methodological questions. The last twenty or thirty years have seen the emergence of social anthropology as an observational science. Field studies of primitive communities have reached a new standard of detail and have been made on the basis of longer and more intensive investigations and by means of a much closer participation in the lives of the people studied. The recent adoption of observational techniques common to other social sciences, such as case histories, social survey, and statistical methods of different kinds will extend the area over which observations can be considered valid and make it possible to estimate more closely the degree of variation from different norms of behaviour.

But the range of anthropological observation was already very wide. Anthropologists have repeatedly claimed that they studied cultures as 'wholes', and that their task was to show the inter-relation of the different aspects of human behaviour, whether economic, legal, religious or political, which go to make up the traditional heritage distinguishing the little Tale from the little Londoner. It is still probably true to say that one of the most distinctive contributions that the anthropologist has made to the social sciences is this concept of culture, which allows him to speculate over wider fields than those open to the more specialist social sciences, such as economics or law.

How, then, is the social anthropologist to deal with the mass of detail with which the new field techniques provide him ? How, in other words, is he going to be able to record more and more about more and more ? Malinowski solved the problem in one way by isolating particular institutions associated with fundamental human needs, such as family and kinship, or economic organisation, and proving with the utmost detail the inter-relation between, say, material culture, knowledge, law, beliefs and social organisation as they enable man to fulfil these particular needs[3]. The work was so detailed that this arch-exponent of the unity of human culture did not, in fact, describe the whole of the culture of the very small island with which he dealt, nor did he proceed on the basis of his detailed field observations to develop comparative studies.

Fortes, together with Radcliffe-Browne, Evans-Pritchard and other followers of Durkheim, follows another course. These writers attempt to achieve simplicity by the rigid limitation of their material to one particular aspect of culture, that is to say, the system of social relationships or social groups, to which they give the name 'social structure', and which they describe with a mathematical precision as abstract as the enunciation of some economic law. This is interesting and stimulating work. Anything which makes for precision of terminology in young sciences is valuable, and Fortes certainly challenges us to think out our kinship terminology anew. There are, however, elements of danger in the experiment he has made. The isolation of structural problems must be in a sense artificial, and Fortes' book shows some of this weakness. Groups do not exist *in vacuo.* They follow organised activities in particular environments ; they obey rules, accept beliefs, and build up an illogical tangle of sentiments and values. Their success is limited by their material equipment and the biological laws to which they are subject. All these different factors make for the infinite variety of human behaviour, and in the context of actual life there are no rigid groups but a variety of possible principles of relationship, some of them quite conflicting. The Tale lineage system is incomprehensible until the geometrical diagrams and symbols in which Fortes expresses it are re-interpreted in terms of ritual, agricultural activities, systems of land tenure and of housing and methods of warfare. Some of the complexity of his descriptions is doubtless due to a rather confused prose style ; but it is also the result of his attempt to isolate an aspect of social structure—in this case, a descent system—from the whole institution of marriage, family life and economic activities from which it springs. Surely anthropologists will have to bring order into the increasing variety of their material by adopting definite conventions for the outline descriptions of the main aspects of culture (activities, structure, beliefs, norms, values) and its major institutions. Detailed accounts of special aspects analysed for comparative purposes will be facilitated by such systematic descriptions. Simplification by elimination of relevant data may lead not only to faulty emphasis but actually to a greater complexity in the presentation of material.

There also seems to be an element of danger in Fortes' attempt to express field data in terms of philosophical abstractions, although such abstractions can obviously be made once the concrete data have been presented. Fortes himself was trained as an experimental psychologist and later in the intensive type of field-work developed by Malinowski. It is clear from passing references what a mass of concrete data he has collected. But his material is often presented in the form of metaphors that were common in the philosophical sociology of the beginning of this century rather than in the language of the observational sciences. Such phrases as "the polar opposites of the idea of unity, arising out of the very same balance of social forces that make unity possible", or the suggestion that Tale society is "a mosaic counterbalanced by cleavages" can have no possible verification in terms of the recorded data or the formalized views expressed by the people themselves. Is it not possible that younger generations of anthropologists, lacking Fortes' scientific training, may come to believe that the framing of a logical system of human relationships and its diagrammatic presentation are more valuable than the analysis of the cases which make for variation ? In other words, may not such work lead to the minimum of observation rather than to the maximum amount ? It was the fashion twenty years ago to rail against the 'arm-chair anthropologist'. Will not such work lead to a movement which might be described as 'Back to the arm-chair' ? For this reason the present reviewer regards Fortes' book as an important, stimulating, and in many ways a brilliant book, but also, from the point of view of scientific method, a somewhat disturbing one.

A. I. RICHARDS

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[1] Fortes, M., and Fortes, S. L., "Food in the Domestic Economy of the Tallensi", *America*, 9, No. 2 (1936).

[2] Evans-Pritchard, E. E., "The Nuer" (Oxford University Press, 1939).

[3] Malinowski's analysis of culture into a series of 'aspects' and 'institutions' centred in fundamental biological needs is described in its final form in his posthumous book "The Scientific Study of Culture", 1944.

THE WAR EFFORT OF A GREAT ENGINEERING ORGANISATION

Men and Volts at War

The Story of General Electric in World War II. By John Anderson Miller. (Whittlesey House Publication.) Pp. xi+272+123 plates. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 19*s*.

THE sub-title of this volume is "The Story of General Electric in World War II", but in content it goes a good deal beyond this scope, and tends to become rather a history of the American war-machine, in which one sees at every turn the applications of the products of the General Electric Co. and the achievements of its scientific workers and engineers in dealing with new war problems. Although the author has avoided saturating his volume with statistics, one is struck by the immensity of the war output from the General Electric Group of factories with their 175,000 workers—output stated to be three times that previously attained.

While many new devices were developed for war purposes by the Company, a great proportion of its effort involved only a modification of its existing products to meet special war requirements; and the great problem in this connexion was the organisation of plant, tools, productive equipment and personnel to meet the stupendous output involved. Such organisation required continual adjustment to satisfy the ever-changing war requirements. Only a company possessing very great resources in scientific and technical personnel, production organisation, and plant and equipment could effect the adjustment required in so incredibly short a time, and in so efficient a manner. The existence of this and other great manufacturing companies was one of the most vital of America's war assets, because they could so rapidly be adapted to war needs. The rapidity with which emergency problems arising in remote theatres of war were solved was remarkable. It is interesting, also, to note that the technical developments that had been undertaken many years previously were of immense war-time usefulness, electrical ship propulsion and the turbo supercharger being two such developments. The author correctly points out that whereas the First World War was largely mechanical in its engineering character, the Second World War was marked by electrical engineering applications, notably in radar, signalling, communications, aircraft, gun ranging, a multiplicity of instruments, welfare, health and medicine.

In a foreword, Charles E. Wilson, president of the General Electric Co., says that since it would be impossible to mention all to whom credit is due, the story of the Company's war-work has necessarily been written without emphasis on the contributions of particular individuals. This is rightly so; but one would like to pay special tribute to the management of this great engineering organisation which had the courage, initiative and resource to shoulder staggering burdens under the greatest possible pressure of time, and with the minimum opportunity to assess in detail the extent of the problems involved in relation to the facilities of materials and personnel available.

The volume is a fine work, well written and excellently produced with many small 'packets' of well-titled illustrations on art paper inserted at intervals. There is a good index and the appendixes which describe General Electric Co. plants and their war production are noteworthy.

A. P. M. FLEMING

CO-OPERATION BETWEEN MEDICAL AND AGRICULTURAL PHYSIOLOGY

The Problem of Fertility

Proceedings of the Conference on Fertility held under the auspices of the National Committee on Maternal Health. Edited by Earl T. Engle. Pp. viii + 254. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1946.) 21*s*. net.

THE practical application of the science of the physiology of reproduction lies in two distinct fields, that of human medicine and that of animal husbandry. The bringing together of workers in these two fields to discuss recent research on the problems of fertility, the results of which are set forth in this book, should have important repercussions in the future, not only for applied, but also for pure science. It is evident from a study of the various chapters that a comparison of the reactions of different species throws considerable light on their different physiological balances and opens the way for advances in disentangling the mechanisms involved. Striking differences exist between species in respect to the methods whereby ovulation can be induced and in the biology of the spermatozoa. In this book recent research work on these subjects has been described in papers by different specialists, and the discussion which followed is reported.

Among the various papers presented, Asdell describes the different patterns of œstrous cycles, and points out that the response to hormones depends not only on dose but also upon the response thresholds, which vary in the different species. Work on ovulation and œstrus in sheep and goats is reviewed by Phillips, Fraps and Frank, who quote many references to recent work, particularly in connexion with the breeding season, optimum time to breed and responses to administration of gonadotrophins. Casida contributes an important paper on the induction of ovulation and subsequent fertility in domestic animals, in which he discusses super-ovulation, and concludes that the potential fertility of the ova that were ovulated by the use of pituitary gonadotrophins was affected markedly by the phase of the reproductive cycle at the time of treatment. Ovulations that were induced during the luteal phase yielded eggs of low fertility. The ovary at the time of ovulation is described by Corner. A review of the hormonal control of ovulation, with extensive references to the literature, is presented by Cole, who concludes that while ovulation can be produced regularly in certain species with several gonadotrophins, the response in primates is a haphazard one.

Pommerenke and Viergiver report observations on the cervical mucus and the menstrual cycle, Simmons discusses the cervix uteri in infertile matings, and Abarbanel gives details concerning spermatozoa and the cervical mucus. In an important paper on the glycolysis, viability and fertility of bovine spermatozoa as influenced by their concentration, Salisbury reports full fertility from dilutions of up to 1 : 100 stored for a limited period of up to about four days. Macleod discusses the metabolism and motility of human spermatozoa, and Berliner the biology of equine spermatozoa. Chang reports experiments on the fertilizing capacity of rabbit spermatozoa and shows that the large number of ova ovulated by gonadotrophin injection does not require a proportionately larger number of spermatozoa for fertilization.

Methods employed in the artificial insemination of cattle are briefly described by Bartlett, and experiments on the effect of synthetic thyroprotein on sterility in bulls are reported by Reineke.

This book not only provides a good source of information for workers in this field, but also should act as a stimulus to further research work on the problems of fertility.

GRAMMAR SCHOOL SCIENCE

The Teaching of Science in Secondary Schools

Compiled by a Joint Committee of the Incorporated Association of Assistant Masters and the Science Masters' Association. Pp. xi+292. (London: John Murray, 1947.) 8*s*. 6*d*. net.

AT the outset we must say that this is the most useful book on the practical problems of the teaching of science in grammar and 'public' schools which has yet appeared. It is the work of a committee of the Incorporated Association of Assistant Masters and the Science Masters' Association. About thirty members, for the most part science masters in public and grammar schools, were assisted by two hundred corresponding members. The result is a book which deals honestly and practically with every problem of the teaching of science at this level. It will prove of special value to teachers in grammar schools and in the education departments of the universities, and much of the book will be of value to those who teach science elsewhere, although the special problems raised by the subject in the secondary modern schools do not receive any attention. In a community the life and prosperity of which can only be sustained by the intelligent and continuous application of the principles of science, and in a civilization which can only continue by a real appreciation of the philosophy and methods of science, it is more than ever necessary that there should be effective teaching of science in all post-primary schools. With the groups of higher intelligence we must ensure that the claims of science, both as a cultural and as a utilitarian subject, are not only understood but also are adequately catered for. Industry and administration attract many well-qualified science graduates who formerly would have entered the teaching profession. The present work does well to deal with the problem of the training of the science teacher in his student days.

The book begins with a succinct account of the history of science teaching in Britain, and its aims and functions. It deals with the problems of school certificate, higher school certificate and university scholarship examinations critically, and comments, "the type of examination imposed often prevents a broad treatment of the subject and tends to reduce science teaching to the memorizing of facts and their reproduction as examination answers". The council of the Incorporated Association of Assistant Masters recently reaffirmed its opinion that in schools with the lower age of entry, the school certificate should normally be taken at the age of sixteen after a five-years course, and it is with this policy in mind that it is considered that the absolute minimum of time which should be allotted to science in the secondary school is two hours per week (three teaching periods) between the ages of ten and twelve, and four and a half hours (six or seven teaching periods) between the ages of twelve plus and sixteen plus. "It cannot be emphasized too strongly that in many instances the apparent failure of science teaching is due to the neglect of this recommendation (made as long ago as 1918) by headmasters and education authorities."

The book deals with laboratories and other science rooms, their equipment and the maintenance of apparatus and supplies. It wisely stresses the value of 'scientific handicrafts' as a part of the equipment of every science teacher. One is impressed by the detailed and comprehensive advice, the result of many years of experience on the part of a large number of practical teachers, in these sections.

The book goes on to give an account of the various methods of science teaching: short and effective sections deal with the project method, group methods, the Dalton plan, class discipline, syllabuses and courses, historical, anecdotal and biographical methods, topic, concentric and unit plans. It has some interesting remarks to make concerning the heuristic method, the psychological development of children in its relation to science teaching. The correlation between the teaching of science and that of other subjects is not forgotten. Other chapters deal with advanced course work, examinations, optical and other aids in teaching, the training of science teachers, first aid in the laboratory and the science teacher and the law. There are useful appendixes on facilities for further instruction in science, examples of 'new type' examination questions and a good bibliography. W. L. SUMNER

THE THEORY OF PRIMARY CALCIFICATION IN BONE

By Dr. MARCEL J. DALLEMAGNE

Laboratory of Experimental Surgery, University of Liège, Belgium

THE theory of primary calcification was advanced in 1928 by Kramer and Shear[1] to explain the stages of mineral precipitation in bone in course of formation. If this theory is to apply to the process of ossification submitted by Roche[2], it will refer to the beginning of the fourth stage, that of the deposit of salt in organic bone.

According to Kramer and Shear, bone salt is not tricalcium phosphate, but is, at any rate at the beginning of calcification, secondary phosphate containing calcium and phosphorus in the quantitative ratio of 1·29. These authors refuse to admit the existence of tricalcium phosphate as a chemical entity and they consider the nature of bone salt to be quite unknown; their hypothesis is that the Ca/P ratio which chemical analysis reveals in bone attains to the normal value of adult tissue (± 2·20), since dicalcium phosphate absorbs lime or carbonate in course of the calcification.

This opinion is derived from the following:

(1) If the classic formula $Ca_3(PO_4)_2$ is attributed to tricalcium phosphate, the formation of this salt must result from a reaction of the fifth order, the possibility of which is open to dispute. Shear and Kramer[3] affirm that they have never been able to obtain proof of the existence of a compound having this formula.

(2) Kramer and Shear refer to the experimental results of Holt, La Mer and Chown[4] and apply to them the solubility product law. Their opinion is that the precipitation of phospho-calcium salt takes place only at the moment when the solubility product of dicalcium phosphate $pK_{sp} = [Ca^{++}] \times [HPO_4^{=}]$ is attained in the liquid phase. This precipitate does not, therefore, correspond to the tertiary salt but to the secondary salt of the type termed by mineralogists 'brushite'.

In an attempt to verify these results obtained in the realm of physical chemistry by experiments on animals, Kramer and Shear made rats rachitic, then cured them and examined the nature of the salts freshly deposited in the osteoid tissue.

They expected to find a Ca/P ratio corresponding to that of dicalcium phosphate; but, on the contrary, they found that the calcium and the phosphorus formed a quantitative ratio greater than that of tertiary salt (1·94).

Although these results constitute a set-back to the theory of primary calcification, it has later been supported by important arguments in its favour.

The chemical study of bone callus[5,6], of the embryonic bone and tooth[7], and of bone of periostic origin[8], reveals that young osseous tissue is far richer in phosphorus as compared with calcium than the adult bone. Fig. 1 shows the evolution of the Ca/P ratio in bone of periostic origin. In tissue of recent formation its value is very low, but it increases progressively as ossification takes place; it passes 1·29, the value of secondary phosphate, and 1·94, that of tertiary phosphate; it then goes beyond this figure and, following the precipitation of calcium carbonate, halts around 2·20, the characteristic figure of adult bone.

One would gladly interpret these results by submitting that, at a certain point in the development of bone, its salt corresponds to brushite susceptible of being transformed into tricalcium phosphate following molecular changes due to local physico-chemical conditions.

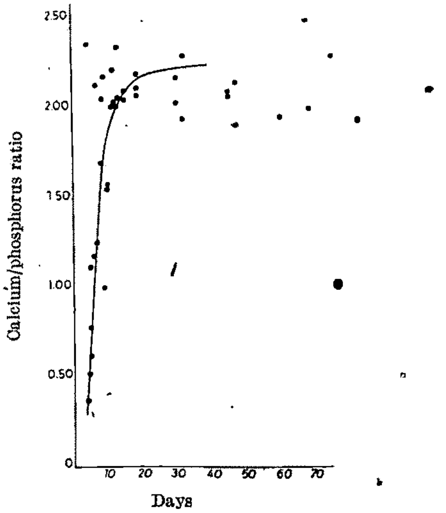

Fig. 1. RISING VALUE OF THE CALCIUM-PHOSPHORUS RATIO DURING OSSIFICATION OF THE HYPERTROPHIC PERIOSTEUM

The possibility of the presence of brushite in young bone is also indicated in the results of Ettori, Grangaud, Benoit and Clavert[9]. These authors study the chemical nature of bone formed in the medulla of some of the long bones following œstradiol administration to pigeons. They determine both calcium and phosphorus together in the newly formed medullary trabeculæ as in the surrounding old diaphyseal bone; they find calcium and phosphorus in a quantitative ratio often nearer to that of secondary salt than to tertiary salt; pigeons are treated from five to a hundred days with a daily injection of 0·25 mgm. of œstradiol dipropionate (the lowest Ca/P ratio would seem to appear after twenty days of treatment).

After examining the whole field connected with primary calcification, we begin to wonder if the arguments which sustain this hypothesis are very convincing.

If the smallest Ca/P ratio found by Roche and by ourselves in bone in course of formation equalled that of secondary phosphate (1·29), which is the salt of calcium and phosphorus richest in the latter element and the least soluble, there would be no doubt. How are we to explain by Kramer and Shear's theory that in very young bone the Ca/P ratio may be less than 1·29? We have found 0·35, and Roche has observed still lower values.

Following these considerations, we proceeded to work out the American authors' theory experimentally from its foundations.

If we add lime to phosphoric acid so as to register *p*H continuously, we obtain the curve (broken line) of Fig. 2. The *p*H rises regularly until a precipitate appears; at this point it falls temporarily. The formation of the precipitate clearly retards the alkalinization of the liquid phase by the lime. The *p*H begins to rise again when the concentration of the anions in solution appreciably diminishes.

At whatever point on the neutralization graph the precipitate phase appears, it always corresponds to tricalcium phosphate; this is demonstrated both chemically and physically[10].

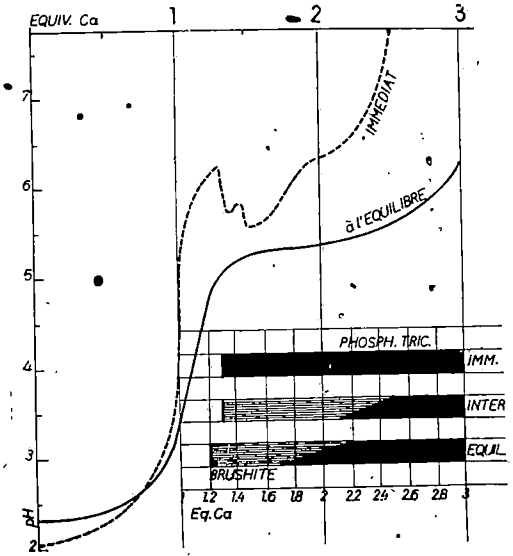

Fig. 2. TITRATION CURVES OF PHOSPHORIC ACID NEUTRALIZED BY LIME ; - - - -, DURING NEUTRALIZATION ; ——, AFTER EQUILIBRIUM. INSET, NATURE OF THE SOLID PHASE AT DIFFERENT TIMES

We are also able to fix each stage of the process of neutralization in separate preparations which we can preserve until equilibrium is obtained; if we take *p*H readings after 15 days, we do not register the same curve : it is much more regular and it has descended in the course of establishing the equilibrium (Fig. 2, full line). This descent is due to precipitation which has slowly taken place and to modifications undergone by the solid phase ; the space between the two curves is the greater because of the abundance of the latter. The composition of the liquid phase has been modified during the establishment of equilibrium, and so has that of the solid phase ; the precipitate is no longer the same at all points of the curve.

From 1·2 to 1·7 equivalents of lime, the precipitate consists of pure brushite. From 1·7 to 2·3 equivalents it is a mixture of tricalcium phosphate and brushite, with the latter gradually diminishing as a greater quantity of lime is added to the acid. Beyond 2·3 equivalents of lime, the solid phase consists of pure tertiary salt.

In the course of establishing this equilibrium, which requires only a few weeks, the precipitate has undergone an intermediate evolution. The original tertiary salt was completely transformed into brushite from 1·3 to 2·05 equivalents of lime and partially from 2·05 to 2·50 equivalents. Brushite, therefore, within certain limits develops and then regresses. This is due to the inverse operation of two reactions : one tends to form brushite at the expense of tertiary salt and the other consists in hydrolysis of the brushite, resulting in reforming tertiary salt.

If the first precipitate formed on contact of the ions Ca^{++} and $PO_4^{\equiv}$ always corresponds to tertiary phosphate, is it possible that, in bone in course of calcification, the neutral salt originally crystallized alters to brushite and then returns to its original condition ? Such a conception in no way agrees with observations which have been made on the deposit of mineral matter in the osseous tissue during growth.

In the course of another series of experiments, we made a particular study of the liquid phase in equilibrium with the precipitate[11]. We observed that in preparations containing brushite crystals, the product $[Ca^{++}] \times [HPO_4^{=}]$ is equal to the solubility constant of secondary salt (Fig. 3, circles). On the other hand, wherever tertiary salt is pure in the solid phase, the liquid phase is under-saturated with secondary salt (Fig. 3, points), and its mineral composition obeys the law $pK_{sp} = [Ca^{++}]_3 \times [PO_4^{\equiv}]_2$. Consequently, in a certain zone of the neutralization graph, although tertiary salt is present, the ionic product corresponds to the solubility constant of secondary salt because the solid phase contains brushite. Nevertheless, in certain samples, there is so little of the latter, on well-defined portions of Fig. 2, that chemical analysis fails to reveal it and returns a Ca/P ratio corresponding to tertiary salt. It can be observed optically only. Kramer and Shear, who do not make use of the optical method of research and of characterization of crystals, have admitted that the total of the precipitate corresponds to dicalcium phosphate with the addition of lime and carbonate ; although it contains only very occasional crystals drowned in the mass of neutral salt ; but these crystals suffice to condition the saturation of the liquid phase with respect to dicalcium phosphate. Further, the zone of the neutralization graph in which the liquid phase is under-saturated with secondary salt and the precipitate entirely constituted of tertiary salt and containing no brushite has not been examined by Kramer and Shear.

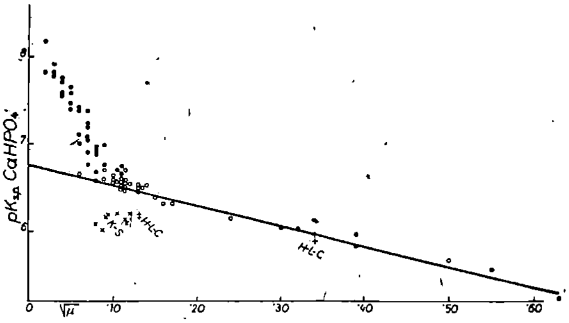

Fig. 3. EFFECT OF THE IONIC STRENGTH OF THE LIQUID PHASE ON THE SOLUBILITY CONSTANT OF DICALCIUM PHOSPHATE

o , Solid phase contains brushite crystals ; ● , solid phase consists of tertiary salt only ; *H-L-C*, values obtained by Holt, La Mer and Chown ; *K-S*, values obtained by Kugelmass and Shohl.

In spite of these authors' observations, the existence of tertiary salt must be admitted as a possibility.

We have also worked out Ettori, Grangaud, Benoit and Clavert's experiments, choosing the condition which enabled them to obtain the lowest Ca/P ratios in pigeon's bone. Unlike Ettori, we prefer, for greater precision, to separate the newly formed bone from the old bone and determine the calcium and phosphorus that both contain. We have never found the Ca/P ratio to be less than that of tricalcium phosphate. So as to confirm the absence of brushite in folliculinic bone by a more exact process than chemical analysis, we measure the refractive index of old bone cortex and of new medullary bone, freed from their organic matter by prolonged boiling in glycerine containing 6 per cent potash.

		Refractive index of mineralized bone (λ = 589·1 A.)
Pigeons control	cortical bone	1·595
	old medullary bone	1·595
Pigeons treated	cortical bone	1·591 ± 0·0004
	new medullary bone	1·590 ± 0·0018
Cattle	cortical bone	1·590
a-Tricalcium phosphate		1·590

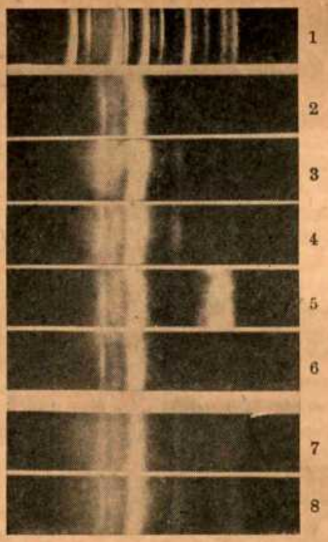

Fig. 4 X-RAY PHOTOGRAPHS OF DICALCIUM PHOSPHATE (1), OF FOLLICULINIC BONE (2–6), AND OF NORMAL DIAPHYSEAL PIGEON BONE (7–8)

As is shown in the accompanying table, the refractive index of new and of old mineralized bone exactly corresponds to that of α-tricalcium phosphate, the hydrated form of tertiary salt[12].

In collaboration with H. Brasseur, we submitted old bone and folliculinic bone to X-ray diffraction, and we obtained in every instance the radiogram of α-tricalcium phosphate, which is very different from that of dicalcium phosphate[13].

These radiograms are grouped together in Fig. 4.

There remains only to consider the opinion of Kramer and Shear in respect to tricalcium phosphate.

We are enabled to characterize tricalcium phosphate in its two forms, hydrated and non-hydrated, by the use of X-ray diffraction and by precise chemical research in collaboration with H. Brasseur[14]. The principal salt present in bone, isomorphous to apatite, is constituted of three molecules of $Ca_3(PO_4)_2$ combined with two molecules of water. When heated to 700° C., the latter are eliminated and tricalcium phosphate answers to the classic formula $Ca_3(PO_4)_2$. Heated to 900°, with a stoichiometrically defined amount of calcium chloride, of fluoride, of carbonate or of oxide, it combines with the latter to form a true apatite.

There is therefore no longer any doubt as to the nature of the stable chemical composition of tricalcium phosphate.

Greenwald[15] introduced an important element which might, if supported by new experimental proofs, cause a modification in the arrangement of the atoms of calcium and of phosphorus in the formula of tricalcium phosphate and which would furnish an answer to Kramer and Shear's objection relative to the manner of formation of tertiary salt. Greenwald submits that tricalcium phosphate is a salt of the acid $HCaPO_4$, the existence of which he thinks he has observed in solution, both in the ionized and non-ionized form. Thus, tricalcium phosphate might originate in course of a second-order reaction which agrees perfectly with the manner of its experimental formation. In its hydrated form, then, α-tricalcium phosphate would correspond to the formula $[Ca(CaPO_4)_2]_3.H_2(OH)_2$.

Thus the theory of primary calcification, having lost both its experimental and theoretical foundations, fails to explain the mechanism of calcification.

How then can we explain, apart from the theory of primary calcification, the progressive rise of the Ca/P ratio in bone in course of formation ?

It is clear that the ions $PO_4^{\equiv}$, when freed from phosphoric esters in the course of the second phase of ossification, must attach themselves to an organic element, for at this point we do not find a sufficient quantity of mineral cations in the bone to constitute an insoluble compound with phosphorus. Possibly it may be to the pre-osseous organic substance itself that they become attached ? But we can say with certainty that by whatever means the $PO_4^{\equiv}$ ions may be fixed in the precursor of the bone ossein, the Ca/P ratio of bone in formation continually rises because the microcrystals of α-tricalcium phosphate are progressively deposited in a tissue rich in $PO_4^{\equiv}$ ions. It is but a coincidence that the Ca/P ratio touches the value 1·29 and in no way explains the presence of brushite in bone in course of formation.

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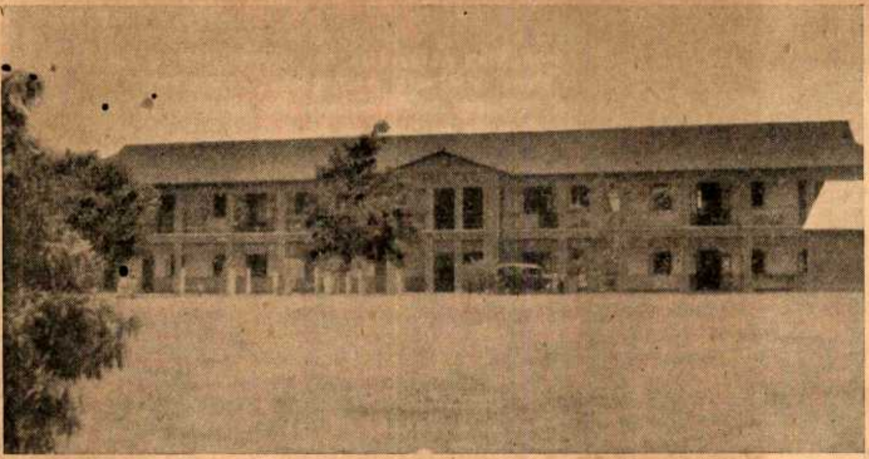
THE WEST AFRICAN CACAO RESEARCH INSTITUTE

By O. J. VOELCKER

A STATEMENT made by the Secretary of State for the Colonies in the House of Commons in 1946 disclosed the fact that a sum of £1¼ million was to be set aside from the profits of the West African Cocoa Control Scheme for cacao research in West Africa. This decision gave effect to the proposal put forward by the previous Government[1].

That a sum of this magnitude should be devoted to research on one specific crop is a matter of considerable interest and importance in the history of agricultural research in the British Colonial Empire. The reason for research on this scale is not far to seek. The territories of the Gold Coast and Nigeria normally produce for export about half the world's 600,000 tons annual consumption of cacao beans, and the wealth of the Gold Coast, and to a lesser degree that of Nigeria, is intimately bound up with the production of cacao. Within recent years, pests, diseases and the degradation of certain soils have led to marked reduction in crops.

The genus *Theobroma* is not indigenous to Africa. The introduction of *Th. cacao* to West Africa is generally considered to have taken place in the



THE WEST AFRICAN CACAO RESEARCH INSTITUTE, TAFO

latter part of the nineteenth century. Over certain areas climatic and edaphic conditions proved favourable for the growth of cacao, and its cultivation by peasant farmers spread rapidly. The migration of pests and diseases from indigenous vegetation to cacao might have been expected under these conditions and has, in fact, occurred. There is evidence that equilibrium has not yet been reached between cacao and indigenous pests and diseases, and further trouble must be expected.

Prior to 1930 cacao research throughout the world had not been impressive, and cacao might well have been termed the Cinderella of tropical plantation crops. In West Africa little attention had been paid to selection, and none to controlled pollination or to methods of propagation; experiments designed to investigate the best methods of growing cacao were few and far between. There were, however, notable exceptions, and among these may be mentioned Cotterell's investigations into the capsid pests *Sahlbergella singularis*, Hagl. and *Distantiella theobroma*, Dist., and Dade's work on black pod disease (*Phytophthora palmivora*), Butl.

In 1930 the Department of Agriculture, Nigeria, followed some years later by that of the Gold Coast, commenced programmes of cacao research on a small scale. Stimulation was further afforded by the inauguration of planned cacao research at the Imperial College of Tropical Agriculture, Trinidad.

The observed deterioration of cacao farms in the Eastern Province of the Gold Coast led, in 1938, to the creation of a research station at Tafo in that Province, to investigate the causes of deterioration and to provide facilities for other lines of cacao research in the Gold Coast. One year later, Posnette demonstrated that much of the deterioration was due to virus disease—commonly known as swollen-shoot. The significance of the discovery of a lethal virus disease of cacao became fully appreciated in London; this and disturbing reports on the prevalence of capsid pests throughout the West African cacao belt resulted in a visit in November 1943 by Sir Harold Tempany, agricultural adviser to the Colonial Office. It was then decided to broaden the scope of the work being done at Tafo to cover all fundamental problems affecting the crop in West Africa. As part of the research programme it was considered necessary to gain reliable information on the conditions prevailing on the cacao farms: the presence or absence of specific diseases and pests, the age of the trees and the location of the farms themselves. The Governments of the Gold Coast and Nigeria, financed to the extent of £105,000 from the £1¼ million, agreed to put in hand at once surveys to provide these data. The adjacent French Colonial Governments also agreed to survey the cacao farms in their territories.

Within the first few months of the commencement of these surveys, small outbreaks of cacao virus disease were discovered in Nigeria. The disease was also found to be widely distributed through the Gold Coast and Ivory Coast, but has not yet been disclosed in the Cameroons. Delay in the discovery of these sources of virus infection and in devising control measures would have jeopardized the whole future of West African cacao.

It stands to reason that the immediate programme of research is to devise control measures against the two major menaces to West African cacao, namely, virus disease and capsid pests. The long-term programme includes fundamental work on the physiology of cacao (edaphic and climatic factors limiting growth and yield), the breeding of improved varieties and the evolution of technical methods of growing cacao and preparing the beans for market. Constant attention will always have to be paid to minor pests and diseases, since experience has shown that these may become of major importance.

The Institute came into being on April 1, 1944, with a European establishment of twenty approved during the year. It has been deemed inexpedient immediately to increase the staff to twenty-seven as recommended by the Cocoa Research Conference held in London in 1945[2]. The establishment consists of a director, a principal research officer, specialists in the Divisions of Pathology and Botany, Entomology, Soil Science and Agronomy, and a secretary. Normally the head of each Division will be a senior specialist. The African staff includes forty technical assistants.

Since 1944 rapid expansion has taken place at Tafo to cater for the increased staff and research activities. The existing laboratories have been purchased from the Gold Coast Government and extended; plans have been drawn up for the erection of permanent houses to replace the ten temporary bungalows, for an administrative building, quarters for African staff and for other permanent structures. Pipe-borne water is to be supplied, and the old station of 270 acres has been increased by the acquisition of a further 640 acres. Detailed topographical, geological, soil and vegetational surveys as well as an aerial photographic survey have been made of the Institute's land. Four experimental sub-stations and one started by the Department of Agriculture in 1940 have been set up in the vicinity of Tafo, and an entomological sub-station has been started in Nigeria.

In spite of the inevitable difficulties of recruiting staff and of obtaining equipment and apparatus, the first three years of the Institute have been productive of results of great importance to the West African cacao industry. This achievement has been made possible by working in the closest collaboration with the Departments of Agriculture, from which the Institute has taken over and developed several lines of investigation initiated prior to 1944.

Much remains to be explored in connexion with swollen-shoot disease; but the field vectors are now known and considerable data have been accumulated concerning the viruses and virus strains causing this disease. While no example of immunity in *Th. cacao* has been discovered, work on tolerance is leading to results which may be of more than academic interest. Control of the disease in the field by rogueing infected trees has been proved, and this method is being adopted with vigour by both the British and French West African Governments.

Although no practical control of capsid pests of cacao has yet been proved, small-scale trials with recently developed insecticides are giving promising results. The system of cacao farming adopted by the Africans and their lack of mechanical skill will, however, act as a severe handicap to the use of mechanical apparatus on which chemical control so largely depends. Unfortunately, no success has yet been obtained on the biological control of cacao capsids. The discovery by the Institute that much of the damage formerly ascribed to capsids alone is, in fact, due to subsequent invasion by the fungus *Calonectria rigidiuscula* (Berk et Brme) Sacc. further complicates the problem.

Definition has now been given to soils in West Africa which are suited to permanent cacao cultivation, and it has been shown that the presence of virus disease or capsid pests is in no way dependent on the type of soil on which cacao is grown. A rapid method of soil surveying, based on the American system, has been evolved by the Institute, and the Gold Coast and Nigerian Governments are now considering putting into effect soil surveys, one object of which would be to assess the area of actual and potential land suited to permanent cacao cultivation.

A valuable collection of varieties of *Th. cacao* has been introduced from the West Indies, South and Central America, and is now established at Tafo. Marked differences in growth are already apparent, and many varieties exceed the West African Amelonado (a lower Amazon type) in robustness. Seven species of *Theobroma* other than *Th. cacao* have also been introduced. The collection is by no means complete; but it will be surprising if that now established by the Institute does not produce plant material of the utmost value either through resistance to diseases or pests, or through increased yields. There is the further possibility that certain varieties may thrive on soils which are not suitable for the growth of West African Amelonado, and thereby extend the range of cacao cultivation.

An ordinance passed in March 1947 by the Gold Coast Government provides for the legal establishment of the Institute and for a statutory committee to control and administer it. After meeting the expenditure on the surveys, the recurrent expenditure of the Institute during 1944–47, and the extraordinary expenditure at Tafo, a sum of some £850,000 remains. The interest from this, fortified by the periodic sale of investments, will provide the Institute with means of meeting recurrent expenditure over the next twenty years.

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[2] Report and Proceedings of the Cocoa Conference, May–June, 1945: Colonial No. 192. (London: H.M. Stationery Office.)

EXHIBITION OF INDIAN ART

IT must at the outset be confessed that to those who know India the Exhibition of Art from India and Pakistan at the Royal Academy, London, is a little disappointing. Since architecture could not be exhibited, it could not really be comprehensive of Indian art; but even so, and in spite of a few superb examples of the carvers' and the armourers' craft, some fine cast bronze and a few magnificent carpets, the bulk of the exhibition consists of sculpture and of painting in miniature. Textiles in general are poorly represented. Nor is all the exhibition very happily displayed. In the first gallery, the material on which small objects are shown is badly chosen in regard to colour, and the labelling is sometimes questionable; the Mohenjodaro copper bull (No. 5) is probably a species of sheep or goat, and the so-called girdle (No. 29) is really too long (4½ ft.) for that purpose, and was probably a neck ornament like some very similar that still survive in at least one marginal area.

The sculpture is inevitably disappointing. Reft from its architectural background, most of it on a very small scale, it would have stood more concentrated grouping than it has received, and it is little helped by a background which fails to show it up. How much difference an appropriate background can make can be judged by the marble arch from Bikanir (No. 279). Even in its own surroundings, and seen on the scale of Ellora, Madura, or Seven Pagodas, Indian sculpture is not easy to appreciate—probably because it is impersonal in style, and the individuality one looks for in European sculpture is suppressed here and subordinated to an abstraction. Indian sculpture bears perhaps to European much the same relationship as the ballet bears to the drama: it is generalized, and individuality is absent. It is possibly significant, therefore, that some of the most attractive sculptures are figures which have lost their heads, like the red sandstone Bodhisattva (No. 207), which is perhaps the best piece in the exhibition, though the magnificent horse from Konarak (No. 276) runs it very close. This horse, it is true, has a head; but it is a live, individual head and it is difficult to suppose that the living prototype had not a personal name given him. An eleventh-century basalt Brahman from Orissa (No. 302) is notable, and among the wood carvings a sixteenth century carving of Krishna (No. 293) in the same gallery.

But the most substantial part of the exhibition is the very large series of Rajput and Mughal paintings. These have much in common with the miniatures in illuminated medieval manuscripts, and the fascination of their execution and conception is often enhanced by their naïvety. On the whole, the Rajasthani and Kangra paintings please more than the Mughal. This is perhaps to be expected, since Muslim painters must often have worked with some misgiving at their infringement of religious injunction, while no such inhibition would trouble a Hindu. There was something particularly suggestive of a Book of Hours about No. 662—Krishna sheltering Radha from the rain, and the Kangra paintings of the heroine, the cat, and the lovebird (No. 652), of Krishna and Radha by moonlight (No. 655), of the messenger's arrival in a storm (No. 680), or of Krishna with the *gopas* (No. 684), struck one in passing as particularly attractive. If one must select among the Mughal paintings, Mansur's hornbill (No. 911) and the portraits of Murad on an elephant (No. 1100), of Muhammad

Riza Kashmiri (No. 1107), of Khan-i-Dauran (No. 1118), of Shah Daulat holding a globe (1124), may be mentioned, while two drawings of a lady at her toilet and a boy holding fruit (No. 1139) are noticeable for the effect obtained with a greater economy of line than the general style of the period would lead one to expect. Very interesting were drawings of Europeans as seen by seventeenth century Indian painters, and the unexpected Mughal copies of Dürer's "Virgin and Child" (No. 1217) and his "St. John the Evangelist" (No. 820), and a sixteenth century Indian drawing of St. Matthew.

But all these very remarkable series of Indian paintings suffer from inadequate description. More explanatory labelling would not have disturbed the general effect, and apart from the crying need for it in regard to so many of the paintings, it should be explained, for example, that the thumb ring (No. 793) was used for drawing a bow; unnecessary inaccuracies, such as describing an obvious pheasant as a "jungle-cock" (No. 896), could easily have been avoided. Moreover, some of the miniatures with the greatest intricacy of detail (for example, No. 534) are hung too far above the eye line, and it is tiresome to find the order of pictures in the catalogue failing from time to time to correspond with the order in which they are hung.

No notice of this exhibition would be complete without mention of the admirable Mughal jade and crystal vessels in Gallery X—No. 1088 in particular—and of the Girdlers' Company's Indian carpet woven for them in 1634. A good many of the modern Indian paintings could have been omitted without loss. On the other hand, it was a pleasant surprise to meet the paintings by British artists in India, the Zoffanys, including Colonel Mordaunt's Cock Match in particular, Tilly Kettle, George Chinnery, and the rest. It is a pity that in Clive's set of ivory chessmen exhibited in the same room the respective sides were mixed when they were set out.

It is to be feared that this account may read a little captiously. That is not ingratitude for such a magnificent feast of the beautiful as has been provided, but rather a feeling that it has not been cared for quite as devotedly as it deserves.

J. H. Hutton

OBITUARIES

Prof. E. C. C. Baly, C.B.E., F.R.S.

The death on January 3 of Prof. E. C. C. Baly, emeritus professor of inorganic chemistry in the University of Liverpool, deprives the scientific world of a vivid and stimulating personality. He was born in 1871, his father, E. E. Baly, being an official of the Bank of England in London. He obtained his scientific training at University College, London, but instead of taking the conventional B.Sc. course he proceeded direct to the Institute of Chemistry qualification. Attracted always to research, particularly in its more romantic aspects, Baly must have found the atmosphere under Ramsay at University College very congenial. Like his chief, Baly loved an element of daring in his investigations, and generations of Liverpool students rejoiced to hear him tell the story of the discovery of the rare gases. This he did with obvious enjoyment and conscious artistry. It was at University College that he acquired his great skill as an experimenter. Indeed, his powers as a glass-blower became legendary. Even after he had suffered the loss of an eye as a result of an explosion in the laboratory, his skill was unimpaired.

Baly was one of the pioneers of spectroscopy. His work on the spectra of the rare gases was a model of its kind, and showed how the artistic side of his temperament was matched by a capacity for careful and precise work of an exhausting nature. He early showed an interest in absorption spectra in relation to chemical constitution, and a long series of papers with colleagues who later earned great distinction laid the foundations of a subject which has grown increasingly important. Baly was elected a fellow of the Royal Society in 1909. He held the post of assistant professor of chemistry and lecturer in spectroscopy during 1903–10 at University College. In 1910 he succeeded Campbell Brown as Grant professor of inorganic chemistry at Liverpool, and held the chair until his retirement in 1937.

Baly's "Spectroscopy" first appeared in 1905 and earned a great reputation as a valuable monograph. The second edition (1912) was nearly 700 pages in length, and the third edition appeared in three volumes in 1927. A fourth volume on absorption spectra of organic compounds was projected, but by that time Baly had transferred his main interest to photosynthesis, a book on which appeared in 1940. The attempt to summarize the vast literature of spectroscopy was a tremendous task, necessitating for a chemist unusually wide reading of physical and astrophysical papers. Over many years Baly prepared reviews of the progress of inorganic chemistry for the Annual Reports of the Chemical Society. Although many will remember him primarily as an adventurous researcher, his great contributions as a scholar should not be forgotten.

During the First World War, Baly became deputy inspector of high explosives for the Liverpool area, and at the end of the War he was awarded the C.B.E.

The post-war 'bulge' found the research laboratories at Liverpool crowded with keen ex-Servicemen, and Baly at the height of his powers. With characteristic courage he threw himself into the very difficult task of imitating in the laboratory the photosynthetic processes occurring in the living plant. In this work he was for a time joined by Prof. (now Sir Ian) Heilbron. The results of these and later researches attracted attention all over the world. They gave a powerful impetus to the continuing attack on a very complicated problem about which much still remains to be elucidated.

Baly's great personal charm, his enthusiasm and his persuasive advocacy, his skill as a musician and his feats as a mountaineer, his verve as a scientific worker and his labours on the councils of the Chemical Society, the Royal Institute of Chemistry and the British Association of Chemists will preserve his memory in many different circles. During his twenty-seven years at Liverpool he gave distinguished service to the University in many capacities.

In 1902 Baly married Miss Ellen Agnes Jago, who, with four sons, survives him.

R. A. Morton

Sir Robert Greig

By the death on November 29 of Sir Robert Blyth Greig, Great Britain has lost a very eminent administrator who in particular did much to further agricultural education and research. A son of George Greig, of Balcurvie in Fife, he was born in March

1874, and his farm upbringing undoubtedly influenced his career. On leaving school he spent a short time in a bank; but farming was in his blood, and after attending classes at the University of Edinburgh, under Prof. Wallace, he went to Canada where, as a very young man, he became manager of a large ranch in Alberta.

On returning to Britain in 1897, Greig was appointed lecturer, first at Cheshire Agricultural College, and later at the Durham College of Science, Newcastle-on-Tyne. In 1903 he married Maud, a daughter of the late Sir George Hunter of Newcastle. In the same year he went to the University of Aberdeen as Fordyce lecturer in agriculture, and during the next eight years took a leading part in building up the high reputation of the University Agricultural Department and the North of Scotland College of Agriculture.

In 1911 Greig was appointed inspector of agriculture under the Board of Education, but had scarcely taken up his duties when he was invited to become one of the three commissioners of the newly formed Board of Agriculture for Scotland, and in 1921 was made its chairman. In 1928, when the Board became the Department of Agriculture for Scotland, Sir Robert became its permanent secretary, and he held this post until he retired in 1934.

In the First World War he served with the Royal Scots in France, and was awarded the M.C. He was knighted in 1919. He held the honorary degrees of LL.D. (St. Andrews), and D.Sc.

Sir Robert travelled widely, visiting Canada, the United States, Australia, and various European countries on agricultural missions, and he was one of the British delegates to the Ottawa Conference. In 1929 he was president of Section M (Agriculture) of the British Association at its meetings in South Africa and, with Lady Greig and their daughter, visited Rhodesia and Kenya on the return journey. In the course of the tour he was in great demand to give talks to farmers and planters; I had the privilege of being with their party, and recall vividly the enthusiasm at these meetings.

During his official career, Sir Robert served on many important committees and councils, including the Carnegie Trust for the Universities of Scotland, of which he became chairman, the University Grants Committee, and the Agricultural Research Council. He was at one time chairman of the River Forth Conservancy Board, and was very active in the establishment of the Imperial Agricultural Bureaux, of which he became the first chairman. In 1940 he became chairman of a Scottish committee to encourage food production in private gardens and allotments, and devoted much time and energy to this work during the War.

Probably Sir Robert will be best remembered for his great services to agricultural education and research. During his period of office at the Department of Agriculture, no fewer than six research stations, now well known throughout the world, were set up in Scotland. These deal with animal nutrition, animal diseases, animal genetics, plant breeding, dairying, and soils, and their establishment was due, in great measure, to Sir Robert's foresight and enthusiasm for research. With the Macaulay Institute for Soil Research he had particularly close connexions, for he was a great personal friend of the founder, the late Mr. T. B. Macaulay, of Montreal, and he never spared himself in furthering the various schemes of agricultural betterment in Lewis and elsewhere in Scotland promoted by Mr. Macaulay. At the time of his death he was chairman of the council of management of the Macaulay Institute. His sincerity and profound knowledge of Scottish agriculture gained for him the respect and confidence of the farming community, and his friendship and encouragement meant a great deal to those of us who were closely associated with him.

When he retired at the age of sixty, Sir Robert was far too vigorous and active to settle down and do nothing. He became a director of the London, Midland and Scottish Railway, and one or two other companies, and threw himself with his usual zest into the new interests without, however, neglecting the old. Perhaps he overtaxed his strength and his death was unexpectedly sudden, but probably he would have wished it so.

It was something of a surprise to find Sir Robert was seventy-three when he died, for he remained so energetic and so youthful in spirit and appearance. His great personal charm and sense of humour made friends for him wherever he went, and those privileged to visit 'Shaws', his delightful home on the outskirts of Edinburgh, will always cherish memories of a charming host and a happy family circle. He is survived by Lady Greig, three sons and a daughter.

W. G. Ogg

Mr. H. W. Pugsley

Herbert William Pugsley, the eminent amateur botanical systematist, died at Wimbledon on November 18. He was born at Bristol on January 24, 1868, and educated at the Grammar School there. At the age of seventeen he went to London to be coached for the Civil Service Examinations, and entered the Department of the Accountant-General of the Navy in 1886, where he remained until his retirement in 1928. After joining the Service he studied privately and obtained his B.A. degree of the University of London in 1889.

He was accustomed to spend his leave studying the floras of Great Britain and of central Europe, particularly of Switzerland, often in company with E. G. Baker and the late C. E. Salmon, who also accompanied him to North Africa in search of daffodils. Ever painstaking and critical, he soon became one of the leading British botanists—to use the general term for those engaged on the study of the flora. Of a quiet demeanour, he worked in close and friendly co-operation with the majority of his contemporaries, but had little patience with those whose identifications he considered slipshod—and occasionally said so.

Pugsley's first important work was on the British capreolate fumitories in 1902: he continued his interest in the genus, and published a monograph of *Fumaria* and *Rupicapnos* in 1919. He was also well known for his researches on *Euphrasia*, and his revision of the British *Euphrasieæ* appeared in 1930. He was interested in narcissi and grew them in his garden for about fifty years: he wrote on the *Poeticus* group in 1915 and monographed the sub-genus *Ajax* in 1933. Orchids had a continued fascination for him, and he wrote several papers on them, particularly the marsh orchids. The British robertsonian saxifrages also attracted him, and he revised the section in 1936. For many years he was engaged on a monograph of the British *Hieracia*. This, which he regarded as his *magnum opus*, is to be published by the Linnean Society, and the last batch of proofs was received during the week of his death. So far as I know, the only recognition of his work was the award of the William Herbert Medal of the American Amaryllis Society in 1940.

His manuscripts were a delight to edit—page after page of foolscap clearly written, with no alterations or erasures.

A little inclined in his later years to dilate on the investigation in hand, he was always willing to give what help he could, particularly to beginners: he was an excellent field naturalist.

He was a keen collector of water-colours, particularly of the Bristol School, and was a well-known frequenter of the sale rooms.

He had six sons, one of the surviving three being Prof. A. J. Pugsley, professor of civil engineering in the University of Bristol.

J. RAMSBOTTOM

Prof. B. Bavink

THE death occurred recently of Prof. Bernhard Bavink, an eminent German teacher of natural philosophy. His great work, "Ergebnisse und Probleme der exakten Naturwissenschaften", is internationally known. His last book, published in 1947, is entitled "Was ist Wahrheit in den exakten Naturwissenschaften ?". He was one of the few men of science who never lost sight of the 'whole' while commanding very specialized knowledge of the sciences. His publications and lectures always attempted to bridge the gulf between modern, technically informed science and the sphere of faith and ethics and all the higher spiritual values. Bavink was born on June 30, 1879, in East Friesland. His last years were sad. A son of seventeen was called up towards the end of the War and was killed. An older son had been a prisoner of war in the U.S.S.R. and died from typhoid fever when he was just expected to go home. In the same year a daughter, lacking the necessary care and food, died of tuberculosis. At the time of his death, Prof. Bavink was on the point of taking a chair at the Stuttgart Technical College.

WE regret to announce the following deaths:

Dr. C. W. Kimmins, chief inspector of the Education Department, London County Council, during 1904–23 and president in 1929 of Section L (Education) of the British Association, on January 12, aged ninety-one.

Dr. John Marshall, reader in mathematics in the University of London (Bedford College), on January 16, aged fifty-seven.

NEWS and VIEWS

Geological Society: Awards

THE council of the Geological Society has made the following awards: Wollaston Medal to Sir Edward Bailey, formerly director of the Geological Survey of Great Britain, in recognition of his researches on the mineral structure of the earth, especially the stratigraphy, structure and petrology of Scotland; Murchison Medal to Dr. J. Phemister, of the Geological Survey of Great Britain, in recognition of his important researches on the igneous and metamorphic rocks of the northern Highlands and his valuable contributions to petrology, mineralogy and geophysics; Lyell Medal to Prof. A. H. Cox, professor of geology at University College, Cardiff, for his researches, particularly on the stratigraphy and petrology of the Lower Palæozoic rocks of Wales; Prestwich Medal to the Abbé Henri Breuil, for his researches on the Quaternary, and especially for his investigations, begun in France, on the succession and correlation of Pleistocene deposits by their contained human artefacts; Wollaston Fund to Dr. J. G. C. Anderson, of the Geological Survey of Great Britain, in recognition of his researches on metamorphic and economic geology and particularly of his work on the Moine and Dalradian rocks of Scotland and Eire; Murchison Fund to Dr. F. W. Cope, of the Geological Survey of Great Britain, for his researches on the stratigraphy and palæontology of the Carboniferous rocks of Derbyshire and adjacent regions; Lyell Fund in two moieties to (1) Dr. Dorothy Rayner, lecturer in geology in the University of Leeds, for her outstanding work on the Mesozoic fishes, notably on the neurocranium, and relationships of the holosteans; and (2) Mr. W. D. Ware, for his researches on Carboniferous stratigraphy and palæontology in South Wales.

Institution of Electrical Engineers: Awards

THE following have been elected to honorary membership of the Institution of Electrical Engineers: Sir Thomas Purves, for his distinguished work in electrical engineering, and his services to the Institution, of which he was president in 1929; and Admiral Sir John Cunningham, First Sea Lord and Chief of the Naval Staff, in recognition of the outstanding part played by him in stimulating the application of electrical techniques in the Royal Navy and the contributions made by officers of the Royal Navy to the applications and development of electrical science and engineering.

The Faraday Medal of the Institution of Electrical Engineers has been awarded to Prof. M. L. E. Oliphant, Poynting professor of physics in the University of Birmingham, for his distinguished work in nuclear physics and his original discoveries in the physical sciences, particularly in the realm of electromagnetic oscillations, their production, study and use. The Faraday Medal is awarded by the Council of the Institution, not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering, or for conspicuous service rendered to the advancement of electrical science without restriction as regards nationality, country of residence, or membership of the Institution.

Industrial Research in East Africa

THE report of the East African Industrial Research Board for the year ended December 31, 1946 (Nairobi. 1*s*. 6*d*.), includes the report of the acting chairman, Mr. H. B. Stant, and separate reports on the progress of the main research projects. The most important of these for agriculture in East Africa is the calcination of rock phosphate with soda ash; a further forty tons of the silicophosphate obtained have been prepared in the pilot rotary kiln for field experiments. The ceramics branch has developed a new technique for building bricks by bonding non-plastic quarry waste with the minimum of highly plastic clay and firing in a kiln to give a building block cheaper than dressed natural stone. Advice has been given to the commercial pottery branch of the Industrial Management Board, and the production of alternative low-cost building materials has received attention, particularly murram, a natural formation consisting of coarse materials, rotten rock or concretionary iron ironstone bonded with clay. Promising results have been obtained in the extraction of pyrethrins from fresh flowers by a three-stage counter-current process, and a hæmoglobin digestion method has been developed for the assay of papain. Further work has been carried out in connexion with the manufacture of totaquina, including improved methods of analysis and study of the conditions for the maximum recovery of quinine and cinchonidine. A method of testing samples of diatomites as filter aids was standardized, and the amelioration of the pollution of streams by effluents from coffee and sisal factories was studied intensively; small-scale plant trials indicate that at least 90 per cent purification of the coffee effluents can be effected by biological filtration. Work was completed on the tannin content of different varieties of mangrove bark.

World Supplies of Oils and Fats

The address "Rebuilding Europe's Fat Supplies the Problem and How to Meet It", delivered by the chairman of Lever Brothers and Unilever, Ltd., at the annual general meeting of that company on September 8, has been reprinted, with a graph and a series of statistical appendixes (Pp. 24. Lever Bros. and Unilever, Ltd., London). The survey of pre-war, war-time and post-war supplies leads Mr. G. Heyworth to the conclusion that there is at present an annual world shortage of some four million tons of oils and fats, and although supplies can be increased, the process will be slow. The tendency for producing countries to consume a greater part of their own products, as well as the tendency towards a heavier consumption of milk, particularly in the United States and Great Britain, and the serious decline in the production of oils and fats in Western Europe, are new contributing factors; and it is estimated that the world production for 1947 will have been about two and a half million tons below the pre-war figure. Allowing for the increase in world population, the gap between supply and demand is too big to permit abandonment of Government controls in either Great Britain or Holland at present; but the control system in Western Europe can be operated so as to improve the terms of trade by more effective combination in the purchase of raw materials and by the removal of subsidies on the finished products.

Mr. Heyworth is emphatically of the opinion that the earliest abolition of the subsidies on food in Britain is essential. Home production in the countries of Western Europe can be increased and production in overseas territories, which were exporters before the War, must be restored to the full, and high priority given to the re-establishment of conditions which make this possible. Additional production must be found by bringing into cultivation unused tracts of land, as typified by the East African Groundnut Scheme, and additional amounts of detergents should be manufactured from materials derived from mineral oil. He even suggested the temporary suspension of the present international limitation on the catching of whales. Finally, he urged better utilization of existing production facilities generally, and the forgoing of expenditure on activities which do not immediately contribute to the alleviation of essential shortages.

Control of Atomic Energy

The Society of Calvinist Lawyers and the Christian Society of Scientists and Physicians in the Netherlands held a meeting at Amersfoort, Netherlands, during November 15–17, 1947, to discuss the problem of atomic energy. Addresses were delivered by Dr. D. J. Lock on "The Military Aspect", Dr. C. C. Jonker on "The Economic Aspect", Dr. Gezina H. J. van der Molen on "The International Aspect", and Dr. R. Schippers on "The Ethical Aspect". The meeting was presided over by the presidents of the two societies, Prof. P. S. Gerbrandy and Prof. G. J. Sizoo. A number of resolutions were adopted, some dealing with spiritual aspects of the problem, and others with the material side. Among the latter, it was noted that the atomic weapon itself does not bring about an essential change in warfare, although the extent of its destructive power is so great that it is not possible to restrict the force of arms to purely military objects. On account of this exceptional character, international control and inspection of the atomic weapon is imperative. Prohibition of the atomic weapon without international control must be rejected as absolutely inefficient in view of former experience with similar prohibitions. Since the application of atomic energy for peaceful purposes leads inevitably to the possibility of preparing for military applications, the production and use of atomic energy for peaceful purposes come within the sphere of international law, and should be put under the supervision and inspection of an international organisation. It was resolved that national sovereignty is not a legal ground for rejecting international control of atomic energy. All nations, it was concluded, should, in view of the far-reaching effects of atomic energy problems, make the utmost effort to find peaceful solutions of international differences.

Horace Wells and Anæsthesia

A century ago, on January 24, 1848, one of the principal actors in the drama of anæsthesia died in prison by his own hand at the age of thirty-three. Born at Hartford, Vermont, on January 21, 1815, Horace Wells studied dentistry at Boston, and practised at Hartford, Connecticut. The idea of inhalation anæsthesia occurred to him on December 10, 1844, during an exhibition of 'laughing gas' by a New York showman, Gardner Quincy Colton, when a young man, Sam Cooley by name, under the influence of the gas severely bruised his leg without apparently feeling any pain. The following day Wells had a troublesome wisdom tooth painlessly removed under nitrous oxide. In January 1845 he went to Boston to demonstrate his discovery at the Harvard Medical School. The experiment went wrong, and the young dentist left the theatre with the words 'charlatan' and 'humbug' ringing in his ears. His physical and mental health now began to decline. The last chapter of his life is steeped in obscurity. On January 24, 1848, in Tombs Prison, New York, he committed suicide under chloroform anæsthesia—slashing his femoral artery with a razor. In 1864 the American Dental Association, and in 1870 the American Medical Association, declared Wells to be the real discoverer of anæsthesia.

Animal and Human Sex Behaviour

ANIMAL and human sex behaviour are the subjects of five papers published in the *Annals of the New York Academy of Sciences* (47, Art. 5, 603–664 ; May 1947). These papers were given at a conference on physiological and psychological factors in sex behaviour held by the Sections of Biology and Psychology of the Academy in March 1946. Prof. S. B. Wortis, in his introduction, says that the conference revealed new material and indicated correlations which emphasize the need to change our attitudes to human sexual behaviour, and he hopes that this material may help to modify the law relating to these matters. He was speaking to Americans, but progressive opinion in Britain has more than once expressed a similar point of view. American and British cultures are not so different that they cannot, in matters like this, be regarded as one. Many of the opinions expressed at this conference will therefore interest British readers of them. There are two papers on animal sex behaviour by W. C. Young, who discusses animal endocrines, and W. E. Galt, whose subject is primate sex behaviour. A. C. Kinsey spoke briefly upon sex behaviour in the human animal, Morris Herman gave a paper on aberrant sex behaviour, and Gregory Bateson gave one on sex and culture.

Historical and Philosophical Society of Jerusalem

IT has often been said that the academic discipline provides a foundation on which international collaboration can be built. The Jerusalem Historical and Philosophical Society, formed in March 1946, with the object of promoting the study of history, philosophy and literature among the Arab, British and Jewish communities of Palestine, is good evidence of such collaboration. The Society meets once a month, when papers are read by members or guest lecturers, and the three subjects, history, philosophy and literature, are taken in rotation, four papers a year being devoted to each subject. Membership is limited and is by invitation only, the sole qualification being an academic interest in one of the three subjects. At present, several of the Arab members belong to the Government Arab College, British members are drawn from the staff of the British Council in Palestine, and Jewish members from the staff of the Hebrew University ; the Department of Education is also represented. So far it has not been possible to print papers in full; but Dr. W. Yourgrau has produced short summaries of seven papers presented during the Society's first year. The president is Sir William FitzGerald, chief justice of Palestine, and the honorary secretary and treasurer is Miss E. Cunnington, Jerusalem, P.O. Box 2.

Calcutta Statistical Association Bulletin

THE publication of *Sankhyā*, one of the leading statistical journals, and the work of Prof. P. C. Mahalanobis, Dr. P. V. Sukhatme and others for national and international statistics, establish India's claim to be considered in the front rank of nations contributing to the theory and application of statistical science. The Calcutta Statistical Association, a new society, has produced a *Bulletin*, the modest aim of which is to publish popular expositions of statistics ; if the journal has the support of the Calcutta school, a high standard should be assured. The first number (No. 1. August 1947. Pp. 1–48. Calcutta, 3*s*.) contains an interesting brief history of crop-sampling in India from the time of Akbar to the present day, a criticism of the recent report of the Indian Central Pay Commission, simple accounts of statistical aspects of public opinion surveying and mental testing, and several shorter notes. The problem of making modern statistical techniques intelligible to readers who lack formal training in the subject has been courageously, though not always successfully, tackled. A more critical approach and increased care in the choice of words should make this *Bulletin* of considerable interest and value outside, as well as inside, India.

Modern Apparatus for Visual Aids

A RECENT publication offers a priced catalogue of representative items in the range of equipment for visual aids in education (Visual Aids : Notes on some Modern Apparatus. By Wilfred J. Garnett. Pp. 36. Manchester : Flatters and Garnett, Ltd., 1947). Each instrument is concisely described, and the pros and cons of each corresponding method of visual presentation are outlined with admirable fairness and objectivity. The most spectacular of the items listed are probably the microprojector and the patent demonstration mirror ; the former as an example of functional efficiency, the latter in view of its comparatively recent development as a visual aid. As a guide to the purchaser of equipment who seeks the best possible results in the way of visual reproduction the author is thoroughly dependable. (The section on "Types of Screen" is particularly helpful, and the actual specimen of 'beaded' screen material does all that is claimed for it.) Technical perfection, however, is not always the last criterion. The technical limitations of film strip sometimes make slides preferable. Yet the growing popularity of film strip among teachers cannot be questioned. The advantages of lightness, compactness and, above all, cheapness are overwhelming. Film strip has come to stay ; can science now produce the non-scratch film ?

Danish Institution of Civil Engineers

IN response to an invitation received from the Danish Institution of Civil Engineers (Dansk Ingeniørforening) Sir Stanley Angwin is representing the presidents of the Institution of Civil Engineers, the Institution of Mechanical Engineers and the Institution of Electrical Engineers in Copenhagen on January 21 and 22 in the celebrations organised by the Danish Institution to mark the opening of their rebuilt headquarters building "Engineering House". The new headquarters replace the Institution's building totally destroyed by the R.A.F. in the spring of 1945, together with the next-door building which the Germans were using as Gestapo headquarters.

International Union of Crystallography

AT the invitation of the American Society for X-ray and Electron Diffraction and of the Crystallographic Society of America, the first General Assembly and International Congress of the Union will be held at Harvard University, Cambridge, Mass., U.S.A., during July 28–August 3, 1948. Delegates to the General Assembly will be nominated by the national academies of countries adhering to the Union; but all crystallographers are cordially invited to attend the International Congress. Those outside the United States expecting to be present are requested to inform the General Secretary (Dr. R. C. Evans, Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England) at a very early date in order that detailed planning may proceed without delay; those willing to contribute papers should at the same time forward details for consideration by the Programme Committee. Crystallographers in the United States will receive separate notification from the American Society for X-ray and Electron Diffraction or the Crystallographic Society of America. It will not be possible for the Union to provide funds to assist delegates in attending the Congress, and crystallographers should therefore make their own arrangements in this matter.

Bristol Symposium on Cosmic Rays

The Colston Research Society, which for many years has made grants in aid of research in the University of Bristol, proposes to support a series of symposia, to be held annually, on selected topics of scientific importance. Papers will be invited from distinguished guests and it is proposed that each year a volume giving an account of the proceedings, including discussions, will be published. The first symposium will be on "Cosmic Radiation", and will be held in the H. H. Wills Physical Laboratory, University of Bristol, during September 20–24, 1948. It will be possible to accommodate a limited number of members of the symposium in Wills Hall, University hall of residence. Further information can be obtained from Dr. C. F. Powell, H. H. Wills Physical Laboratory, Royal Fort, University of Bristol.

Speech Therapy Conference

A Speech Therapy Conference, arranged by the College of Speech Therapists, 68 Queen's Gardens, London, W.2, will be held during September 20–24 at the house of the Royal Society of Medicine. There will be sessions on the following subjects: the aim and scope of speech therapy, the emotional background of stammering, speech disorders arising from head injuries, the speech clinic and the speech-defective child, and the role of emotional problems in producing disorders of speech. Summaries of proposed papers must reach the Secretary not later than March 1. It is hoped to inaugurate during the Conference an International Federation of Speech Therapists. Further information can be obtained from the Conference Secretary, College of Speech Therapists, 68 Queen's Gardens, London, W.2.

Conference on the Family

A conference on "The Family: Whose Responsibility?" is to be held under the auspices of the British Social Hygiene Council and the Town and Country Planning Association in the Conway Hall, Red Lion Square, London, W.C.1, during February 10–11. The chairman of the conference will be Mr. Ivor Thomas, M.P., and chairmen of the various sessions include Dr. Letitia Fairfield, Mr. Walter Raeburn and Sir Anderson Montague-Barlow. Speakers will include Mr. Maurice Reckitt, Dr. Mary Smith, Dr. William Moodie, Miss W. M. Crossman, Mr. B. G. H. Brooke-Taylor, Sir Wilfrid Garrett and Dr. Macalister Brew. Further information can be obtained from the Secretary, British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.2.

Summer School in Micro-Chemical Techniques

In view of the interest shown in the Summer School in Micro-Chemical Techniques held at the Queen's University, Belfast, in 1947, the course will be repeated this year in a somewhat amplified form during June 21–July 3. Lectures will be given together with demonstrations and practical work on standard inorganic microchemical techniques. In addition, limited provision is being made for instruction in selected topics such as physico-chemical measurements on small quantities of material, use of the microscope and micro-electrolytic methods.

Awards for Scientific Journalism

The American Association for the Advancement of Science – George Westinghouse Science Writing Awards for 1947 have been presented to George A. Keaney, feature writer on the *New York World-Telegram*, for his series of five stories on blood, and more especially on the *Rh* factor of blood, which appeared in the *New York World-Telegram*, March 18–22, 1947; and to Steven M. Spencer, associate editor of the *Saturday Evening Post*, for his article, "New Hope for the Anemic" (dealing with folic acid), which appeared in the December 14, 1946, issue of that journal. An honourable mention for the Magazine Writing Award was given Lorus J. and Margery J. Milne, free-lance writers, for their article, "The Life of the Water Film", published in the June 1947 issue of *Natural History*. The two awards, of 1,000 dollars each, are available from funds provided by the Westinghouse Educational Foundation of the Westinghouse Electric Corporation and under the administration of the American Association, and are made in an effort to stimulate and maintain a high standard of science reporting for the lay public through newspapers and general magazines.

Announcements

Under the provisions of Rule II of the Athenæum, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services, the following have been elected members of the Club: Lord Jowitt, Lord Chancellor; Sir Alexander Fleming, professor of bacteriology, University of London; Sir Oliver Franks, provost of Queen's College, Oxford.

Dr. R. L. Smith-Rose, superintendent of the Radio Division of the National Physical Laboratory, has been appointed to the new post of director of radio research in the Department of Scientific and Industrial Research. He will be in charge of the radio research work of the Department, for which a new station will eventually be established. The new station will incorporate the work now being carried out in the Radio Division of the National Physical Laboratory, and the Radio Research Station of the Department of Scientific and Industrial Research at Slough, and also work at present being done for the Department at the Telecommunications Research Establishment at Malvern.

Prof. Frederick R. Miller, professor of physiology in the Faculty of Medicine, University of Western Ontario, has been appointed research professor of neurophysiology in the University.

Dr. R. E. G. Armattoe, director of the Lomeshie Research Centre, Londonderry, has been given a Viking Fund award of about 3,000 dollars to enable him to undertake a field trip to West Africa this year.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Pre-erythrocytic Stage in Mammalian Malaria Parasites

THIS laboratory, in common with many others throughout the world, has for years been working on the life-cycle of malaria parasites in the vertebrate host. The most important details have already been elucidated so far as avian malaria is concerned, but the development of the sporozoites in the prepatent stage in mammalian malaria has remained obscure in spite of the most painstaking and meticulous work in many centres of malaria research.

The latest results obtained by us in this laboratory in the case of monkey malaria, *Plasmodium cynomolgi*, have been striking and, we think, unequivocal. The briefest details of these experiments are as follows.

Anopheles maculipennis, in large numbers, were infected by feeding on a rhesus monkey carrying gametocytes of *Plasmodium cynomolgi*. These mosquitoes, when at the infective stage, with large numbers of sporozoites in the salivary glands, were fed upon a clean rhesus monkey. The total number of anopheles was then ground up in a mortar in heparinized monkey plasma, diluted with normal saline solution, and half the resulting suspension inoculated intra-peritoneally and the other half intramuscularly into the same clean rhesus monkey.

The latter was sacrificed seven days later and various internal organs were taken for examination by smears and in sections. Material was also inoculated into clean monkeys.

This material is now being examined; but the first results obtained are considered worthy of recording here.

In sections of the liver there appeared numerous parasites in the form of plasmodial masses undergoing schizogony. These measure about 25 μ–30 μ in the largest diameter. The masses are clear cut and are scattered through the liver tissue. In sections stained by Giemsa stain, the cytoplasm is a deep blue colour and the discrete particles of chromatin are a magenta colour, both being typical of the usual reaction of protozoal blood parasites with this stain.

Similar results have been obtained in the case of another monkey sacrificed on the sixth day of the incubation period. Further investigation is proceeding.

The importance of these results seems to us to lie in the fact that *P. cynomolgi* is a parasite very closely akin to *P. vivax* of human malaria, and it is reasonable to suppose that the human parasite will show similar developmental changes in the incubation period of an infection.

These results appear to confirm the almost universal belief in the existence of a pre-erythrocytic stage in the mammalian malaria parasites.

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Action of Nitrogen Trichloride on Proteins: Production of Toxic Derivative

FOLLOWING Mellanby's discovery[1] that 'Agenized' wheaten flour, when fed to dogs, produces hysteria, it was shown in a first paper[2] from these laboratories that the syndrome is not due to a nutritional deficiency but to the effect of a toxic substance produced by the action of nitrogen trichloride (the main constituent of commercial 'Agene') upon the wheat protein. Furthermore, nitrogen trichloride can react with other proteins such as casein and zein to produce a similar substance. The simplest conception, somewhat similar to that advanced by Dixon and Needham[3] for the action of mustard gas upon tissues, is that a reactive protein contains a number of centres, *C*, probably of several types, all of which react with nitrogen trichloride; but of these centres only one type, *E*, which may occur at several places in the molecule, is essential for the production of the toxic substance. As this can be produced by the complexes of nitrogen trichloride with wheat protein, casein, zein, egg albumin, hæmoglobin, rice protein and probably many other proteins, it is obvious that the *E* centre is common to most proteins. On the other hand, we have prepared two proteins (arachin and kerateine[4,5]) which absorb nitrogen trichloride to form complexes having no significant toxic effect, while gelatin is in much the same category.

The actual chemical interaction between nitrogen trichloride and *E* at the point of attack can involve only small molecular groupings. Nevertheless, it is almost certain that *E* must be part of a larger unit of form —*A*—*E*—*B*— contained within the protein molecule. The simplest form of unit is an individual amino-acid residue, but our failure to produce canine hysteria after treatment with nitrogen trichloride of the mixture of amino-acids obtained on acid hydrolysis of casein suggests that the unit is larger than a single amino-acid. One such unit, strepogenin, has been recognized as common to several proteins[6], but this particular unit cannot be involved in the toxic substance since it is absent in egg albumin.

If the active *E* centre is a portion of a particular amino-acid, it is necessary first to identify the acid and then to ascertain the nature of any environmental specific groupings necessary for the production of the full toxic effect. Our work has been confined chiefly to investigation of the chemical nature of the reactive *E* grouping.

The facile production of hysteria by the zein complex appears to eliminate lysine, tryptophane and glycine both as *E* centres and as necessary concomitant groups. Similarly, the harmless nature of the kerateine complex with its abundance of cysteine (11–12 per cent) and the marked toxicity of the casein complex with its relatively low cysteine content suggests that this amino-acid can also be ruled out, despite the suggestion of other workers[7].

Recent evidence indicates that the feeble toxicity of a mixture of gelatin and maize starch after treatment with nitrogen trichloride is due partly to the small amount of protein, about 0·4 per cent, in this starch. Gelatin is therefore a useful standard, and a comparison of its composition with that of the highly reactive casein and zein suggests that one or more of the following amino-acids are associated with the *E* centre: methionine, glutamic acid, tyrosine, phenyl-alanine, threonine, leucine and *iso*-leucine.

We have given some attention to the conditions under which nitrogen trichloride reacts with proteins and amino-acids and have found that with proteins the extent of the absorption of nitrogen trichloride from the vapour phase can sometimes be greatly increased by reprecipitation of the protein from a suitable solvent, and in the case of some crystalline amino-acids, by dispersing them in a filler such as starch at a suitable moisture content. Methionine mixed with starch at 14 per cent moisture, similar to that of normal flour, is, however, unique in its capacity to react with nitrogen trichloride, of which it takes up about one third of its own weight. Furthermore, the starch–methionine mixture when treated in this manner to half saturation and fed to dogs produces marked paralysis in their legs; the symptoms, however, pass off in a matter of hours. No such effect is observed at full saturation, while we have been unable to produce the symptoms of hysteria at any dosage. Cysteine reacts with nitrogen trichloride if mixed with starch of 25 per cent moisture content, but we have failed to produce any untoward symptoms in the dog by feeding this product.

If methionine contains the active *E* centre, one would expect that for the production of the toxic substance it would be necessary for it to be present in amount above a critical threshold-level. A comparison of the methionine contents of the proteins so far examined shows that arachin, gelatin and kerateine all contain only about 0·5 per cent, whereas casein, zein, gliadin, rice protein and egg albumin contain at least 2 per cent[8]. Our feeding tests have shown that whereas the latter group of proteins is particularly potent in producing hysteria, the former is of low or zero potency. Our source of arachin was defatted peanut meal, which contains not only large amounts of arachin but also a small amount of a very water-soluble protein of appreciable methionine content[9]. This latter, when separated from peanut meal previously heavily treated with nitrogen trichloride, is highly toxic, whereas the arachin fraction from the same meal is practically non-toxic. Hæmoglobin with its non-protein constituents is a special case; but it has intermediate potency and methionine content.

If this hypothesis associating methionine with the *E* centre is correct, the destruction of methionine in an active protein should destroy its capacity to form a toxic complex. It is therefore of interest to note that when zein and casein are oxidized with hydrogen peroxide in appropriate solvents to destroy methionine[10,11], their capacity to form a toxic complex with nitrogen trichloride, which they still absorb generously, is eliminated. It is, of course, known that this chemical treatment inactivates other portions of the molecule, notably tryptophane and in part cysteine; but, nevertheless, the evidence as a whole suggests strongly that the methionine unit contains the *E* centre, probably at the reactive —S.CH$_3$ grouping.

Glutamic acid might also be considered as an *E* centre[12], but as the non-toxin-producing arachin and kerateine contain 15–17 per cent, or about the same as egg albumin, this seems unlikely. Nevertheless, casein, zein and particularly gliadin are rich in this amino-acid, while gelatin, which produces little of the toxic factor, only contains about 5 per cent. It may be, therefore, that glutamic acid is involved not as an *E* centre but as an essential environmental or concomitant grouping. We have as yet no evidence suggesting that any other amino-acid is involved as an *E* centre.

Nitrogen trichloride appears to be unique among the common flour improvers in producing this toxic derivative from a protein. Thus flour treated with other chemical improvers—chlorine, chlorine dioxide, potassium bromate and ammonium persulphate—at twelve times the normal commercial dosage, produced no abnormal symptoms in dogs when fed for a period of twelve weeks. By contrast, nitrogen trichloride at the same dosage will produce hysteria in one to two days.

Full details of the above and related work will be published elsewhere.

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Enzymic Conversion of Amylose into Amylopectin

POTATO juice was shown by Hanes[1] to contain a phosphorylase (*P*-enzyme) by the agency of which the long, largely unbranched chains of the amylose component of starch were built up from glucose-1-phosphate. The main component of potato starch is, however, the branched-chain component (amylopectin), and this is not synthesized by *P*-enzyme acting alone on glucose-1-phosphate. An investigation instituted by Haworth, Peat and Bourne[2] of the enzyme system of the potato resulted in the isolation of a second enzyme (*Q*-enzyme) which, in conjunction with *P*-enzyme, effected the synthesis of amylopectin from glucose-1-phosphate[3,4]. The cross-linking enzyme (*Q*-enzyme) possesses a dual function. In addition to its synthetic activity, it also functions as an amylase in effecting the hydrolytic, as opposed to the phosphorolytic, degradation of amylose[4]. The synthesis and degradation of starch by the agency of *P*- and *Q*-enzymes is schematically represented in the paper by Bourne and Peat[3].

The hypothesis thus pictorially presented implied that the completed action of *Q*-enzyme on amylose, in the absence of *P*-enzyme and amylases, should result in the conversion of the long unbranched-chain structure of amylose into the ramified short-chain structure of amylopectin without the concomitant liberation of reducing sugars. The experimental confirmation of this hypothesis has had to wait upon the isolation of a purer *Q*-enzyme than was at first available, and has been delayed because of the labile nature of crude *Q*-enzyme and the difficulties encountered in freeing it completely from the normal amylases with which it is associated in potato juice. These difficulties have now been overcome, and by using a modified technique for its isolation, involving the precipitation of the enzyme as a lead complex, it has been possible to isolate a *Q*-enzyme entirely free from amylase of either the α- or β-type. The action of this amylase-free preparation of *Q*-

enzyme on a natural amylose, separated from potato starch by the thymol method[5], has been quantitatively examined and the product isolated. This polysaccharide product is indubitably an amylopectin, and it is formed in such yield from amylose as completely to establish the truth of the hypothesis previously advanced.

Preliminary quantitative experiments with the purified *Q*-enzyme revealed: (i) that thymol-amylose is rapidly degraded by its agency without the simultaneous liberation of reducing sugars, the diminution in the iodine-staining power (blue value) of the amylose being taken as a measure of the extent of the degradation, and (ii) that *Q*-enzyme is more heat-labile than is *P*-enzyme and is, in fact, largely inactivated at 35° C., the temperature of incubation usually employed. In a larger-scale experiment, thymol-amylose of blue value 1·04 was incubated with lead-precipitated *Q*-enzyme at 20° C. The blue value of the iodine complex diminished progressively, reaching a constant value which was approximately 10 per cent of the original in 24 hours. During the reaction, the maximum development of reducing power was equivalent to less than 5 per cent apparent conversion to maltose.

When first isolated, the product contained a high proportion of inorganic material, but it was calculated that the polysaccharide formed had blue value 0·11 and represented at least 90 per cent by weight of the original amylose. The crude product was purified by dialysis in 'Cellophane' against distilled water. There was some loss of polysaccharide during the dialysis, the passage through the membrane of a substance which stained red with iodine being observed. The bulk of the polysaccharide product, however, did not dialyse and was obtained as a white ash-free powder in a yield equivalent to 74 per cent of the weight of the amylose from which it was derived. It was protein-free, and by acid hydrolysis was converted to glucose to the extent of 97 per cent.

In the accompanying table a comparison is made of the properties of the initial thymol-amylose, the amylopectin formed from it by the agency of *Q*-enzyme, and natural amylopectin separated from potato starch by the thymol method and therefore still retaining a certain proportion of the amylose component.

CONVERSION OF AMYLOSE INTO AMYLOPECTIN

Property	Potato amylose (thymol separation)	Synthetic amylopectin from amylose	Potato amylopectin (thymol separation)
Solubility in hot water	Sparingly soluble	Easily soluble	Easily soluble
Stability of solution	Retrogrades	Stable	Stable
Iodine complex:			
Colour	Blue	Red	Red-purple
Blue value	1·04	0·136	0·198
Wave-length of peak absorption	*c*. 6400 A.	*c*. 5200 A.	*c*. 5550 A.
Limit of hydrolysis by *β*-amylase (% conversion to maltose)	90	55	58

The properties of the synthetic product given in the table conclusively demonstrate its branched-chain structure. In particular, the fact that the action of β-amylase ceases when little more than half the polysaccharide has been converted to maltose definitely classifies it as an amylopectin with about the same degree of branching as is found in thymol-amylopectin. The amylose from which the synthetic amylopectin is derived is, on the other hand, almost completely converted (90 per cent) to maltose by β-amylase.

In this conversion of amylose into amylopectin, *Q*-enzyme displays its dual function, inasmuch as the long amylose chains are broken by hydrolytic scission into shorter chains (pseudo-amylose[3]), which are eventually cross-linked to form the ramified structure of amylopectin:

$$\text{Amylose} \xrightarrow{\text{(degradation)}} \text{Pseudo-amylose} \xrightarrow{\text{(synthesis)}} \text{Amylopectin.}$$

The investigation of pure *Q*-enzyme and its role in the biological transformations of starch is being continued. Full details will be published elsewhere.

We wish to express our indebtedness to Sir Norman Haworth, who has inspired so much of the work in this field.

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Adenosinetriphosphate in Glutamine Synthesis

IT was shown by Krebs[1] that the energy required for the synthesis of glutamine from glutamic acid and ammonia which occurs in tissue slices of brain cortex, can be furnished by the oxidation of glucose. In the course of a more general investigation of phosphate-transferring enzymes, evidence has been obtained that adenosinetriphosphate is the immediate energy donor for glutamine synthesis. Since this work was performed, Speck, in a recent publication[2], has reported similar results obtained from work on glutamine synthesis in pigeon liver.

An enzyme system has been extracted from sheep brain which catalyses the formation of glutamine. The extract was freed from adenosinetriphosphatase activity as follows. Acetone-dried grey matter of sheep brain was extracted with ten volumes of water and the solids removed by centrifuging. The crude extract, after cooling to 4°, was mixed with one fifth vol. of 0·1 *M* acetate buffer, *p*H 4·2. The precipitate which formed was centrifuged down and redissolved in water by adjusting the *p*H to 6·7. The purified extract showed negligible adenosinetriphosphatase activity. Glutamine was formed when the extract was incubated in the presence of glutamate, ammonia and adenosinetriphosphate. When the ammonia in this system was replaced by hydroxylamine, a hydroxamic acid was formed which could be estimated by the colorimetric method devised by Lipmann and Tuttle[3] for the estimation of acyl-phosphates.

Incubations were carried out in open centrifuge tubes at 37° for 25 min. The complete system contained acetate buffer *p*H 5·4, 0·25 *M*; magnesium chloride, 0·02 *M*; neutralized hydroxylamine hydrochloride, 0·02 *M*; neutralized cysteine hydrochloride, 0·02 *M*; sodium *l*(+) glutamate, 0·05 *M*; adenosinetriphosphate containing 0·56 mgm. pyrophosphate-P; enzyme solution, 0·5 ml.; final vol., 2 ml.

For experiments showing the formation of amide, the hydroxylamine was replaced by ammonium chloride containing 100 μgm. ammonia-nitrogen. After the period of incubation, the reaction was stopped by the addition of the reagents used for the estimation of the hydroxamic acid[3]. Values of the latter are expressed in terms of a standard prepared from acetyl-phosphate.

TABLE 1

		Details of incubation	Hydrox. acid (μmol.)	Phosphate lib. (μmol.)	Amide formed (μmol.)
Expt.	1	Complete system	2·3	1·86	1·6
,,	2	No glutamate	0·0	0·12	
,,	3	No adenosinetriphosphate	0·0	—	
,,	4	No magnesium salt	0·3	0·2	
,,	5	*M*/100 sodium fluoride present	0·56	0·42	
,,	6	Adenosinetriphosphatase activity	—	0·1	

From Table 1 it can be seen that the formation of amide, or of hydroxamic acid, was paralleled by the liberation of inorganic phosphate from adenosinetriphosphate (expt. 1). The purified extract was almost completely inactive without the addition of magnesium ions (expt. 4) and was inhibited by fluoride (expt. 5). After prolonged dialysis the extract was activated by cysteine. The enzyme is completely specific for the natural isomer of glutamic acid, the *d*(−) form being inactive. Table 2 shows that the formation of hydroxamic acid was dependent on the adenosinetriphosphate added to the system.

TABLE 2

Mgm. adenosinetriphosphate pyrophosphate-P added	0·0	0·056	0·112	0·224	0·56
μmol. hydrox. acid	0·0	0·89	1·45	2·0	2·5

The mechanism by which adenosinetriphosphate enters into the synthesis of glutamine is at present unknown, but one possibility which is being examined is that the first stage in this synthesis might be a transfer of a phosphate group of adenosinetriphosphate to the γ-COOH of glutamic acid, forming glutamyl-phosphate. This could then be expected to react with ammonia or hydroxylamine, to form glutamine or a hydroxamic acid respectively, with the liberation of inorganic phosphate. No accumulation of an acyl-phosphate could be demonstrated when ammonia and hydroxylamine were both absent during the incubation.

Further work on this system will be reported later.

I wish to thank Dr. Malcolm Dixon for the valuable advice he has given during this work and the Medical Research Council for a grant.

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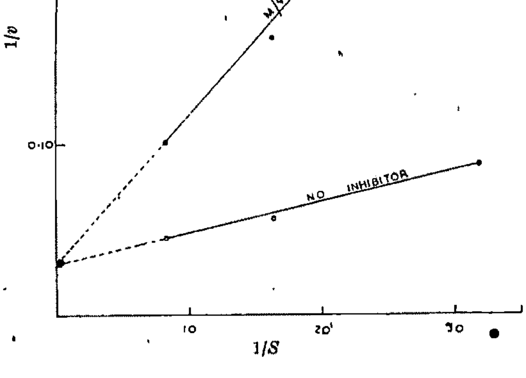
Glutamine-synthesizing System of *Staphylococcus aureus*: its Inhibition by Crystal Violet and Methionine-sulphoxide

IN the course of studies on the assimilation of glutamic acid by Gram-positive cocci, it has been shown that dyes of the triphenylmethane series inhibit some phase of glutamate metabolism within the cells[1]. Other studies of the action of glutamate antimetabolites have shown that methionine-sulphoxide competitively antagonizes glutamic acid in the nutrition of *L. arabinosus*; since it has no inhibitory action in the presence of glutamine, it has been suggested that methionine-sulphoxide inhibits the synthesis of glutamine from glutamic acid[2]. Elliott has described[3] the preparation of an enzyme system from sheep brain which catalyses the formation of glutamine from glutamic acid in the presence of adenosinetriphosphate. A survey of the occurrence of this enzyme in bacteria has now been undertaken.

The formation of a hydroxamic acid in the presence of glutamic acid, adenosinetriphosphate and hydroxylamine was used as a test for the presence of the enzyme system synthesizing glutamine[3]. Thick washed suspensions of *Staph. aureus* showed no activity; but mechanical disintegration of the cells gave an active extract. The organisms were grown for 6 hr. at 37° in a casein-digest medium in Roux bottles, the cells harvested, washed once in distilled water and then made up into a thick suspension of approximately 30 mgm. dry weight of cells per ml. This suspension was disintegrated by shaking with 'glow beads' at 50 vibrations/sec. for 45 min. The solid particles were centrifuged down and the supernatant liquid used as enzyme preparation. It was found convenient, owing to the smaller activity of the crude bacterial enzyme preparation, to modify slightly the conditions of testing used with the brain enzyme[3], as described below. This gave a hydroxamic acid formation large enough to be measured accurately. Incubations were carried out in open tubes at 37° for one hour. The system contained acetate buffer *p*H 5·4, 0·2 *M*; sodium *l*(+) glutamate, 0·06 *M*; magnesium chloride, 0·045 *M*; cysteine, 0·025 *M*; neutralized hydroxylamine hydrochloride, 0·066 *M*; adenosinetriphosphate, 2·46 mgm. pyrophosphate-P; enzyme, 1 ml.; final vol., 4·5 ml. After the incubation period, the colour was developed by adding, in turn, 0·5 ml. each of hydrochloric acid (1 vol. concentrated acid diluted with 1 vol. water), 20 per cent trichloracetic acid, and 10 per cent $FeCl_3.6H_2O$ in 0·2 *N* hydrochloric acid.

The effect of the triphenylmethane dyes was tested on the enzyme. Incubations were carried out in the presence of various concentrations of the dyes,



the latter being extracted with *iso*butanol and finally with ether before estimation of the hydroxamic acid in the photo-electric colorimeter. Crystal violet was completely inhibitory at a concentration of $M/4,000$, although the dye had no effect at $M/40,000$. *p*-Rosaniline at a concentration of $M/2,000$ had no effect.

The enzyme is also inhibited by methionine-sulphoxide, but in this case the inhibition is of the competitive type. In the accompanying graph the reciprocals of the velocity ($1/v$) are plotted against the reciprocals of the glutamate concentration ($1/S$). By extrapolation it can be seen that the maximum velocity (that is, the intercept on the ordinate) is the same whether inhibitor is present or not, showing that the inhibition is competitive[4]. When the concentration of glutamate is 0·033 *M*, $M/90$ methionine-sulphoxide gives an inhibition of 72 per cent; if the glutamate concentration is increased to 0·13 *M*, the same concentration of inhibitor gives 57 per cent inhibition. These findings can be related to the results of Waelsch *et al.*[2], on the effect of methionine-sulphoxide in the nutrition of *L. arabinosus*.

No inhibition of the enzyme system was obtained with sulphathiazole (saturated solution) or penicillin (60 Oxford units per ml.), and the enzyme is formed to the same extent in cells grown in the presence of 4 units penicillin per ml. medium[5].

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Use of Solubility Curves at Varying *p*H and Constant Ionic Strength for the Precipitation and Crystallization of Proteins

PROTEIN solubility curves at varying *p*H and constant ionic strength have permitted us to secure important data regarding the fractionation of muscle proteins of the myogen group. This is illustrated by Fig. 1, showing a set of such curves drawn for a rabbit muscle extract of the same kind as that prepared by Baranowski[1] to obtain crystalline myogen A.

The precipitations are carried out at 22° C. on the 0·5 saturated ammonium sulphate bulk extract, by adding solutions of equal ionic strength, containing ammonium sulphate buffered by phosphates. The precipitates are separated by centrifugation. The refractive index increment of the clear supernatant is measured by comparison with a protein-free solution of the same salt concentration. We use a Pulfrich refractometer with double-compartment prism. Protein concentrations can be estimated within 0·5 per cent by this method. The *p*H values are calculated from glass electrode measurements at 22° C.; no corrections were made for diffusion potentials.

The diagram shows eight different solubility minima at the following *p*H values: 5·59, 5·71, 5·83, 5·95, 6·00, 6·07, 6·52 and 6·70.

The salting-out limits of each protein are determined by the ammonium sulphate concentrations at which a given minimum appears and disappears. The curves show evidence of considerable overlapping in the salting-out of the proteins of our extracts.

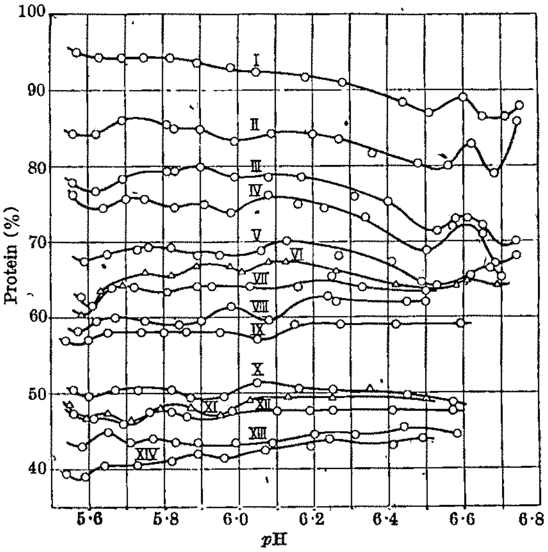
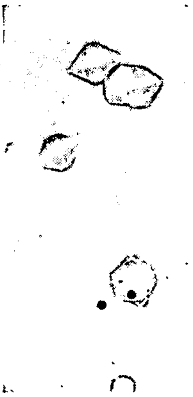


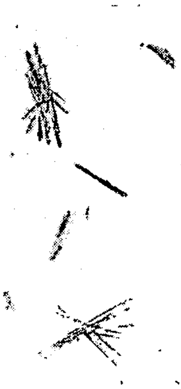
Fig. 1. CONCENTRATIONS OF AMMONIUM SULPHATE IN mol./l.:

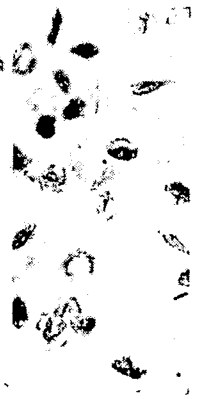
I	2·192	V	2·308	IX	2·401	XII	2·508
II	2·225	VI	2·325	X	2·441	XIII	2·575
III	2·258	VII	2·341	XI	2·475	XIV	2·641
IV	2·275	VIII	2·375				

Salting-out alone could not be used in this case to separate single proteins, but it soon became evident that the diagram indicates the conditions necessary to obtain crystalline proteins: when an isoelectric protein is brought to its saturation point, it has a greater tendency towards crystallizing than any other protein in the mixture.

We have succeeded in preparing three different kinds of crystals from the fraction precipitated between 2·008 and 2·341 mol./l. This fraction is separated at 22° C., at the *p*H of the minima 5·59, 5·83, 6·00, 6·52 and 6·70, using the same precipitating solutions as for establishing Curve VII. The precipitates are dissolved in the least amount of water and the solutions are brought to saturation point by adding small amounts of solid ammonium sulphate. After storage at 4° C., three different kinds of crystals separate at *p*H 5·59, 5·83 and 6·00, as shown in the accompanying microphotographs (Figs. 2, 3, 4). The fractions obtained at *p*H 6·52 and 6·70 are very thixotropic and crystallization seems more difficult.


*p*H 6·00
Fig. 2


*p*H 5·83
Fig. 3


*p*H 5·59
Fig. 4

However, bundles of long needles appear at pH 6·70, but only after prolonged storage.

Work is now in progress to define the properties of the different crystals and their state of purity. We also propose to investigate the possibility of obtaining other crystals.

We think that the facts recorded here are sufficient to demonstrate the usefulness of this solubility method. Fractionation schemes, based on it, can be developed on less empirical bases than usual. The tracing of the different substances in the precipitates is done by using a property common to all proteins, the technical work is quite simple and the method shows itself to be sensitive and of great help for crystallizing proteins in bulk extracts.

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Reaction between Catalase and Hydrogen Peroxide

IN a recent communication in *Nature*[1], Dr. P. George described manometric experiments which showed a rapid initial decay of the enzyme compared with which the well-known decay due to irreversible destruction was so slow that the rate became almost steady. These experiments were carried out with rather high concentrations of hydrogen peroxide.

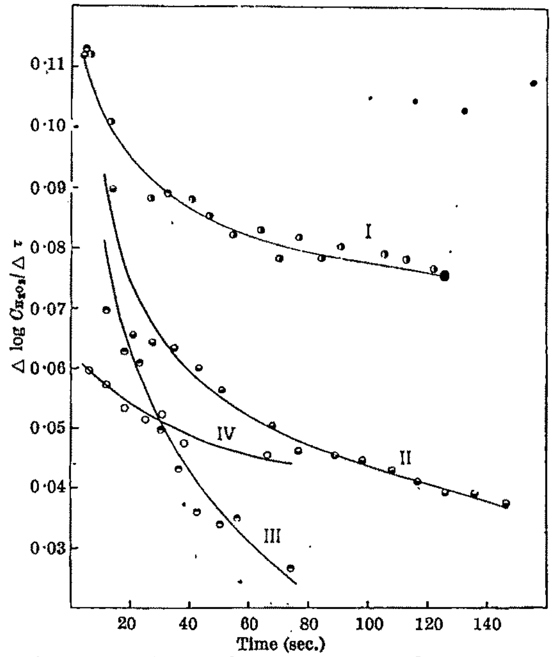
In previous experiments in this laboratory no such initial effect has been observed with the oxydimetric method[2], the reaction following closely the course mathematically deducible from the two equations :

$$-dC_{H_2O_2} = k.EC_{H_2O_2}\,dt \quad \text{and} \quad -dE = k'E.C_{H_2O_2}.dt.$$

With an improved oxydimetric technique allowing exact timing and estimation in intervals of a few seconds, we have now been able to confirm the initial rapid decay. With a hydrogen peroxide concentration of 0·005 M, this technique shows the rapid decay to be limited to the first half to one minute, and the amount of hydrogen peroxide decomposed during it to be small compared with the amount decomposed during the usual three minutes intervals.

In the same article, George described some preliminary experiments on the action of azide and cyanide on the catalytic decomposition of hydrogen peroxide. We have been engaged for some time on a study of azide and cyanide inhibition of catalase with the improved oxydimetric technique. The preliminary results of these studies have been presented in a paper read before the Adelaide Science Congress in August 1946, and are being published in the Congress Reports[3].

The graph shows the variation of the apparent monomolecular reaction constant of hydrogen peroxide decomposition with time. Whereas $1·9 \times 10^{-8}$–$3·9 \times 10^{-6}$ M cyanide causes an immediate inhibition of the enzyme activity and no marked initial rapid decay, $1·1 \times 10^{-7}$ M azide, even if added to the enzyme before hydrogen peroxide, causes no immediate inhibition but a marked rapid decay. There is thus a fundamental difference in the mechanism of inhibition of catalase by azide and by cyanide. These experiments were carried out with horse liver catalase of Kat.-F. 25,000. Identical results were obtained with horse erythrocyte catalase of Kat.-F. 56,000.



ACTIVITY OF $3·5 \times 10^{-10}$ M CATALASE AT 0° C., pH 6·8. I, control ; II, $1·1 \times 10^{-7}$ M sodium azide ; III, $1·1 \times 10^{-7}$ M sodium azide in carbon monoxide ; IV, $3·9 \times 10^{-6}$ M potassium cyanide

According to George, the initial rapid decay is due to the attainment of an equilibrium the kinetics of which agree with the reduction of the hæmatin iron to the ferrous state, as was assumed by Keilin and Hartree[4].

Our experiments support this assumption for the case of catalase in the presence of azide. Carbon monoxide causes an increase in both the rapid decay and the degree of inhibition as measured over longer times. Nevertheless, there are complicating observations. No activation by oxygenation after disappearance of hydrogen peroxide could be obtained. The absorption spectrum of Keilin's azide ferrocatalase[5] was not altered by nitric oxide, whereas carbon monoxide shifted the bands. Moreover, nitric oxide had a specific effect in replacing carbon monoxide and regenerating the spectrum of the original 'azide ferrocatalase'. These observations suggest the overall reaction :

$$N_3^- + Fe^{+++} - \text{catalase} + H_2O_2 \rightarrow NO.Fe^{++} - \text{catalase} + H_2O + N_2.$$

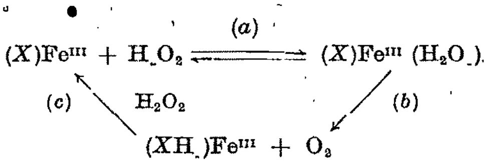
As even in the presence of carbon monoxide we could obtain appreciable inhibition of catalase only by a large molar excess of azide over catalase, the accuracy of the methods available for azide estimation did not allow a direct proof of the oxidation of azide.

Hydroxylamine and hydrogen peroxide yield a spectroscopically undistinguishable compound, and again an oxidation of hydroxylamine to nitric oxide would supply the explanation.

We can confirm the observation that the inhibition of catalase by cysteine is increased by carbon monoxide, and found the same to hold for *BAL* (dimercaptopropanol). No iron is removed from catalase by *BAL*, as has been assumed by Webb and van Heyningen[7] in explanation of the inhibition it causes.

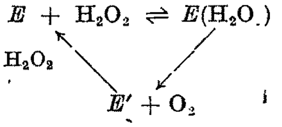
While in the above cases reduction of catalase iron takes place, there is no evidence for such a reaction with uninhibited catalase, or with catalase plus ascorbic acid. Ascorbic acid (neutralized) forms a spectroscopically observable ferric compound with catalase with absorption bands at 565 and 535 mμ; this is not reduced by hydrogen peroxide in an atmosphere of carbon monoxide.

In the paper read at the Adelaide Congress one of us (R. L.) developed a theory of catalytic action which formulates the mechanism as follows:



where X represents a hydrogen acceptor group in the protein.

Catalase is not inhibited by $M/100$ iodoacetic acid; but it is not clear whether it contains essential SH groups[6,8]. While no such reaction of hydrogen peroxide complexes with hydrogen acceptor groups in proteins is known, the specificity of catalase may reside in such a mechanism. The above cycle would correspond to the initial rapid rate. As the 'steady state' of uninhibited catalase is not affected by carbon monoxide, the initial decay is unlikely to be due to slow reduction of the ferric iron by XH_2 after reaction (b). A possible explanation would appear to be a competition for peroxide in step (c) between XH_2 and other hydrogen donor groups in the protein. It is noteworthy that the above cycle corresponds formally with the cycle as postulated by George:



With low hydrogen peroxide and high catalase concentration, catalase acts peroxidatively on alcohols[9]. Under such conditions reaction (c) of the catalytic cycle may be replaced by combination of the iron of the Fe^{III} (XH_2) complex with hydrogen peroxide, followed by oxidation of alcohol bound in the complex. Some observations on the effect of azide and ascorbic acid on the peroxidative action of catalase also support the view of a specific action of the catalase protein.

This work has been supported by grants of the National Health and Medical Research Council of Australia. Full details of the experimental work will be published elsewhere.

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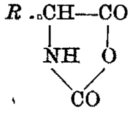
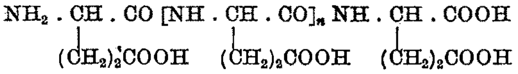
Synthetic Polyglutamic Acid

The recent paper by Woodward[1] records the synthesis of polypeptides of very high molecular weight by the polymerization of N-carbonic anhydrides (I). This reaction is a well-known method of preparing polypeptides[2,3,4], and Go and Tani[5] prepared both a polyglycine of molecular weight about 6,000, and a co-polymer of L-leucine and glycine.

We have been using this method to synthesize a polyglutamic acid (II). This should resemble the capsular substance of *Bacillus anthracis*, which has recently been shown to consist of an α-peptide chain of D-glutamic acid residues joined by γ-peptide chains of D-glutamic acid residues; thus one specimen (H 230 B), molecular weight 21,000, contains about ten γ-peptide links and the α-peptide chains contain 50–100 residues[6]. The infra-red spectra of the silver salt of the synthetic polymer (II) and the silver salt of H 230 B have, in fact, been found by Mr. E. J. Ambrose of this Laboratory to be very similar.



I



$$NH_2 . \underset{(CH_2)_2COOH}{CH} . CO\,[NH . \underset{(CH_2)_2COOH}{CH} . CO]_n\,NH . \underset{(CH_2)_2COOH}{CH} . COOH$$

II

The carbonic anhydride (I: $R = CH_2—CH_2—COOCH_3$) was prepared from γ-methyl L-glutamate; polymerization in cold pyridine gave the methyl ester of polyglutamic acid (II) as a colourless solid soluble only in pyridine. Hydrolysis of this polymer with hydrobromic acid gave partially racemized glutamic acid; since, however, the same specific rotation was observed when L-glutamic acid was heated with hydrobromic acid under the same conditions, partial racemization is ascribed to the hydrolytic procedure. This conclusion is confirmed by the fact that the extent of racemization was independent of the method of polymerization, so that we conclude that no appreciable racemization accompanies the polymerization of this carbonic anhydride.

Hydrolysis of the ester groups in the methyl ester of the polymer (II) was effected by alcoholic, followed by aqueous, alkali. The potassium salt of the polyglutamic acid (II) was purified by dialysis; its molecular weight as determined by Van Slyke amino-nitrogen estimation was about 15,000. Treatment with silver nitrate gave the synthetic silver salt referred to above. The treatment with alkali, however, caused considerable racemization.

A full account of this work will be published later.

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Oct. 3.

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Dielectric Relaxation of Molecules Containing Rotating Polar Groups

DEBYE's theory of dielectric relaxation has been extended to molecules consisting of two similar polar groups, which cannot rotate freely relatively to one another about their common rotational axis owing to their mutual potential energy. As a result the mean dipole moment of the molecule in the field $F = F_0 \exp i\omega t$ can be expressed by a sum of terms of Debye's type, namely, $C_n/(1 + i\omega\tau_n)$. The determination of the relaxation times τ_n and of the C_n's leads to the problem of the characteristic values and functions of a differential equation of Hill's type, the explicit form of which is determined by the potential function $V(\varphi)$, where φ is the azimuthal angle between the dipole moments of the groups.

In order to obtain a first orientation, $V(\varphi)$ has been assumed to have the form $(2/\pi^2)E\varphi^2$; then $2E$, the difference between the potential energies in the equal and opposite directions of the moments of the groups, is a measure of the interaction between the groups; in this case the mean moment of the molecule can be obtained relatively easily with any desired accuracy, for all values of the parameter $q = E/kT$. We give here the results for long wave-lengths only, and for symmetrical molecules in which the components of the dipole moments of the groups perpendicular to the rotational axis are equal (μ_1, say) and the sum of their parallel components is zero. Then the mean moment can be written in the form

$$m = \frac{F}{3kT}\mu^2 (1 - i\omega\tau),$$

where μ is the measurable dipole moment of the molecule and τ is the 'relaxation time for long wave-lengths'. In the case of free rotation, one has $\mu^2 = \mu_f^2 = 2\mu_1^2$ and $\frac{1}{\tau} = \frac{1}{\tau_f} = kT\left(\frac{1}{\rho} + \frac{1}{\rho_1}\right)^1$, and for a rigid molecule, that is, when the relative position of the groups is completely fixed in parallel orientation of their moments, then $\mu^2 = \mu_r^2 = (2\mu_1)^2$ and $\frac{1}{\tau} = \frac{1}{\tau_r} = kT\left(\frac{1}{\rho} + \frac{1}{2\rho_1}\right)^2$. Here ρ_1 is the coefficient of friction of one of the groups, ρ that of the molecule as a whole; ρ refers to rotations about axes which are perpendicular to the axis of the groups. Some values of μ^2 and τ, expressed in the units μ_f^2 and τ_f, are given in the accompanying table. The values of τ are calculated for $\rho/\rho_1 = 2$ and 4; the headings *cis* and *trans* in the table correspond to the cases in which the potential function has its minimum at equal or opposite directions of the moments of the groups.

	Cis			*Trans*		
q	μ^2/μ_f^2	τ/τ_f $(\rho/\rho_1=2)$	τ/τ_f $(\rho/\rho_1=4)$	μ^2/μ_f^2	τ/τ_f $(\rho/\rho_1=2)$	τ/τ_f $(\rho/\rho_1=4)$
0	1	1	1	1	1	1
0·125	1·050	1·076	1·105	0·950	1·001	1·010
0·25	1·099	1·143	1·201	0·901	0·980	0·995
0·5	1·187	1·249	1·348	0·813	0·924	0·914
1·0	1·341	1·366	1·503	0·659	0·780	0·751
2·0	1·546	1·449	1·606	0·454	0·564	0·519
4·0	1·735	1·485	1·649	0·265	0·353	0·312
8·0	1·857	1·496	1·662	0·143	0·200	0·173
16·0	1·926	1·499	1·665	0·074	0·107	0·091
∞	2	3/2	5/3	0	0	0

Experimentally, E. Fischer found[3] that the relaxation time, for long wave-lengths, for *oo'*-dichloro-diphenyl ($\mu = 1·75$) is 1·19 times greater than that for the *mm'*-dichloro-diphenyl ($\mu = 1·68$). When we use for μ_f and τ_f the experimental values of the latter, in which the dipoles of the groups are far enough apart, then the ratios obtained experimentally are $\mu^2/\mu_f^2 = 1·085$ and $\tau/\tau_f = 1·19$, which agree very well with our results for the *cis*-case; the table gives for $q = 0·25$ and $\rho/\rho_1 = 4$ the ratios 1·099 and 1·20, the approximate value 4 for ρ/ρ_1 being obtained on the basis of Perrin's theory. But the results are not in agreement for the *trans*-case. This shows that in the mutual potential energy of the groups, not only the electrostatic interaction of their dipole moments, which favours the *trans*-position, but also other influences are of importance.

The terms used above have the conventional meaning attached to them in the Debye theory. Details of this work will be published elsewhere.

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Emission of Enhanced Microwave Solar Radiation

IT is now well known that radiation in the 1-metre wave-length range from the quiescent sun corresponds to that from a black body at about 10^6 °K., but that when large spot groups are present the effective temperature is many times higher, the extra radiation originating in the neighbourhood of the spot group. The million degree radiation has been explained by Martyn[1], who attributes this to thermal emission from the normal corona. Kiepenheuer has suggested[2] that the enhanced emission comes from thermal electrons spiralling around lines of magnetic force. This idea has been attacked by Martyn[3], and both he and Shklovsky[4] have advanced theories for the enhanced emission involving radiation by electrons oscillating at the fundamental frequency of the plasma.

A theory involving a different origin for the energy, but assuming emission of radiation by spiralling electrons, is outlined below. We consider first a mechanism whereby electrons may gain energies much greater than thermal; and, secondly, the resulting intensities of the radiation received at the earth.

A detailed discussion of the induced currents in the sun's atmosphere consequent on sunspot growth is being published elsewhere[5]. It has been shown that the current paths, which must follow lines of magnetic force, may pass partly through the corona, but that any complete circuit must also lie partly below the sun's surface. Plausible assumptions enable us to predict that if the conductivity be 10^{-8} E.M.U., the current density along suitable circuits will be of the order of 10^{-3} E.M.U. for an average rate of growth of a sunspot. The total E.M.F. around such a circuit may be about 10^{15} E.M.U. The fields can be shown sufficient to cause chromospheric flares[6].

The weak-field conductivity of the sun's atmosphere varies as the 3/2 power of the temperature, so that in the corona it is normally 10^{-5} E.M.U. as against 10^{-8} E.M.U. in the chromosphere. The conductivity changes, however, with electric field-strength. In the weak fields, electrons make frequent elastic collisions with ions. But the collision cross-section varies inversely as the fourth power of the electron velocity, and it can be shown that with stronger fields the elastic collision cross-section becomes quite small, so that the conductivity increases[7]. If the electrons have sufficient energy, inelastic collisions can occur, and in the chromosphere these limit electron velocities unless the field is great enough. Both in the chromosphere and corona, electrons travel unimpeded by collisions for sufficiently high fields.

At any one time the current is constant across all sections of any given circuit, so that for small current densities the field in the corona is 10^{-3} of that in the chromosphere. Passing to the other extreme, relativistic limitations on electron velocities prevent the current density from exceeding $n\ e\ c$, where n is the minimum electron concentration in the circuit, that is, the concentration in the corona. Thus the current density cannot exceed $2 \cdot 2 \times 10^{-2}$ E.M.U. if $n = 10^8$ per c.c. (about twenty times the normal current as given above). Thus if the E.M.F. around a circuit is of the order of 10^{16} E.M.U. (10^8 volts) or more, as may well happen near a rapidly changing spot group, an appreciable part of this may be localized somewhere in the upper chromosphere or corona; the distribution of E.M.F. elsewhere in the circuit will be limited to that which suffices to give the same current as can flow in the corona. Thus electrons may obtain energies up to 10^6–10^7 electron volts there.

If electrons the velocities of which are initially directed along lines of magnetic force are now scattered at collisions, they will spiral around the lines of force. The mean free path between such collisions is so long, however, that this process is unlikely. On the other hand, if the lines of force curve through a large angle, as is certainly so in the corona for the case under discussion, the electrons will spiral around the lines of force, and an appreciable part of their kinetic energy will be involved in such motion.

Bailey has shown[8] that in the presence of a steady magnetic field H in an ionized gas with finite electron density there are three fundamental modes of free oscillation of an electromagnetic field. We shall refer here to only one of these, although the others may also be of importance. This particular mode has a frequency which depends on the electron concentration and on the collision frequency; but when these quantities are both small, this natural frequency approximates to the gyrofrequency, $eH/2m$. For conditions such as occur in the inner corona, variations from this frequency are of the order of only a few per cent, and may be neglected. Selecting 100 gauss as a typical value of the magnetic field, we obtain the frequencies for various electron energies as given in the accompanying table.

FREQUENCY OF RADIATION FROM SPIRALLING ELECTRONS OF VARIOUS ENERGIES

Electron velocity (cm./sec.)	Electron energy (volts)	Frequency per 100 gauss (cycles/sec.)
3×10^8	$2 \cdot 5 \times 10$	$2 \cdot 8 \times 10^8$
3×10^9	$2 \cdot 9 \times 10^3$	$2 \cdot 7 \times 10^8$
$1 \cdot 5 \times 10^{10}$	$7 \cdot 5 \times 10^4$	$2 \cdot 4 \times 10^8$
$2 \cdot 1 \times 10^{10}$	$1 \cdot 7 \times 10^5$	$2 \cdot 0 \times 10^8$
$2 \cdot 7 \times 10^{10}$	$4 \cdot 7 \times 10^5$	$1 \cdot 2 \times 10^8$
$2 \cdot 85 \times 10^{10}$	$7 \cdot 4 \times 10^5$	$8 \cdot 7 \times 10^7$
$2 \cdot 97 \times 10^{10}$	$1 \cdot 8 \times 10^6$	$4 \cdot 0 \times 10^7$
$2 \cdot 997 \times 10^{10}$	$5 \cdot 8 \times 10^6$	$1 \cdot 2 \times 10^7$

The intensity of the radiation emitted per unit surface area cannot exceed that from a black body at the same effective temperature (obtained approximately by multiplying the energy in electron volts by 10^4). Computation shows that, in the absence of self-absorption, the energy emitted by the spiralling electrons would be very much greater than this, so that there is little doubt that, in fact, black body intensities are achieved. For a source of projected area 3×10^{14} metre^2 on the sun (1/5,000 of the sun's disk), the radiation received at the earth would be $1 \cdot 65 \times 10^{-29}\ T$ watts/metre^2/c./s. This is $1 \cdot 6 \times 10^{-19}$ W./m.^{2}/c./s. for 10^6 eV. electrons, which is in the range of magnitude of the observed enhanced radiation[9].

The dependence of the emission on high fields leads us to expect that this would be sometimes associated with flares, which are predicted under rather similar conditions. This is in accordance with observation.

The above theory will be presented in greater detail elsewhere. The work described has been carried out as part of the programme of the Commonwealth Council for Scientific and Industrial Research. I am indebted to Dr. J. L. Pawsey for information concerning observed radiation intensities at the earth's surface, and to Prof. V. A. Bailey for his kindness in placing at my disposal his as yet unpublished results on the natural oscillations of an ionized gas in a magnetic field.

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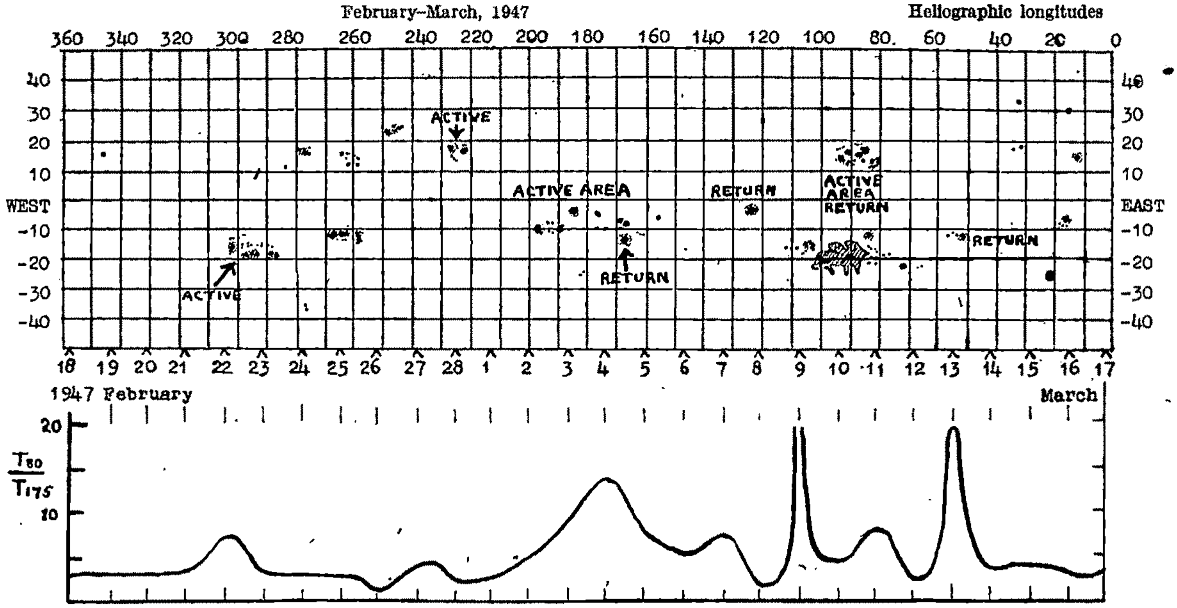
Solar Radio Emissions and Sunspots

THE ratio of the equivalent source temperatures as deduced from observations of solar electromagnetic radiation for frequencies of 80 Mc./s. and 175 Mc./s. (T_{80}/T_{175}) by Ryle and Vonberg[1] would appear to have considerable significance to solar as well as radio physicists.

A comparison of their curve of (T_{80}/T_{175}) for the period December 1946–April 1947 with sunspot records shows a surprising general agreement. It was recognized at a very early stage that the amount of radio-frequency emission from the sun was probably dependent in some way on sunspots[2], and this was confirmed later by several workers[3,4,5] covering short periods generally during the passage of one of the large sunspot groups which have been frequent during the present solar maximum period. The index used by Ryle and Vonberg, however, is of such a nature, and covers a sufficiently long period, that a comparison with sunspot records is possible. From records at this Observatory, it was nearly always



possible to ascribe some significant sunspot group to each of the maxima of the curve, which, at least qualitatively, appears to follow spot activity faithfully.

By following the curve through, the accompanying table shows how the variations agree with sunspot activity. Small pores and insignificant groups have been neglected. The remarkable general agreement is shown in the accompanying diagram for the solar rotation No. 1250 from February 18 to March 17 as an example.

Case No.	Date from curve	C.M. passage sunspot	Helio. lat.	Remarks
1	Dec. 17	Dec. 17	− 8°	Large spot, rapid growth.
2	Dec. 23	Dec. 21·6	+10	Fairly regular spot preceded by moderate group. Remnant of active region.
3	Dec. 27	Dec. 28	+18	Moderate spot.
4	Dec. 31– Jan. 9			No outstanding spots, but curve variations correspond with C.M. passages of small spots.
5	Jan. 12	Jan. 12·5	− 6	Large single spot with following train. Remains of (1). Active region with small outbreaks following.
6	Jan. 20	Jan. 20·5	−12	Moderate group. Great development.
7	Jan. 25	Jan. 26·9	−20	Large group. Rapid development.
8	Jan. 31			Nothing.
9	Feb. 6	Feb. 5	−15	Moderate spot with groups preceding and following. Small southern outbreaks on 3rd and 5th.
10	Feb. 11	Feb. 11	−19	Large leader of active group.
11	Feb. 15	Feb. 16·5	−15	Approx. mean of active area represented by two groups.
12	Feb. 22	Feb. 22·9	−19	Active group. Return of (7).
13	Feb. 28	Feb. 28	+18	Small but active group.
14	Mar. 4	Mar. 4·5	−15	Large spot preceded by several spots. Return of case (9).
15	Mar. 9	Mar. 10	−20	Giant group. Return of (11).
16	Mar. 13	Mar. 13	−12	Small spot and prominence in high N. lat. on C.M.
17	Mar. 22	Mar. 21	−13	Moderate spot, but a considerable outbreak immediately preceding it on March 20 and developing rapidly.
18	Mar. 30	Mar. 29·2	−10	Large spot. New, but in same area as (4).
19	Apr. 7	Apr. 7	−23	Giant group. Return of (15).
20	Apr. 19	Apr. 19	−18	Moderate group.

If the connexion is as real as is suggested, then the emission from the undisturbed sun would appear to give an equivalent temperature varying somewhat less than λ^2 as indicated by Ryle and Vonberg, and more nearly to an exponent of λ between 1 and 2. Also, the suggestions of periodicities of 28, 27 and 26·3 days would appear to have no significance, except perhaps the 27-day period, since such periods in particular cases would be due to the vagaries of sunspot activity itself.

So far as the graph can be read, two other points are confirmed: (*a*) the maximum emission is received somewhere near the time of central meridian passage; (*b*) in general, groups in the early stages of vigorous development, or showing activity by large umbral movements and changes and accompanied by flares, give the greatest emission.

Various factors would make the relationship between times of central meridian passage of sunspots and maximum radio-frequency emission difficult to determine in individual cases. They might be summarized as follows:

(*a*) In the case of a large complicated spot or active area zone, the emission intensity may vary over the area.

(*b*) The axis of the magnetic field may not be perpendicular to the photosphere as is suggested by Martyn[4].

(*c*) A large spot or group takes an appreciable time to cross the central meridian, and just what part should be taken for timing, if (*a*) holds, is debatable.

(*d*) Flares apparently greatly increase the radio emission in the form of short bursts, even when the flare is not exactly on the meridian, and the general emission remains at a fairly high level for some hours following[5,6], due to the remaining bright *Hα* flocculi. This may have an upsetting factor on any radiation index used for correlation.

(*e*) There is slight evidence that increased emission may also occur at the time of central meridian passage of certain types of prominences unassociated with sunspots. This would provide an additional masking effect.

A statistical study of a large number of observations would probably eliminate these factors, for the general case. From observations made in New Zealand on 75 Mc./s., a few cases have been noted in which there has been an increased radio emission without any obvious solar feature with which the phenomenon may be connected. The results, however, are still in the process of reduction, and no definitive statement can be made at the moment.

It is suggested that astronomers with more complete and accurate solar data than is available at this Observatory may be able to make a close analysis of the work considered in this note.

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Carter Observatory, Wellington, W.1,
New Zealand.
Oct. 9.

[1] Ryle and Vonberg, *Nature*, **160**, 157 (1947).

[2] Appleton, *Nature*, **156**, 534 (1945).

[3] Pawsey, Payne-Scott and McCready, *Nature*, **157**, 158 (1946).

[4] Martyn, *Nature*, **158**, 308 (1946).

[5] Lovell and Banwell, *Nature*, **158**, 517 (1946).

[6] Ellison, *Nature*, **158**, 450 (1946).

MR. THOMSEN has made an interesting analysis of our results in relation to the positions of sunspot groups. I should, however, like to make two comments.

(*a*) The suggestion (originally made by Appleton and Hey[1]) that the equivalent temperature varies as the square of the wave-length referred only to the high-intensity radiation associated with sunspots. The improved sensitivity of our apparatus makes it possible to detect solar radiation at all times, even on frequencies as low as 80 Mc./s., and the results obtained during the past eleven months show that for frequencies of 80 Mc./s. and 175 Mc./s. the ratio of the minimum equivalent temperatures which have been observed is about 2·2.

Until more information is available on the conditions of escape of radio-frequency radiation from sunspot regions, this method of determining the ratio T_{80}/T_{175} for the undisturbed sun appears more reliable than simultaneous observations on the two frequencies made at times when no disturbed region appears to be near the central meridian.

(*b*) The ratio T_{80}/T_{175} has now been plotted for a period covering twelve solar rotations, and additional confirmation has been obtained of the suggestion (made in our previous communication) of an apparent periodicity of this ratio. During this time the existence of three major 'active regions' is suggested by our results, with mean periodicities of 27·9, 27·0 and 26·3 days. The disturbances can be followed for 5, 7 and 11 solar rotations respectively.

While these results cannot yet be regarded as sufficient proof, they seem to provide good evidence for the existence of long-lived active regions, which at some time in their development give rise to the appearance of visual sunspots.

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Cavendish Laboratory,
Cambridge.
Nov. 27.

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Structure of Calcium Fluoride Films Evaporated on Polished Glass Surfaces

CONSIDERABLE research has been carried out on the structure of thin films of calcium fluoride deposited by evaporation on polished surfaces[1-5]. But very little, if any, attention has been paid to the temperature of the surface during the period of deposition. In a letter published in 1946[6], it was shown that this temperature plays an important part in the adhesiveness, the water solubility and the optical properties of quarter wave-length anti-reflexion films evaporated on to glass. It has now been found, mainly from X-ray examination, that the structure of a film depends very much on the temperature of the glass surface during the process of evaporation. Initial results of this investigation were included in the letter mentioned above.

In continuing the measurements, the same Seeman-Bohlin type of powder camera was employed. This camera has a radius of 10 cm. and records X-rays scattered through angles up to about 80°. With the iron $K\alpha$ radiation used, it is capable of recording the three strong spectral lines 111, 220 and 311 of calcium fluoride. With films having an optical thickness of $\frac{1}{4}\lambda_{5500}$, it was impossible to obtain sufficiently clear photographs of some of these lines. The line 220 was always present, irrespective of the temperature of the glass surface during coating. It was difficult to determine whether the line 111 was present or not as the angular deviation for this line is 36° only and the background of scattered radiation was comparatively strong. The line 311 was difficult to see one reason being that it was weakened on account of its distance from the irradiated calcium fluoride coated surface. For $\frac{3}{4}\lambda_{5500}$ films some photographs were taken, and it was found that the three lines were present in the case of films on glass surfaces maintained at about 25° C. during deposition, but the line 111 was absent for films on surfaces maintained at 105° C

In order to procure clearer photographs it was decided to work with calcium fluoride films having an optical thickness of $5/4\ \lambda_{5500}$. These films proved sufficiently thick to give good definition with an exposure of 50 milliampere-hours. Results have so far been obtained for crown and flint glasses, the polished surfaces of which were maintained at various temperatures, T, during coating. Below is a summary of the results for crown glass ($n_D = 1{\cdot}52$): (*a*) When T is 25° C. the line 111 is fairly strong, the line 220 i weak and the line 311 is very weak; (*b*) when T i 75° C. the line 111 is fairly weak, the line 220 i rather strong and the line 311 is very weak; (*c*) when T is 105° C. the line 111 is absent, the line 220 i strong and the line 311 is very weak; (*d*) When T has various values between 105° C. and 300° C., the line 111 is absent, the line 220 is strong and the lin 311 is very weak.

Microphotometer measurements of the half-width of the strong 220 lines indicate that there is a growth of the crystallites as T increases from 100° C. to 300° C. This growth would correspond roughly to an increase in mean crystal diameter from 170 to 250 A.

Using crossed nicols and monochromatic light there was very little evidence of the double refraction phenomenon[3] in the case of films for which T wa 25° C. Double refraction was definitely present fo 75° C. films. It appeared to reach a maximum valu for those at about 100° C. and then weakened as T increased to 300° C. When a drop of liquid (chloroform acetone mixture) having a refractive index of abou 1·35 was allowed to spread over the surface of a 100° C. film, say, the double refraction disappeared and returned as the liquid dried away.

Results very similar to those given above wer found when *D.F.* and *E.D.F.* glasses were used.

It may reasonably be concluded from the data that in $5/4\ \lambda_{5500}$ films, for which T is 25° C., the (111) planes of the crystallites are not appreciably orientated. There is considerable orientation o these planes, however, at 75° C. and a random arrangement of the (110) planes. For T equal to 105° C., the orientation of the (111) planes appears to be practically complete. For T equal to 75° C. and greater, the (311) planes give in all cases a line much weaker, in proportion to the line 220, than is to be expected. As there is no evidence, from the positions of the lines in the X-ray photographs, of any change in the crystallites from the cubic system, the double refraction phenomena, mentioned above, indicate that the films are in general of a fibrous construction. The weight of evidence points to the fact that when the (111) planes are orientated they are perpendicular to the axes of the fibres and approximately parallel to the glass surface[3,4]. Consequently, from our results it would seem that there is very little fibre structure in films for which T equals 25° C. and that the structure is not complete in those where T is 75° C. It has already been shown[6] that $\frac{1}{4}\ \lambda_{5500}$ calcium fluoride films increase in density and decrease in thickness as T increases, and from our observations the same seems true for $5/4\ \lambda_{5500}$ films. These changes, for the higher values of T, indicate a crowding together of the fibres and contractions in their lengths. That a maximum double refraction effect appeared for T equal to about 100° C. might easily be expected if the fibres shortened and stood more closely together above this temperature, and if the fibrous arrangement were not complete below this value.

The structure suggested for films of $5/4\ \lambda_{5500}$ optical thickness would seem, from the measurements made so far, to be applicable to $\frac{3}{4}\ \lambda_{5500}$ films, and probably also to $\frac{1}{4}\ \lambda_{5500}$ films. These $\frac{1}{4}\ \lambda_{5500}$ films, as already stated, are very adhesive and water-resistant for large values of T. The reason appears to be that, for such temperatures, the fibres have contracted considerably and have become closely packed.

It is intended later to publish a paper which will include a more complete account of the investigations leading to the results described above.

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Department of Physics,
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Sept. 10.

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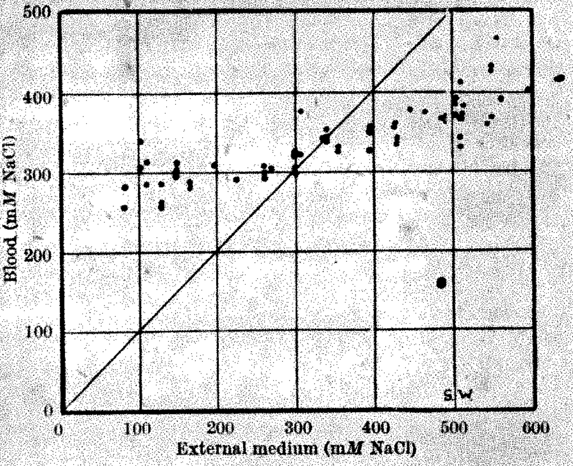
Active Regulation of Chloride in *Metapenæus monoceros* Fabricius

Metapenæus monoceros is a widely distributed Indo-Pacific prawn often met with in shores and estuaries liable to great variations in salinity. At Madras, it is a common inhabitant of the saline part of the Adyar and Cooum Rivers, and sexually mature as well as post-larval prawns have been obtained in brackish water[1]. Dakin[2] has recently reported that the Australian species of *Metapenæus*, which is usually known under the name *M. monoceros* but is believed to be different, breeds in the coastal lakes and estuaries unlike other Penæids. As part of a programme of study on the osmotic regulation in Penæid prawns, we have recently examined the changes in the chloride content of blood in this prawn by employing the micro-modification of the Volhard titration as described by Wigglesworth[3]. The results obtained appear to be of considerable interest since powers of active regulation of chloride are developed to a very high degree in this prawn (see graph).



CHANGES IN THE CHLORIDE CONTENT OF THE BLOOD OF *Metapenæus monoceros* IN DIFFERENT CONCENTRATIONS OF THE EXTERNAL MEDIUM

Diagonal line indicates where points would fall if the chloride concentration for external and internal media were identical. Each point represents mean values obtained for estimations carried out on a single specimen. *S.W.*, range of undiluted sea water

The amount of chloride in blood is in the neighbourhood of 2·2 per cent sodium chloride as against 2·9–3·0 per cent for the external sea water, showing a definite tendency on the part of the animal to resist the uptake of chloride. An average of twelve estimation in animals kept under identical conditions in sea water gives chloride values of 2·16 per cent sodium chloride (370 mM.) for blood as against 2·92 per cent (500 mM.) for the external medium. An external salinity equivalent to 1·9–1·8 per cent sodium chloride (20 per mille) gives approximately similar values for blood and the external medium, but in media of still lower salinities the animal is able to maintain a fairly steady chloride concentration; and even in the lowest salinity of 5–6 parts per mille to which the species has been acclimatized in experimental tanks, there is no fall in chloride concentration below about 250 mM. These values in low dilutions of sea water are very much higher than in many other euryhaline animals on which studies have been made. On the other hand, chloride values for prawns kept in sea water are appreciably lower than for most marine invertebrates[4,5]. A general similarity between this species and the Chinese wool-handed crab (*Eriocheir sinensis*)[6] may, however, be found.

The significance of these results lies in the fact that the Penæid prawns show in their osmotic properties a condition probably similar to that described for the Palæmonid prawns[7], both in their ability to maintain a hypotonic blood in defiance of the external medium and the homoi-osmotic behaviour as judged by the fairly steady values for chloride over a wide range of dilutions of the external medium. From these observations on *Metapenæus* it also seems probable that the hypotonic osmo-regulation in the few instances described[7,8], which is presumably of much wider occurrence than is at present realized, is achieved as a result of the active regulation of the chloride ion by these crustaceans.

Further experiments are in progress and will be fully reported elsewhere.

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Sept. 25.

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Development of Cestodes *in vitro* : Production of Fertile Eggs ; Cultivation of Plerocercoid Fragments

Plerocercoid larvæ of *Schistocephalus solidus* and *Ligula intestinalis*, when removed aseptically from their respective fish hosts by means of a special technique, develop into sexually mature tapeworms if cultured *in vitro* in certain nutrient media at 40° C.[1,2]. The eggs, which were produced *in vitro* in large numbers, proved on testing to be infertile. It was tentatively suggested that infertility of such eggs was possibly due to failure of normal copulation to take place within the culture tube, although other factors were also considered.

This and other problems have now been investigated in greater detail in the case of *Ligula*. Plerocercoids were obtained from heavily infected roach (Fig. 1) and cultures prepared by the usual technique[2]. The most significant results were as follows :

(1) The acid (acids ?—unidentified) produced during development proved to be very toxic to larvæ and slowed down development considerably. In order to obtain maturation *in vitro* within a period equivalent to that required in the bird's intestine during the natural life-cycle (that is, about 72 hr.), it was necessary to use 50 c.c. medium per larva and renew it every twenty-four hours. In medium renewed infrequently, 4–8 days incubation was required to induce maturation.

(2) With one larva per tube of 50 c.c. renewed every twenty-four hours, different artificial media were used in an attempt to obtain fertile eggs, but without success. When, however, undiluted horse serum was used, some 6 per cent of eggs produced were found to be fertile, and hatched out normal coracidia. Since these fertile eggs were produced from worms cultured individually in separate culture tubes, it can now be definitely stated that *Ligula* is self-fertilizing, and that copulation between two worms is not essential for the production of fertile eggs.

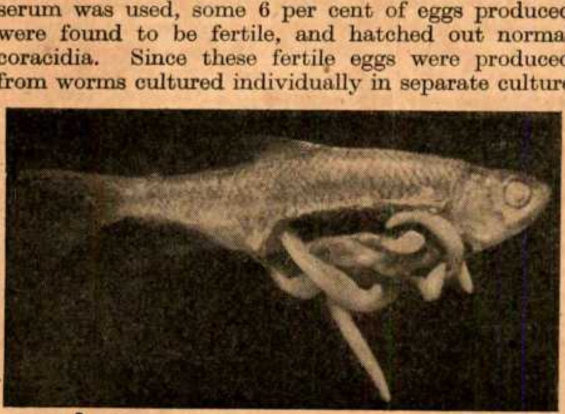

Fig. 1. Roach infected with plerocercoids of *Ligula intestinalis*

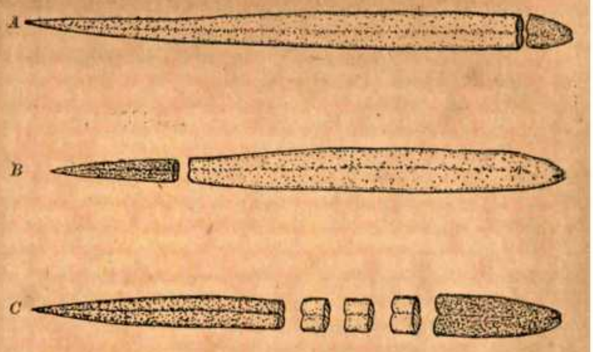

Fig. 2. Cultivation of fragments of *Ligula* plerocercoids. Lightly shaded parts were cultured ; heavily shaded parts were discarded

There are little data to explain the fact that fertile eggs were produced in serum and not in other media ; it can be speculated that possibly serum contains some substances (hormones, vitamins ?) thought to be essential for normal cestode development[3,4,5], or it may be that the physical properties of serum—density, viscosity or osmotic pressure—are more suitable either to the worm itself or to the ejected spermatozoa. Owing to the large quantities required, sera from animals other than horse have not yet been tried as culture media.

(3) The following fragments of larvæ were cultured aseptically at 40° C. in broth : larvæ with scolex removed (Fig. 2*A*) ; larvæ with posterior tip removed (Fig. 2*B*) ; three small pieces about 3 cm. long, cut from the middle region of a large plerocercoid (Fig. 2*C*). All these fragments, although showing reduced activity during cultivation, developed and produced eggs in exactly the same manner as complete larvæ. In all cases, there was no tissue regeneration in either anterior or posterior regions.

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Sept. 30.

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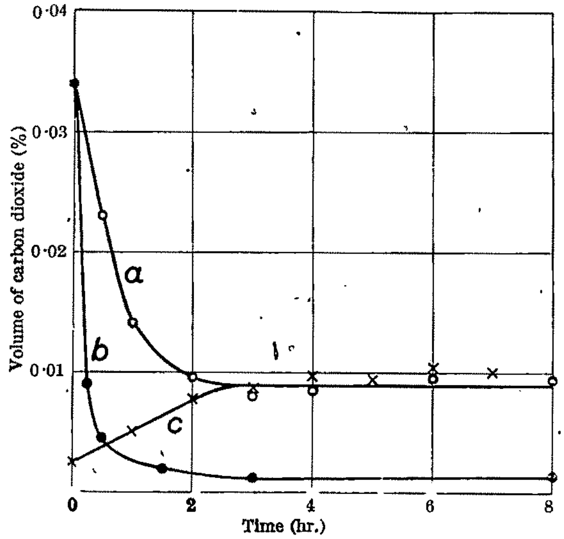
Threshold Value of Carbon Dioxide Concentration in Photosynthesis of Foliage Leaves

How much can the carbon dioxide concentration of the atmosphere be diminished by photosynthesis of green leaves ? Blackman[1], in his researches in vegetable assimilation and respiration, observed that leaves exposed to sunlight took up completely all the carbon dioxide molecules from an enclosed volume of air in a very short time. Reinau[2] did not accept this result which, he thought, was caused by some experimental error. He concluded, entirely on the basis of theoretical considerations, that the carbon dioxide concentration of the atmosphere (mean value 0·030 vol. per cent) could be lowered only very slightly by the photosynthetic activity of leaves. Later, in 1935, the problem was investigated by Miller and Burr[3], who placed potted greenhouse



plants in a chamber inside a closed system through which a vigorous circulation of air was maintained. When the leaves were illuminated with 2,050 foot-candles, they found that the carbon dioxide concentration in no case (thirty-four plants from ten species were employed) could be brought below 0·010 vol. per cent.

However, in Miller and Burr's experiments carbon dioxide was produced inside the apparatus from respiration of roots and stems, and from micro-organisms in the soil. The results, therefore, became expressions of a balance between production and consumption, and did not give correct information about the actual lowest concentration at which photosynthesis can take place.

Aiming at an exact determination of this value, I have, in the summer months of 1947, carried out two series of experiments with leaves of elder (*Sambucus nigra* L.). Stress was laid upon using leaves with fully opened stomata. In the first series (fourteen experiments) leaflets about 30 cm.^{2} in area with the stalk immersed in a little carbon dioxide-free water were placed in a 6,000 ml. separating funnel filled with atmospheric air. After exposure to incandescent light (10,000 lux) from 30 min. to 8 hr., the leaves were taken out through an air trap, and the non-assimilated carbon dioxide shaken out with barium hydroxide. The titration allowed determinations within an accuracy of ± 0·0002 vol. per cent carbon dioxide. The results are shown in the accompanying figure (Curve *a*). In two hours the carbon dioxide concentration was brought down to 0·0090 vol. per cent ± 0·0004 (lowest determination 0·0073), and maintained at this level for at least 8 hr. The temperature of the air around the leaves was 24–28° C. Curve *b* shows the results of control experiments, in which 30 cm.^{2} of filter-paper moistened with 0·8 ml. 10 per cent sodium hydroxide was inserted instead of the leaves.

In the second series (twelve experiments) the leaflets were inserted through the air trap and exposed in air poor in carbon dioxide (mean value 0·0024 vol. per cent). Light and temperature were maintained as in the first series. Under these conditions carbon dioxide was liberated at a steady rate until a level at 0·0089 vol. per cent ± 0·0004 was reached (Curve *c*). The production-rate was calculated from the linear part of the curve and the value found (1·40 mgm. CO_2/dm.^{2} hr.) agreed closely with the rate of carbon dioxide production in respiration of elder leaves in the dark (1·45 ± 0·03).

From these preliminary investigations two facts are clear: (1) There exists a threshold value for carbon dioxide concentration in photosynthesis, which for elder leaves is about 0·0090 vol. per cent. Below this threshold no carbon dioxide assimilation takes place. Thus, it seems that only about two-thirds of the atmospheric carbon dioxide is available for photosynthesis. (2) The rate of carbon dioxide production from respiration is the same in light as in the dark. This finding contradicts the theory of Warburg[4], Miller and Burr[3], and others, according to which an intermediate product of respiration is re-utilized in photosynthesis before any carbon dioxide is liberated.

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Extermination of *Aëdes ægypti* in Khartoum

IN the note referring to Lewis's paper on mosquitoes and yellow fever in the Sudan which appeared in *Nature* of August 9, 1947, p. 186, it is stated that the disease has been exterminated from Khartoum as a result of mosquito control measures. This is not entirely correct. Khartoum is some distance north of the northern boundary of the yellow fever endemic area in the Sudan. Yellow fever has never been recorded in Khartoum, and immunity surveys reveal no evidence of the infection having occurred there during the life-time of the present inhabitants. Any suggestion that the disease has ever been identified in Khartoum might greatly increase the confusion of those who are at present devising regulations to prevent the international spread of yellow fever.

The entity which has been virtually exterminated in Khartoum is not yellow fever but *Aëdes ægypti*. This was apparently first accomplished in 1906 by the energetic anti-mosquito campaigns of the late Sir Andrew Balfour. Since then the mosquito situation in Khartoum has been under constant observation. From records extending over forty years it seems probable that at Khartoum, which is in the southern border of a desert tract unfavourable to the species, *A. ægypti* has never been very abundant, and has been eradicated, to reappear on infrequent occasions and be rapidly destroyed. It is very probable that the infrequent reappearances of *A. ægypti* were due to re-importation, since in the early days this mosquito was regularly brought to Khartoum by river steamers. Lewis states that the mosquito control measures at present in force in the Sudan have had the effect, among others, of very greatly reducing the numbers of mosquitoes, particularly those with domestic breeding habits, carried on steamers. *A. ægypti*, in particular, has not now been reported in steamers for several years.

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LIMITATION OF BACTERIA BY MICRO-PREDATORS IN SOIL

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EIGHTY-SEVEN strains of very varied bacteria, comprising common and rare strains from soil, pigmented and non-pigmented 'miscellaneous' strains, and a number of plant pathogens, were tested on eight micro-predators belonging to four different groups commonly found in soil. The methods used and the results obtained are given by one of us (B. N. S.) in papers dealing with these groups[1-10]. It has been shown that soil micro-predators are very selective in their bacterial food requirements; some bacteria are edible and the others are completely or almost completely inedible. This article deals with the comparative edibility of bacterial strains by these micro-predators, and the probable role of micro-predators in limiting the bacterial numbers in the soil. The following soil micro-predators were used: two unidentified species of amœbæ, a giant amœboid organism (*Leptomyxa reticulata* Goodey), myxamœbæ of two species of *Dictyostelium* (*D. mucoroides* and *D. giganteum*) and three species of Myxococcaceæ (*Myxococcus virescens*, *M. fulvus* and *Chondrococcus exiguus*). The first five organisms are holozoic; the Myxococcaceæ destroy and digest their food by means of secretions[6,10].

TABLE 1

	Large soil amœba		
	Inedible	Edible	Total
Small soil amœba			
Inedible	31	1	32
Edible	7	48	55
Total	38	49	87
	D. giganteum		
	Inedible	Edible	Total
D. mucoroides			
Inedible	28	3	31
Edible	8	48	56
Total	36	51	87
	M. fulvus		
	Not lysed	Lysed	Total
C. exiguus			
Not lysed	37	7	44
Lysed	2	41	43
Total	39	48	87

Of the eight micro-predators tested, it was found that the two soil amœbæ reacted very similarly to their bacterial prey; that is, nearly all bacteria edible to one amœba were edible to the other. Similarly, the myxamœbæ of the two *Dictyostelium* spp. were very similar in their food preferences, as were also two of the myxobacteria, namely, *Myxococcus fulvus* and *Chondrococcus exiguus*. This is shown in detail, in 2 × 2 contingency tables, in Table 1.

Disregarding now one member of each of these three pairs of micro-predators, we consider the following five predators: large soil amœba, a giant amœboid organism (*Leptomyxa reticulata*), myxamœba of *Dictyostelium giganteum* and two myxobacteria (*Myxococcus virescens* and *M. fulvus*). These five are but slightly correlated in their choice of bacterial food. Their relation in pairs is shown in Table 2. It will be seen that there is some tendency, but not very pronounced, for bacteria that are edible to one predator to be edible to any other one. In fact, the number of bacterial strains that are edible or inedible to both of any two predators is of the order of 6 higher than it would be if the two predators made a completely independent selection of bacterial food. There is, however, one exception to this rule, as there appears to be no such correlation between *Myxococcus virescens* and *Leptomyxa reticulata*.

TABLE 3

	Large soil amœba		
	Inedible	Edible	Total
Leptomyxa reticulata			
Inedible	27	21	48
Edible	11	28	39
Total	38	49	87

To make this clear, consider the relation of the large soil amœba and *L. reticulata* (Table 3). If the two predators made independent selections of host bacteria, we should have expected that 48/87 of the 38 bacterial strains inedible to the soil amœba would have been inedible to *L. reticulata* also, that is, about 21, in place of the 27 actually observed. Similarly, we should have expected the number of bacteria edible to both the predators to have been 22 instead of 28, and the two remaining entries to have been each 6 larger, that is, 27 and 17 instead of the 21 and 11.

Considering now the five micro-predators together, we obtain Table 4, showing how many of the 87 bacterial strains tested are edible to 0, 1, 2, 3, 4, 5 of the micro-predators. Thus seven strains are inedible to all predators while thirteen are each attacked by only one predator.

The calculated numbers shown in the last column were obtained assuming that the bacterial strains vary in their intrinsic edibility, some being more

TABLE 2

	Large soil amœba		*Leptomyxa reticulata*		*Dictyostelium giganteum*		*Myxococcus virescens*		*Myxococcus fulvus*		Totals
	Inedible	Edible	Inedible	Edible	Inedible	Edible	Not lysed	Lysed	Not lysed	Lysed	
Leptomyxa reticulata											
Inedible	27	21									
Edible	11	28									
Dictyostelium giganteum											
Inedible	23	13	24	12							
Edible	15	36	24	27							
Myxococcus virescens											
Not lysed	15	9	12	12	13	11					
Lysed	23	40	36	27	23	40					
Myxococcus fulvus											
Not lysed	23	16	27	12	22	17	18	21			
Lysed	15	33	21	27	14	34	6	42			
Gram stain, negative	21	25	26	20	13	33	12	34	14	32	46
,, ,, positive	17	24	22	19	23	18	12	29	25	16	41
Totals	38	49	48	39	36	51	24	63	39	48	87

N.B.—The edible and lysed strains are those which are completely eaten and completely lysed either slowly or readily; inedible and non-lysed strains also include those bacteria which are either very slightly eaten or show very slight lysis.

TABLE 4

Number of predators (out of 5 considered)	Observed number of bacterial strains attacked by the foregoing numbers of predators	Calculated number of bacterial strains
0	7	6·7
1	13	12·1
2	13	16·1
3	17	18·5
4	25	18·6
5	12	15·0
Total	87	87·0

edible to predators than others, but that otherwise it is a matter of chance whether any one strain is edible to any one predator, and there is no tendency for predators to feed complementarily (that is, one generally preferring strains left uneaten by another). The actual mathematical distribution assumed, a type of modified binomial distribution, will shortly be described elsewhere by one of us (F. J. A.). It will be seen that the calculated numbers agree well with the observed.

Thus of the eight micro-predators tested together, five behave in the way just described, showing some tendency, but not a very pronounced one, to feed on the same selection of host bacteria; whereas the remaining three predators are each highly correlated with one of the five already considered, and so not likely to affect appreciably the total number of bacterial strains edible to one or more of the predators. It is interesting to consider, as a matter of speculation, what percentage of the bacterial strains tested would remain inedible by any predator if more predators could be found having the same degree of independence from the five here considered and from one another as these five have from one another. We should expect the percentage of uneaten strains to vary with the total number of predators as shown in Table 5.

TABLE 5

Number of different predators	% of strains uneaten
5	7·7
6	5·9
10	2·6
15	1·3
20	0·8

In Table 2 is also shown the relation of the five micro-predators to the Gram-staining of the bacterial strains. Two of the predators, *Dictyostelium giganteum* and *Myxococcus fulvus*, show a definite negative association, suggesting that they prefer bacterial strains that are Gram-negative. The same will also apply to the similarly behaved *Dictyostelium mucoroides* and *Chondrococcus exiguus*. It should be remembered that many soil organisms such as antibiotic actinomyces and fungi show a strong preference for Gram-positive bacteria. Such organisms will thus tend to be complementary to the above predators in their food preferences.

The remaining predators tested do not show any such association with the Gram-reaction.

[1] Singh, B. N., *Ann. Appl. Biol.*, **28**, 52 (1941).
[2] Singh, B. N., *Ann. Appl. Biol.*, **29**, 18 (1942).
[3] Singh, B. N., *Brit. J. Exp. Path.*, **26**, 316 (1945).
[4] Singh, B. N., *Ann. Appl. Biol.*, **33**, 112 (1946).
[5] Singh, B. N., *Nature*, **157**, 133 (1946).
[6] Singh, B. N., *J. Gen. Microbiol.*, **1**, 1 (1947).
[7] Singh, B. N., *J. Gen. Microbiol.*, **1**, 11 (1947).
[8] Singh, B. N., *J. Gen. Microbiol.*, in the press.
[9] Singh, B. N., *J. Gen. Microbiol.*, in the press.
[10] Oxford, A. E., and Singh, B. N., *Nature*, **158**, 745 (1946).

RESEARCH AND DEVELOPMENT IN BRITISH COLONIAL TERRITORIES

Colonial Research Committee

THE fourth annual report of the Colonial Research Committee, published under the title "Colonial Research 1946–47"*, together with the fourth annual report of the Colonial Products Research Council, the third annual report of the Colonial Social Science Research Council and the second annual reports of the Colonial Medical Research Committee and of the Committee for Colonial Agricultural, Animal Health and Forestry Research, covers the period April 1, 1946–March 31, 1947, and refers again to the lightening of the task of the Committee by the creation of separate bodies to advise the Secretary of State on special aspects of reseach. Early in 1947, the Colonial Insecticides Committee was created, with Sir Ian Heilbron as chairman, to initiate research, including experimental field work, to examine schemes for research and experiment submitted by Colonial Governments or other appropriate bodies, to advise on problems concerning the use of insecticides, and to make available the latest scientific information to those concerned with the use of insecticides in the Colonies. This Committee has already decided to concern itself primarily with the experimental application of the results of fundamental insecticide research, but will also encourage and reinforce research projects of Colonial Government Departments as well as co-ordinate agricultural, medical and veterinary interests in the use of insecticides. Economic research has now been entrusted to a Colonial Economic Research Committee, with Sir Arnold Plant as chairman, which, working in close association with the Colonial Social Science Research Council, will advise the Secretary of State on economic research and statistics.

While the Colonial Research Committee continues to act as the central advisory body on expenditure schemes initiated by the other bodies, with the exception of the Colonial Products Research Council, its own report becomes essentially a cover note appended to the list of schemes approved for research grants, although the whole report is a most useful reference paper in view of the information it contains concerning membership of the various committees, etc. Referring to Dr. E. B. Worthington's appointment as joint secretary to the Committee, the report states that Dr. Worthington's services have been placed at the disposal of the East African Governor's Conference for a period of two years, to advise on the regional organisation of research in the three East African territories in which the Governor's Conference is interested. The Central African Council, established in 1945 as a consultative body to foster co-operation between Southern Rhodesia, Northern Rhodesia and Nyasaland, also decided to appoint a research secretary to survey existing facilities for research and report upon additional facilities required; but no definite steps were taken to consider the regional organisation of research in West Africa. Five Colonial Research fellowships were awarded during the year, but one was ultimately declined by the applicant.

* Colonial Office. Colonial Research 1946–47. Pp. ii+72. (Cmd. 7151.) (London: H.M. Stationery Office, 1947.) 1s. 3d. net.

Dealing with specific fields of research, censuses were taken during the year in Aden, Ceylon, Cyprus, the Falkland Islands, Fiji and Western Pacific and St. Helena, and the urgent need for complete censuses in all Colonial territories in Africa is stressed. Regional fisheries research institutes are being organised in East, Central and West Africa, and funds are being made available from the Colonial Development and Welfare Research allocation for a Freshwater Research Station at Jinga in Uganda. The shortage of trained staff and equipment, however, are great obstacles to the development of fisheries. Recruitment of trained men has also been a difficulty at the headquarters of the Geodetic and Topographical Survey opened at Bushey Park in March 1946. Only about a quarter of the programme of air photography for West Africa was complete owing to bad photographic weather, but a large programme of air photography covering parts of all the East and Central African Colonies and the High Commissioners' Territories was arranged to start in May 1947. Dr. F. Dixey, appointed as geological adviser and director of Colonial geological surveys from January 1, 1947, has been studying the needs of such surveys in regard to organisation and expansion of staff, but expansion is likely to be hindered by the shortage of geologists. Active control campaigns against the desert locust in the Middle East and the East African and adjacent territories continued during the year, and considerable success was achieved, particularly with 'Gammexane' as poison in baits; a much more toxic spray for locusts from aircraft has been developed. The anticipated progress has not been made in the organisation of a meteorological service. Sixty-seven schemes approved for research grants during the year aggregated £1,085,259; eighteen were for agriculture, veterinary science, forestry or fisheries, twenty-seven for medical and thirteen for social sciences. Actual issues in respect of schemes during the year totalled £164,329.

Colonial Products Research Council

The report of the Colonial Products Research Council refers particularly to the work in Sir Norman Haworth's laboratory at the University of Birmingham on sugar and starch. The study of the chemistry of cane sugar and its immediate transformation products has resulted in the preparation of a sulphonamide derivative which is a promising chemotherapeutic agent, while derivatives of lævulinic acid with marked analgesic properties have been found. Sodium lævulinate appears to be superior in some respects to ethylene glycol as an anti-freeze agent, and the palmityl and stearyl derivatives of dianhydromannitol and dianhydrosorbitol may find application as detergents and emulsifiers. The chief feature of the work on starch is the separation of starch into amylopectin and amylose, and it appears that by first separating starch into these two components its industrial utilization could be greatly extended, amylopectin, for example, being superior to starch as a beater size in paper-making, while amylose acetate is compatible with cellulose acetate in the manufacture of textile fibres and films. It has also been observed that starch glycollate is an ideal indicator in iodometry analysis.

As a result of the work on arrowroot, a process has now been devised which allows the extraction by a grinding mill of special design of practically the whole of the starch from the roots. In the field of citrus products, work at the Imperial College of Science and Technology, London, under Sir Ian Heilbron and Dr. E. R. H. Jones has led to the determination of the nature of the troublesome deposit formed in Tanganyika bitter orange oil during shipment and storage, while work under Prof. T. P. Hilditch at the University of Liverpool suggests that the oil prepared from specially heat-treated seeds of a West African vine (*Tetracarpidium conophorum*) may prove a satisfactory substitute for linseed oil. Other work has been concerned with plants of possible medicinal and insecticidal value, including the exhaustive fractionation of the extract from the flowers of *Brayera anthelmintica* and the separation of the principal carbohydrate fractions of the tissues of *Hydrocotyle asiastica*. Erection of the laboratory of the Colonial Microbiological Research Institute at Trinidad commenced in February 1947, and before leaving for Trinidad, Dr. A. C. Thaysen continued his study of the Actinomyces, developing a new culture medium. Dr. Thaysen is to study the fermentation processes which occur after the harvesting of cocoa beans and on which the flavour of the cocoa is believed largely to depend.

In September 1946, Sir Ian Heilbron and the Director of Research (Dr. J. L. Simonsen) visited Kenya, Tanganyika, Uganda and Zanzibar, discussing the position of both the Industrial Management Board and the East African Industrial Research Board with the managing director and acting-chairman of the Board and with the economic adviser of the Governor's Conference. They were greatly impressed by the possible mineral developments of Tanganyika, and in Uganda discussed the work of the Colonial Insecticide Research Unit and saw the field experiments in mosquito and tsetse control. In their report to the Council, they urged the establishment of a specific Colonial insecticide committee to coordinate research effort in the Colonial field and to bring to the notice of workers the latest information and advice. A list of publications and of patent applications is appended to the report.

Colonial Social Science Research Council

The third annual report of the Colonial Social Science Research Council, pointing out that progress in this field continues to be sporadic and unequal, emphasizes that the chief difficulty remains, that of finding the right man for a project. There has been little alleviation of the shortage of trained personnel, and more adequate provision is required for post-graduate training in the special techniques and skills and in the special background knowledge without which the social science graduate is not equipped for field work among the simpler and less-developed peoples. The Council has given much consideration to such training and records further progress in the preparation of programmes of research needs and priorities. Some twenty projects have been listed for priority in West Africa, and of projects mentioned in earlier reports Miss Phyllis Kaberry's study of the economic and cultural status of women in the British Cameroons, Dr. K. Little's ethnographical study of the Mende in Sierra Leone, Mrs. Meyeronitz's study of the role of gold in the art and culture of the Gold Coast, Mrs. Matson's study of the legal aspects of land tenure in the Gold Coast and Mrs. Ingram's documentary survey of social and economic conditions in the Aden Protectorate have been completed or almost completed, as is Dr. Geoffrey Tooth's study of mental illness and juvenile delinquency in West

Africa so far as it relates to juvenile delinquency in the Gold Coast. New projects launched during the year include a sociological study of the peasant community in Jamaica, an investigation of secondary school science teaching in West Africa and a study of the relations between the extent of education and the after-school occupational life of girls and women in the Gold Coast. A project for a study of the efficiency of labour among the six thousand African employees of the Kenya–Uganda Railway stationed in Nairobi to be undertaken by a team of research workers under Dr. C. H. Northcott was also approved. The project has been planned in conjunction with the Human Nutrition Research Unit, on the recommendation of which there has also been launched a scheme for a survey of nutritional problems in all their aspects in the Gambia.

Colonial Medical Research Committee

The second annual report of the Colonial Medical Research Committee, in addition to reviewing research work completed or in progress, refers to the establishment of sub-committees to deal with nutrition problems, research on helminthiasis, and personnel as well as an East African Medical Survey Sub-Committee, which has already prepared preliminary plans for a medical and sanitary survey as a first stage in a long-term policy of development to establish preventive medicine in East African territories. This was one of the main recommendations of the late Prof. McSwiney as a result of his visit to East Africa in 1946, and his other main recommendation for the establishment of a bureau of health in East Africa is being considered by the Committee in consultation with the East African Governor's Conference. The Colonial Medical Research Service has not yet been brought into being; although the results of most of the field trials of 'Paludrine' arranged in different Colonies are not yet available, the Malaria Sub-Committee considering the relative prophylactic use of 'Paludrine' and quinine has expressed the opinion that 'Paludrine' is a superior drug to quinine for suppressive or prophylactic purposes; in much higher weekly doses than 300 mgm. it has given no toxic manifestations, the latitude between effective and toxic dosage, for therapeutic purposes, being much greater than with quinine. It would be quite safe to sell 'Paludrine' in post offices and similar Government offices in the same way as quinine is now sold.

A research team has been dispatched to British Borneo under a three years scheme to study the transmission of malaria in that Colony, and a Nutrition Field Research Station is being established at Farjara near Bathurst in the Gambia. Following on studies of the microbiology of Kaffir beer and its nutritional value, the effect on the nutritional value for man of maize products obtained by various treatments is being investigated, and the physical and chemical changes in rice during soaking and steaming are being examined with the view of providing a satisfactory basis for parboiling rice. Another link in the co-ordination of Colonial nutrition work is provided by the formation of a Department of Nutrition in the London School of Hygiene and Tropical Medicine and the creation of a chair in nutrition in the University of London, to which the Director of the Human Nutrition Research Unit has been appointed. Research has been carried out on schistosomiasis in the United Kingdom at the London and Liverpool Schools of Tropical Medicine, while work on filariasis has been directed mainly to a search for a chemotherapeutic remedy. Arrangements have been made for work on scrub typhus to be continued at Kuala Lumpur.

Committee for Colonial Agricultural, Animal Health and Forestry Research

The second annual report of the Committee for Colonial Agricultural, Animal Health and Forestry Research refers to the attention given to the terms of service for the Colonial research worker, and a sub-committee under the chairmanship of Sir Edward Salisbury prepared a memorandum on terms of service considered suitable for a Colonial research service for agriculture, animal health and forestry. The sub-committee was primarily concerned to recommend terms that would attract and retain voluntarily in Colonial research a fair proportion of the available research workers in the sciences related to agriculture, and also that there should be no barrier to the free movement of research workers between research institutions in the Colonies and in the United Kingdom and the Dominions. The policy sub-committee was preparing a report on research needs of the Colonies and the organisation of research in Colonial regions. Some progress in the regional organisation of research in East Africa has been made as a result of the visit of Sir Frank Engledow, Prof. J. W. Munro and Sir Harold Tempany in February and March 1946, and the recommendations of a Conference at Nairobi for the replacement of the existing East African Agricultural Research Institute by an East African Agricultural Research Organisation on a more suitable site than Amani, and for the expansion of the East African Veterinary Research Institute at Kabete, Kenya, have now been accepted by the Secretary of State. Attention has also been given to the regional organisation of research in the West Indies, and schemes for research on soils, bananas and cocoa have been recommended by the Committee for assistance under the Colonial Development and Welfare Act.

The Cocoa Research Sub-Committee kept under close review the progress of the West African Cacao Research Institute [see p. 117] and examined in detail the West Indian regional cocoa research scheme as well as considering the control of cocoa virus diseases in Trinidad. A Soils Sub-Committee appointed during the year with Dr. W. G. Ogg as chairman dealt chiefly with Colonial soil classification and nomenclature, West Indian regional soils research and fertilizer experiments. The Stored Products Research Sub-Committee has agreed with the Infestation Division of the Ministry of Food that infestation conditions in the West African territories should first receive attention, and has recommended a survey of these territories, to include the infestation problems of cocoa, ground-nuts, palm kernels and centrally stored foodstuffs for local consumption. Mr. G. S. Cottrell was appointed leader of the survey team in May 1946. A small working party has been appointed under the chairmanship of Prof. J. W. Munro to prepare a memorandum on the control of infestation for the guidance of Colonial governments, while other subjects engaging the attention of this Sub-Committee have been the provision of entomologists and chemists for infestation control work and the use of the new synthetic insecticides in direct contact with stored foodstuffs.

USE OF EQUIVALENT METRIC VALUES IN SCIENTIFIC PAPERS

THE Royal Society Empire Scientific Conference held in June 1946 considered and approved a resolution advocating that where scientific papers or text-books are expressed primarily in British units, provision should be made for the inclusion of metric equivalents or conversion factors.

In July 1947 a letter, signed by the presidents of the Royal Society and of the British Association, the secretary of the Department of Scientific and Industrial Research, the director of the National Physical Laboratory and the chairman of the British Standards Institution Council, was sent to various scientific and technical societies and publishers, directing attention to the resolution and suggesting that, if necessary, a meeting, representative of the various interested organisations, should be held to discuss the implementation of the resolution. Replies to the letter indicated a considerable measure of support for the proposal, and on December 12, 1947, a meeting was held in the rooms of the Royal Society at which methods of implementing the resolution were discussed. This meeting was arranged by the National Physical Laboratory and the director of the Laboratory, Sir Charles Darwin, took the chair.

As an experiment, National Physical Laboratory papers have, since the Conference, so far as possible provided metrical equivalents whenever British units have been used. A paper was therefore prepared at the Laboratory setting out, with examples, ways in which this aim can be achieved; this was circulated to learned societies and institutions and to publishers of scientific text-books and periodicals, to provide a basis of discussion. Thirty-eight societies and thirty-five publishers accepted the invitation and sent representatives to the meeting.

Sir Charles Darwin in opening the meeting emphasized that the matter to be discussed was one of intelligibility only, and had nothing to do with the introduction of the metric system in Britain. By making it possible for the foreigner to convert British units immediately into metric, publishers of scientific papers and books would assist Britain to attain the position of the centre of science in Europe. A little more work would, of course, be entailed on the part of both authors and publishers, but the addition of a few days to the time normally required for the production and publication of a book was not seriously to be weighed against the great loss of time to all the readers if they had each to look up appropriate factors and make the conversion for themselves. He then referred briefly to the experience gained at the National Physical Laboratory since June 1946; this was incorporated in the paper which the meeting had before it for consideration.

Mr. F. A. Gould, a member of the staff of the National Physical Laboratory, in describing the methods of inserting metric equivalents or conversion factors put forward in the paper, said that these incorporated in some way the principle of double entry. For example, where a numerical quantity was cited in the text in English units, the metric equivalent would be given in parenthesis. In some cases such a method would become unwieldy and other devices were suggested. Where the whole text was full of numerical quantities, recourse might be had to a table of conversion factors at the beginning of the paper. Where a numerical table was printed, the conversion factors might be given at its foot, and sometimes to avoid the danger of blunders in the conversion, a single row of the table might also be given in metric form. One of the most effective methods was in diagrams, where it would in most cases be possible to insert additional scales in the metric units.

In the general discussion most speakers expressed a strong dislike of a proposal to give conversion charts in the form of bookmarkers, as these were troublesome to print and were easily mislaid, and suggested as an alternative the use of a 'pull-out'. In order to minimize the additional labour required, there was also a rather natural tendency to favour the method of inserting a list of conversion factors at the beginning of the paper, rather than to give converted figures in the text itself.

The additional paper and extra expense involved in a large amount of double entry, as, for example, in tables, made such a method unpopular with publishers, but it was agreed that in diagrams it would generally be possible to mark ordinates on the left in the British system and on the right in the metric, and that this would make an easy and convenient method of showing the conversion.

The British Medical Association representative outlined the methods which the Association had used without difficulty for some twelve months, and mentioned how much the inclusion of metric values had been appreciated. A recent document produced by the Association without metric equivalents had brought many protests. Some speakers, in mentioning the need for an authorized list of conversion factors, suggested an extension of the list contained in British Standard Specification No. 350.

In summarizing, Sir Charles Darwin said that although there were obvious difficulties to be overcome in dealing with the problems concerned with the insertion of suitable metric information in scientific papers, the representatives at the meeting had shown that there was general support for the policy advocated by the Royal Society Empire Scientific Conference, and he felt that by consulting various organisations an acceptable scheme could be produced. Another general meeting did not seem to be required, and the National Physical Laboratory would produce summarized suggestions for distribution to those interested.

SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING

THE forty-fifth annual meeting of the Science Masters' Association was held during December 30–January 2 in the University of Sheffield, under the presidency of the Vice-Chancellor of the University, Dr. J. I. O. Masson, when a full programme of lectures, visits, demonstrations and exhibitions was enjoyed by some four hundred members. The meeting opened with a civic reception in the Town Hall, when the Lord Mayor of Sheffield, Alderman W. E. Yorke, welcomed the Association to the City and, afterwards, with the Lady Mayoress, entertained members to tea.

In his presidential address, Dr. Masson made a strong plea for the recognition of the importance and value of first-hand knowledge. The eminent man of science of real life, unlike his counterpart in fiction, is not the mere possessor of a card-index mind, but derives his store of knowledge from personal experience. The wisdom of men such as Ramsay, Arrhenius, W. H. Perkin, William Bragg and Karl Pearson did not derive from knowledge deliberately learned or consciously memorized. The man of science must also resist the very human temptation to take a narrow view of his work and to use it as an instrument for the furtherance of his own worldly reputation. Likewise, he will not allow partisanship for one study to prejudice him against excellence in other fields, of science or the humanities. For both the man of science and the scholar complete intellectual honesty is essential, and the same code covers both. For the scientific worker, the chief danger to be guarded against is the materialistic view that science is to be judged according to the practical inventions that follow in its wake. This is a narrow view and loses sight of ultimates. The virtue of a fine scientific research is similar to that of a fine poem, and each can have a profound effect on human thought, and on the understanding of the universe in which we are set.

On the second evening of the meeting, the Bishop of Birmingham addressed a crowded session of the Science and Religion Group. Defining religion as experience of ultimate reality, Dr. Barnes stated his belief that the minds of mankind make the world as it is known to us; these human minds must be akin to that of God, or science would be impossible. The advice "seek and ye shall find" is as appropriate to the laboratory as to the Church. The pure Christian faith rests on mysticism, strengthened by morality and joined to scientific knowledge; its formulation is not fixed but will change as the generations pass. The failure of traditional forms of religion imposes on all teachers the duty of forging their own religious understanding and passing this on to their pupils.

The third evening was devoted to the Science and Citizenship Lecture, delivered to a public audience by Prof. W. T. Astbury, in the Memorial Hall, Sheffield. Prof. Astbury emphasized the need for a greater appreciation of the work of pure scientists by leaders of industry. Such examples as the production of textile fibres from globular proteins and the release of atomic energy show that pure research finds application in the most unexpected directions. Recent developments in the textile industry show also that the craftsman and the scientific worker can learn much from each other, once the difficulties of mutual understanding are resolved. It is here that the educationist can play his part by ensuring that all members of the public have some appreciation of the spirit and methods of science, and the potentialities for good or evil of its applications. The human race, owing to its discoveries having outrun its moral standards, is in grave danger of descent into the abyss of ruin and destruction. The avoidance of this catastrophe, and the development of the constructive spirit in world affairs, depends in no small degree on the efforts of science teachers.

During the meeting, members heard a number of stimulating and informative lectures by members of the staff of the University of Sheffield. Prof. W. Sucksmith, on "Magnets and Magnetism", gave a lucid exposition of the modern picture of magnetism, with especial reference to the domain concept, and a review of recently developed magnetic materials; Prof. J. H. Andrew, on "Metallurgy as a Profession", outlined many examples of the applications of metallurgy, with a useful discussion of careers open to those with qualifications in this subject; Prof. Harry Moore, on "The Physics and Chemistry of Glass", dealt with the history of glass manufacture, giving many useful data regarding modern glasses, and the results of research into their structures; Prof. L. E. S. Eastham, on "The Evolution of a Developmental Process", illustrated the phenomena of insect metamorphosis on the assumption that the rates of developmental processes are controlled by genes; Dr. T. B. Smith, on "The New versus the Old in the Theory and Practice of Analysis", considered the impact of new ideas of physical chemistry on the teaching of analytical chemistry in 'sixth forms', both from the theoretical and practical aspects; and Dr. V. M. Conway, on "Pollen Analysis", outlined the development of this study and the many uses to which it can be put.

Science masters found much of interest in the excellent experimental demonstrations arranged by the Departments of Botany, Chemistry, Glass Technology, Metallurgy, Physics and Zoology of the University of Sheffield, and the members' exhibition showed its usual high standard of ingenuity. The publishers' and manufacturers' exhibitions were also popular, and the comprehensive visits' programme enabled members of the Association to see many typical local industries.

METEOROLOGY AND THE PROPAGATION OF RADIO WAVES

THE development of radio communication and radar during the War emphasized the fact that the propagation of metre and centimetre waves was greatly influenced by the meteorological conditions in the lower atmosphere. The subject was of such importance that a large-scale investigation of the phenomena involved was organised in Great Britain as a co-operative effort between the staffs of several radio research establishments and of various sections of the Services. The Navy, Army and Air Force, the Ministries of Supply and Aircraft Production, the Meteorological Office and the National Physical Laboratory, and also the Research Laboratories of the General Electric Co., Ltd., each played an important part in this work. The experiments were conducted over both land and sea paths, along which both the radio transmission characteristics and the meteorological conditions were measured simultaneously. The installations at one end of each path comprised a radio-sending station emitting a known amount of radiation towards the receiving station at the other end of the path, where the field strength of the arriving waves was measured and continuously recorded. In the case of one of the oversea paths the meteorological conditions, temperature, pressure and humidity, were measured at various heights along the path by flights of aircraft between the sending and receiving stations. These observations were supplemented by other measurements made from a captive balloon attached to a ship located along the path. In the case of other paths, the meteorological conditions were largely deduced from the normal daily weather charts, supplemented by observations at the terminal points.

This 'field' type of investigation was supplemented by many subsidiary experiments on the properties of the constituents of the atmosphere and the effect which these might have on the propagation of very short radio waves through it. Much theoretical work was also carried out by individual workers on both the meteorological and radio aspects of the whole investigation.

As the various items of all this work reached appropriate stages, reports were prepared and issued as confidential or secret documents under the restrictions of war-time conditions. But the value of the research from the point of view of the scientific world has now been considerably enhanced by the fact that many of the results obtained have been placed on permanent record in the form of published papers. In the first place, the propagation of ultra-short waves formed the subject of one of the sessions of the Radiolocation Convention of the Institution of Electrical Engineers held in March 1946. The resulting papers and lecturettes were published in a special number of the Institution's *Journal* (93, Part IIIA, No. 1, 1946). This Convention was followed in April of the same year by a Joint Conference held by the Physical and the Royal Meteorological Societies, at which the various aspects of the influence of atmospheric conditions on the propagation of radio waves was discussed in considerable detail; and in *Nature* of June 29, 1946 (**157**, 860), Prof. P. A. Sheppard gave a detailed account of this Conference and of the various papers presented at it.

The report of the latter Conference has now been published by the Physical Society as a special volume entitled "Meteorological Factors in Radio-Wave Propagation" (price to non-members 24*s*. including postage). This volume contains the full text of the ten papers read at the meeting, together with eleven other papers describing work on various closely related subjects. Dr. J. A. Saxton gives an account of the experimental determination of the dielectric properties of steam for frequencies between 3,000 and 20,000 Mc./s. (wave-lengths 1·5–10 cm.). The results of such measurements were used to estimate the amount of attenuation to be expected, due to atmospheric water vapour, in the transmission of these waves through the lower atmosphere. The estimated values of such absorption are found to be reasonably consistent with those obtained from theoretical considerations. In four subsequent papers the same author, in one case jointly with J. A. Lane, has studied experimentally and theoretically the anomalous dispersion of water in the centimetre wave-range. The results of this work have provided a detailed knowledge of the refractive index and absorption coefficient of liquid water over a wave-length range from 10 cm. down to a few millimetres, and of the variations of these quantities over the temperature range 0°–40° C.

In a paper entitled "Observations of Unorthodox Radar Vision in the Vicinity of New Zealand and Norfolk Island", Dr. F. E. S. Alexander presents and analyses many observations of anomalous wave propagation obtained by the operators of radar stations on wave-lengths of 10·5 and 150 cm. Another paper, by J. A. Ramsay, describes the results of further observations made at radar stations using wave-lengths of 1·25, 3 and 10 cm. The conditions of propagation were studied at a nominally fixed range, by raising the reflecting target to known heights above the sea by means of a balloon. The results confirmed the prediction, made on theoretical grounds, that anomalous propagation would be experienced on a wave-length of 1·25 cm. to a much greater extent than on 10 cm.

The remaining papers deal with various aspects of the vertical gradient of refractive index in the atmosphere and its effect on the propagation of the very short radio waves under consideration. Dr. G. G. Macfarlane describes a method of deducing the refractive index gradient in a stratified atmosphere from radio observations: while G. A. Bull has provided a note on errors in the measurement of the refractive index consequent upon errors in the meteorological measurements from which the index is deduced. Using information provided by published weather charts, supplemented by some special measurements made in Great Britain, Dr. A. C. Stickland has studied the average condition of the atmosphere as a refracting medium for the propagation of radio waves. From this empirical study, it is shown that the average refractive index of the lower atmosphere varies logarithmically with height, the actual radius of curvature of the path of the waves increasing linearly with height above the earth's surface.

In a field of investigation such as this, where the meteorologist and radio scientist meet on common ground, it is clearly desirable that there shall be some agreement on the definition of what may be termed a 'standard atmosphere', to which both theoretical and experimental investigations may be referred. It is therefore very appropriate that the publication now under review should include a paper by A. C. Best entitled "A Standard Radio Atmosphere for Microwave Propagation". The author discusses three possible definitions of standard atmosphere, one of which is already in use for aeronautical purposes; but he suggests that the final choice of definition for the standard radio atmosphere must be made by the radio investigator rather than by the meteorologist.

All the work described above represents the conclusion of a very satisfactory and highly successful series of investigations initiated and conducted under war-time conditions. It demonstrates the ability of a large body of scientific workers and Service personnel to plan and conduct in an efficient manner a very complicated research programme in the laboratory and in the field. In spite of the varying interests of the many individuals concerned, they worked together as an enthusiastic team and were inspired in the main by two British Government committees. One of these was under the chairmanship of Sir Edward Appleton, who at the end of his introductory paper to the joint Conference mentioned above acknowledges with pleasure the collaboration he received from its members. He also states that his committee, or, to give it the full title, the Ultra-Short Wave Panel of the Ministry of Supply, had the good fortune to work in close collaboration with the U.K. Joint Radio Meteorological Committee, under the chairmanship of Sir Nelson Johnson, and also with the U.S. Wave Propagation Committee under the chairmanship of Dr. C. R. Burrows. R. L. Smith-Rose

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RELEASE OF INFORMATION ON ATOMIC ENERGY

Two lists of British reports on atomic energy, which had been 'declassified' and made available for purchase through H.M. Stationery Office, P.O. Box 569, Cornwall House, London, S.E.1, were announced last year (*Nature*, March 22, p. 411, September 27, p. 445). The following further twenty-three reports have now been released and should, wherever possible, be ordered by B.D.D.A. number; if this is given, no other identification is needed.

It is hoped that, in the future, reports will be supplied to H.M. Stationery Office as and when they are declassified, and no special announcements will be made; information as to the latest reports available would then be obtained from the regular announcements from H.M. Stationery Office.

B.D.D.A. No.	Report No.	Title and Author(s)	Date	Price
99	Br. 10	Organic derivatives of U. N. Haworth		2*s.* 8*d.*
100	Br. 18	Uranyl fluoride. Miscellaneous notes. Note No. 8. The adsorption of atmospheric moisture by anhydrous UF_4. A. M. Roberts	Feb. 16, 1942	2*s.* 0*d.*
101	Br. 174	Investigation of the Pressure-density relationship for the hexafluoride of U at 49·2° C. C. B. Amphlett and L. F. Thomas	Feb. 28, 1942	2*s.* 0*d.*
102	Br. 27	Uranyl fluoride. Miscellaneous notes. Note No. 18. The true and packing densities of anhydrous UF_4. A. M. Roberts, B. G. Harvey	Mar. 30, 1942	1*s.* 4*d.*
103	Br. 36	The reduction of UF_4 by hydrogen. J. Ferguson	May 14, 1942	4*s.* 0*d.*
104	Br. 182	Pressure density relationship for UF_6 at 50° C.; revised figure for $\left(\frac{\partial e}{\partial p}\right) - 50°$. C. B. Amphlett	June 30, 1942	2*s.* 0*d.*
105	Br. 186	The vapour pressure of UF_6 from 12° to 50° C. C. B. Amphlett	June 30, 1942	2*s.* 0*d.*
106	Br. 187	Determination of the vapour density of UF_6 at room temperature. C. B. Amphlett and L. F. Thomas	June 30, 1942	1*s.* 4*d.*
107	Br. 222	The analysis of gaseous fluorine, Part I. The determination of total and free fluorine. A. F. Williams	Sept. 14, 1942	7*s.* 4*d.*
108	Br. 188	Determination of the ultraviolet absorption of UF_6 vapour. A. E. Martin and C. B. Amphlett	Nov. 30, 1942	2*s.* 0*d.*
109	Br. 166	Gland experiment. H. S. Arms	Jan. 20, 1943	8*s.* 8*d.*
110	Br. 167	Experiments on the pressure dependence of heat conductivity concentration meters. A. F. Brown	Mar. 1, 1943	6*s.* 8*d.*
111	Br. 242	Absolute calibration of a neutron source. O. R. Frisch	June 1943	5*s.* 4*d.*
112	Br. 280A	Remarks on some physical properties of uranium metal. F. E. Simon	Aug. 16, 1943	8*s.* 0*d.*
113	Br. 281	The viscosity of gaseous fluorine. Critical literature survey. Rudge and Southam	Aug. 23, 1943	6*s.* 0*d.*
114	Br. 315	Notes on Br. 44 "On the Correction for Self-Absorption in β-Ray Measurements", Broda, Guer-on and Kowarski, 1942. N. Feather	Aug. 16, 1943	6*s.* 0*d.*
115	Br. 425	Determination of U^{235} content of enriched uranium samples. E. Bretscher and E. B. Martin	Nov. 3, 1943	2*s.* 0*d.*
116	Br. 397A	Memorandum on American tests on fluorocarbon lube oils. J. R. Park	Mar. 16, 1944	1*s.* 4*d.*
117	Br. 516	A hard valve pulse analyser. M. L. Poole	May 7, 1944	12*s.* 0*d.*
118	BI. 37	Stability of solutions of UCl_4 in alcohol, acetone, and water. C. B. Amphlett	May 31, 1944	2*s.* 0*d.*
119	Br. 673A	The analysis of nitrogen – argon mixtures. P. A. I. Tahourdin	Dec. 7, 1945	4*s.* 8*d.*
120	Br. 718A	The tensile properties of uranium at elevated temperatures in the α-range. National Physical Laboratory	Mar. 4, 1946	1*s.* 4*d.*
121	Br. 775	Preliminary creep tests on 99·8% aluminium at 300°, 350° and 400° C. British Non-Ferrous Metals Research Association	July 1947	6*s.* 8*d.*

FORESTRY IN TRINIDAD AND TOBAGO

THE present forest policy for the Colony of Trinidad and Tobago has had several predecessors. The Annual Forest Administration Report for the Year 1946, written by Mr. John Carter, acting conservator of forests, starts with a statement on the present forest policy formulated in 1942 and now formally accepted by the Government and the Secretary of State for the Colonies. Briefly summarized, it is as follows: (*a*) Permanent reservation by the Crown of suitably situated areas of forest of a total acreage sufficient to supply the objects aimed at, both direct and indirect. (*b*) Management of reserved forests on the basis of a sustained yield. (*c*) The fullest utilization of the forest products, based on the correct forest management and the most economic utilization of imported lumber. (*d*) Organised research in all branches of forestry. (*e*) A fully trained staff, both gazetted and subordinate, and the education of all classes of the community to understand the benefits of forestry. (*f*) The encouragement of, and assistance to, private forestry. (*g*) Co-operation between forestry and other land interests with the object of bringing into force a sound land utilization policy.

These are good clauses in a correct forest policy. They have been enunciated on more or less similar lines many times in the past in the British Empire. It would appear from the action being taken both in the Empire and outside it in other parts of the world that Governments generally have become conscious of the serious dangers which are threatening their populations through wasteful utilization of the forest resources, involving possible wood famines in certain regions of the globe, and seriously increasing erosion and degradation of soils and interference with water supplies and rainfall.

The present report describes the steps being taken in carrying out the resolutions on the above heads of policy. The report then continues with details on the actual work carried out during the year. Among other points the question of game preservation and the difficulty of control in the close season is mentioned: and also that negotiations were continued with the Trinidad Field Naturalists Club with a view to the formation of a zoological society which would undertake to establish and maintain a zoological 'garden'. It is interesting to note that a site of about 6 acres in the Royal Botanic Gardens has been made available for the proposed zoo, and the Government has agreed to hand over to a zoological society when it is formed the funds standing to the credit of the Wild Birds Fund, and an annual grant equal to the amount collected for hunting licences.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, January 26

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 4.30 p.m.—Dr. C. H. Andrewes, F.R.S.: "The Common Cold" (Cantor Lecture).

UNIVERSITY COLLEGE LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. Ernest Baldwin: "The Comparative Biochemistry of Respiration and Metabolism". (Further Lectures on February 2, 9, 16, 23 and March 1.)*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Sir George Thomson, F.R.S.: "Determinism in the Physical World" (Joule Memorial Lecture).*

Institution of the Rubber Industry, Manchester and District Section (joint meeting with the Plastics Institute, at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. N. J. L. Megson and Mr. G. L. Hammond: "Polymer Progress".

Institution of Electronics (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7 p.m.—Mr. L. E. A. Bourn: "Electronic Organs" (with demonstrations).

Tuesday, January 27

University College London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. C. B. Fawcett: "Geography and Planning".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "Reproductive Capacity of Plants". (Further Lecture on February 3.)

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. J. F. Gittins: "Theory and Application of the Coloration of Alkaline Halides".

Society of Instrument Technology (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Dr. G. E. Bennett, Dr. J. R. Richards and Mr. E. C. Voss: "Some Electronic Methods of Measurement in Engineering".

Society of Dyers and Colourists, Scottish Section (at St. Enoch Hotel, Glasgow), at 7 p.m.—Mr. J. Boulton: "What Research has Meant to the Practical Dyer and What it will Mean".

Royal Institute of Chemistry, London and South-Eastern Counties Section (at the Technical Institute, Darnley Road, Gravesend), at 7.30 p.m.—Dr. C. W. Herd: "The Chemist in the Flour Mill".

Wednesday, January 28

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. A. J. Philpot: "Recent Progress in the Making of Precision Instruments".

Royal Microscopical Society, Section of Industrial Microscopy (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. C. Seyler: "Microscopy of Coal".

Institute of Welding (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—The Sir William J. Larke Medal Paper.

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. E. Davis: "Some Metallurgical Aspects of Jointing Non-ferrous Materials".

Society of Chemical Industry, Manchester Section (in the Chemistry Lecture Theatre, The University, Brownlow Hill, Liverpool), at 6.30 p.m.—Annual Joint Meeting of the Manchester and Liverpool Sections; Mr. H. W. Cremer: "Water—a National Asset" (Jubilee Memorial Lecture).

Society of Chemical Industry, Nutrition Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—"Farm Animals as Converters of Vegetable Food for Human Use".

Thursday, January 29

Society of Public Analysts and other Analytical Chemists (joint meeting of the Physical Methods Group and the Biological Methods Group, in the Barnes Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 2.30 p.m.—Discussion on "Methods of Penicillin Assay—their Purpose, Scope and Validity" (to be opened by Dr. A. J. Amos and Dr. J. G. A. Griffiths.)

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.: Mr. M. Ryle and Mr. D. D. Vonberg: "An Investigation of Radio-frequency Radiation from the Sun"; Prof. D. F. Martyn: "Solar Radiation in the Radio Spectrum", Part 1, "Radiation from the Quiet Sun".

Chemical Society, Sheffield Section (joint meeting with the University of Sheffield Chemical Society, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. R. P. Linstead, F.R.S.: "Stereochemical Regularities in Catalytic Reactions".

Chemical Society, Manchester Section (joint meeting with the Local Sections of the Royal Institute of Chemistry and the Society of Chemical Industry, at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Dr. G. M. Bennett, F.R.S.: "Nitration by Mixtures of Nitric and Sulphuric Acids".

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Dr. D. A. Spencer: "Photographic Visual Aids".

Textile Institute, Lancashire Section (at 16 St. Mary's Parsonage, Manchester), at 7 p.m.—Mr. J. Pollitt: "Geometry of Cloth Structure".

Friday, January 30

Institute for the Study of Animal Behaviour (at the Zoological Society of London, Regent's Park, London, N.W.8), at 3 p.m.—Mr. M. R. A. Chance and Mr. D. C. Yaxley: "Some New Aspects of Post-Convulsive Behaviour in *Peromyscus*"; Prof. George Humphrey: "Some Psychological Factors relating to Convulsive Behaviour in Rats"; Sir Edward Mellanby, F.R.S.: Film on "Canine Hysteria". (Members of the Royal Society of Medicine (Section of Neurology), the League against Epilepsy and the Central Veterinary Society are invited.)

Chemical Society, Birmingham Section (in the Main Chemistry Lecture Theatre, The University, Birmingham), at 4.30 p.m.—Dr. G. B. B. M. Sutherland: "Recent Developments in the Application of Infra-Red Spectroscopy to Chemical Problems".

Chemical Society (joint meeting with the University College of Wales Chemical Society, in the Chemistry Lecture Room, University College of Wales, Aberystwyth), at 5 p.m.—Prof. D. H. Hey: "Some Recent Advances in the Theory of Polymerisation".

Bedson Club (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Dr. E. Chain: "The Chemical Structure of Penicillins" (Sixty-eighth Bedson Lecture).

Institution of Electrical Engineers, Measurements Section (joint meeting with the London and Home Counties Branch of the Institute of Physics, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Practical Considerations in Instrument Design".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Discussion on "Some Recent Developments in Technique of Radio Valve Manufacture" (to be opened by Mr. J. W. Davies, Mr. H. W. B. Gardiner and Mr. W. H. C. Gomm).

Chemical Society (joint meeting with the Hull Section of the Oil and Colour Chemists' Association and the University College Scientific Society, in the University College, Hull), at 6 p.m.—Prof. R. P. Linstead, F.R.S.: "Phthalocyanines and related Recent Developments in Pigments".

British Institution of Radio Engineers, Midland Section (at the Technical College, The Butts, Coventry), at 6.30 p.m.—Mr. M. P. Johnson: "Some Aspects of Moderate Precision Temperature Control in Communication Engineering".

Manchester Statistical Society, Industrial Group (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. K. A. Brownlee: "The Applications of Statistical Methods in Industrial Chemistry".

Saturday, January 31

British Mycological Society (in the Department of Biology, Chelsea Polytechnic, Manresa Road, London, S.W.3), at 11 a.m.—Papers on "Mycological Education".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Laboratory Technician—The Regional Transfusion Officer, Regional Transfusion Centre, Meanwood Park Colony, Tong Lane, Leeds 6 (January 31).

Lecturer in Chemistry up to B.Sc. standard—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (January 31).

Vice-Principal of the Farm Institute and Deputy Principal Agricultural Officer to the Education Committee at the Somerset Farm Institute, Cannington—The Chief Education Officer, County Hall, Taunton (February 7).

Assistant Professor or Lecturer in Reinforced Concrete in the Faculty of Engineering, Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (February 14).

Senior Lecturer or Lecturer in Mining—The Registrar, The University, Sheffield (February 17).

Senior Principal Scientific Officer (for the development and supervision of research in problems of fluid mechanics applied to mechanical engineering, especially research on hydraulic machinery), and a Senior Principal Scientific Officer (for the development and supervision of research in problems of heat transfer and heat exchange apparatus), at the Mechanical Engineering Research Organisation of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2095 (February 28).

Assistant in the Department of Astronomy, United College, St. Andrews—The Secretary, The University, St. Andrews (February 28).

Turner and Newall Research Fellowship in Engineering, Inorganic Chemistry or Physics, or in an allied science—The Registrar, University Office, 46 North Bailey, Durham (February 28).

Leverhulme Studentship in Chemical Engineering—The Registrar, King's College, Strand, London, W.C.2 (February 29).

Gas Research Fellowship, and a British Coke Research Fellowship—The Registrar, The University, Leeds 2 (February 29).

Chair of Mathematics at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 2).

Laboratory Assistant (man) at Coopers Hill Emergency Training College, Englefield Green, Surrey, and a Laboratory Assistant (man) at Shoreditch Training College, Pitfield Street, London, N.1—The Education Officer (Estab./2), County Hall, London, S.E.1.

Technician in the Department of Zoology—The Professor of Zoology, King's College, Newcastle-upon-Tyne.

Senior Assistant in Metallurgy—The Clerk to the Governors, National Foundry College, Technical College, Wulfruna Street, Wolverhampton.

Research Engineer, a Research Physicist, an Information Officer, a Chemical Laboratory Assistant, and a Metallurgical Laboratory Assistant—The Director, Motor Industry Research Association, Great West Road, Brentford, Middx.

Chemist, and an Applied Botanist, in the Intelligence Section, and Chemists (2) in the Laboratories, of the Plant and Animal Products Department—The Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

Laboratory Technician (Grade B) in the Department of Pathology—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff.

Senior Laboratory Steward, and a Laboratory Steward, in the Chemistry Department—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

NATURE

No. 4083 SATURDAY, JANUARY 31, 1948 Vol. 161

CONTENTS

Page
Land Use and Service Requirements in Britain 149
Chronicle and Commentary. By Maurice Bruce 151
The Living Plant. By Prof. F. T. Brooks, C.B.E., F.R.S. 153
Sampling Practice in the United States of America. By Dr. F. Yates . 153
Blinking : its Role in Physical Measurements. By Dr. Robert W. Lawson 154
The Ecological Approach to Botany. By Dr. H. Godwin, F.R.S. . 157
Science and U.N.E.S.C.O. : Meeting at Mexico City. By F. J. M. S. . 159
The Earth's Surface Magnetic Field and its Secular Change. By Prof. Sydney Chapman, F.R.S. 160
Obituary :
Prof. Ludwig Becker. By Prof. W. M. Smart 161
News and Views 162
Letters to the Editors :
Structure of Cyclo-octatetraene.—H. S. Kaufman, Dr. I. Fankuchen and Prof. H. Mark 165
Infra-Red Absorption Spectra of Crystals.—Sir C. V. Raman, F.R.S. 165
Thermal Mutual Inductance.—Dr. R. C. L. Bosworth . . . 166
Solar Noise.—E. C. Drewe and D. Maurice 167
Use of High-frequency Current in Surgery.—A. W. Lay . . 167
Intracellular Determination of Protein by X-Ray Microspectrography.—Dr. A. Engström and M. A. Jakus 168
Micro Estimation of Amino-Nitrogen and its Application to Paper Partition Chromatography.—A. J. Woiwod . . . 169
Solvation of Hydrogen Ion in Oxygen-containing Solvents.—Dr. Ernest A. Braude and E. S. Stern 169
Critical Temperature and Molecular Weight of *n*-Paraffins.—L. Grunberg and Dr. A. H. Nissan 170
Olefine Reactions Catalysed by Lewis Acids.—Dr. John W. Baker 171
Formation of Hydroxy Peroxides.—C. A. Bunton, E. S. Halberstadt, A. J. Everett and Dr. G. J. Minkoff 172
Reaction between Manganous Ion and Manganese Dioxide.—J. M. Cowley and Allan Walkley 173
Seasonal Variation in Chemical Constitution of some Common British Laminariales.—Dr. W. A. P. Black 174
Aerobic Mesophilic Bacteria in Composts.—D. M. Webley . . 174
Pre-erythrocytic Stage in Mammalian Malaria Parasites.—Dr. Frank Hawking 175
Variations in Spermatogenesis of Oligospermic Men.—Prof. B. Zondek, Y. M. Bromberg and Z. Polishuk 176
Honeydew on Lime Trees.—C. A. Mawson 176
Structure of Cyclopropane.—Sir Robert Robinson, F.R.S. . . 176
Complexity of Fresh *Hevea* Latex. By Miss L. N. S. Homans, J. W. van Dalfsen and G. E. van Gils 177
Studies in Stomatal Action :
Adequacy of the Porometer in the Investigation of Stomatal Aperture. By Dr. O. V. S. Heath and Dr. W. T. Williams . 178
Control of Stomatal Movement by a Reduction in the Normal Carbon Dioxide Content of the Air. By Dr. O. V. S. Heath . 179
Social and Scientific Development of the West Indies 181
Recent Scientific and Technical Books . . . . . Supp. ii

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LAND USE AND SERVICE REQUIREMENTS IN BRITAIN

TO the first of the two critical questions arising out of the Services' requirements for land the promised White Paper on the "Needs of the Armed Forces for Land for Training and Other Purposes" (Cmd. 7278. London: H.M. Stationery Office, 1947. 4*d*. net) gives a reasonably satisfactory answer. A total area of just over a million acres—702,000 for training and 325,000 for other purposes, which include airfields, barracks, defence works, radar installations, and Ministry of Supply purposes other than airfields—represents about one acre in every fifty-six and does not seem an excessive proportion to be set aside for purposes of national defence. Moreover, while the Government recognizes that even this modest total involves asking the nation to make some sacrifice of wealth, recreation and enjoyment, the reasons why more land is required than in pre-war years are set forth clearly and persuasively.

It is important that the new factors in this demand, such as the consequences of the increased turnover of men under training due to the continuance of national service, the larger space required for manœuvre and for the use of modern weapons, and the effect of training various arms in co-operation with live ammunition, should be plainly stated and recognized widely. Any sacrifices which the nation is called upon to make for such reasons must be patently justified and the area of unavoidable encroachment kept as small as possible. The White Paper is, however, much less convincing in its exposition of the reasons why training overseas is impracticable or why more training could not be done in Scotland or Northern Ireland. The very fact that, as the White Paper admits, training of the regular army is actually taking place abroad to some extent and will do so for some time to come, goes to undermine the main contention. Whether the continuance of training abroad would adversely affect recruitment is open to doubt, and does not affect the argument that some training of the regular army could, and probably must, always take place overseas. The White Paper only weakens the case by its emphasis on the redisposition and reorganisation of training establishments which would be required in the event of war if the bulk of such training were carried out overseas. Redisposition and reorganisation in emergency are inescapable, whatever policy is adopted, and here and elsewhere the White Paper betrays a regrettable lack of the wide vision and sense of proportion which are needed to eliminate the suspicions and misunderstandings already engendered by official actions, and to take full advantage of the goodwill and general understanding of the situation which is so widely apparent throughout the country.

Nor is the White Paper happier in its observations upon the unsuitability of Scotland as a training area. The disproportion between the 33,000 acres claimed by the Services in Scotland and the total of 702,000 acres in Great Britain is too pronounced to be brushed aside by such slender arguments. The objections will have to be supported by much more convincing reasons if the public is not to believe that the examination of possible areas in Scotland has not been somewhat superficial, or that the attractiveness of proximity to greater amenities in southern Britain has not considerably influenced the decision.

On the question of the total land requirements, the White Paper is reassuring ; on the choice of training areas within Great Britain, however, it does little to meet the substance of current criticism of piecemeal action. To the question of what land is to be chosen it gives no answer ; and the procedure for examining individual proposals by Service departments gives no indication that the problem will be looked at as a whole and decided from a national, and not a departmental, point of view on any particular issue. It is true that the White Paper provides a comparatively firm basis for argument for or against any specific project ; but the procedure proposed affords no adequate guarantee that decisions will ultimately be determined with reference to the best use of the land of Great Britain as a whole. Nor is it easy to see how such assurance will be forthcoming while the Government persists in its refusal to treat claims for land on the same basis from whatever source they come, and to insist that the Services, and other Government departments, provide fully substantiated reasons for particular proposals at the time when they are advanced, and not afterwards in deference to public protest.

In outlining the proposed procedure, which has already been indicated in some detail by the Parliamentary Secretary to the Ministry of Town and Country Planning in a debate in the House of Commons on November 26, the White Paper gives as one of the main reasons for the time taken in coming to final conclusions about Service land requirements the continuing review of particular proposals with reference to the dependence of the nation upon home agriculture, the vital importance of home-grown timber, the need to maintain unpolluted sources of water, fisheries and the recreational value of the countryside. The Government affirms its desire to make sure that both local authorities and amenity societies have full opportunity to make representations upon the effect of the proposals on the public interest they represent ; and the regional consultations by the Ministry of Town and Country Planning with the local authority and water supply interests, and by the headquarters of that Ministry with amenity and scientific societies having no regional organisation, are intended to ascertain and resolve so far as possible objections advanced against particular proposals. The proposals are then considered by an interdepartmental committee in the light of objections expressed by any Civil department and of representations made in the previous consultations and reports submitted for the consideration of Ministers.

These consultations and consideration of the reports of the inter-departmental committee may lead to a decision, presumably by Ministers, though whether at Cabinet-level is not indicated by the White Paper, that the Service departments proposals must be abandoned. With other proposals there may be no objections, or modification may eliminate all substantial opposition If, however, substantial objections on grounds of the public interest still remain, a public local inquiry will be held, subject to security considerations, to hear and report on objections raised on grounds of public interest, national or local, whether by local authorities, water supply undertakings, amenity societies, or other bodies, and on representations of scientific or archæological societies against curtailment of opportunities for scientific investigation, such as bird-watching, or damage to areas of unique scientific interest. This inquiry will be presided over by a person selected by the Ministry of Town and Country Planning or by the Secretary of State for Scotland on the basis of his experience and standing in public affairs. Thus it would appear that in general there should be reasonable opportunity for objections to be raised on scientific and other grounds to particular proposals before they are too far advanced. Suggestions for the use of specific areas in the same general locality as alternatives to those under inquiry will be admissible, but not general arguments, such as that the requirements should be met in some other part of the country or abroad. Although the intention of the latter restraint is not so much to limit discussion as to prevent repetition tending to prolong the inquiry without benefit, the effect of this restraint may well be, under the existing conditions, to undermine some of the general goodwill and understanding essential to a satisfactory settlement.

On that ground alone it is important that there should be full discussion of the matter in Parliament before the proposed procedure and the general principles indicated are irrevocably adopted. The debate on the second reading of the Requisitioned Land and War Works Bill on December 16 illustrates the value of such discussion. Mr. Glenvil Hall had no difficulty in showing that the Services cannot fairly be blamed for all the delay in working out their permanent requirements, or that there are reasonable grounds for extending the period during which Service departments could exercise their wartime powers on land requisitioned for military purposes. None the less, it was manifest that there is a feeling that the extension of four and a half years requested is excessive, and some instances were cited of unreasonable delays.

Naturally enough, the debate involved some discussion of the White Paper, but the core of the criticism centred around two points : the effect of the Bill and of Services' demands for land on the position of the National Trust and on the proposed national parks. Speaker after speaker testified to the unfortunate effect of the encroachments on National Trust properties; and of the failure of the Services to relinquish such encroachments and to restore them with the utmost dispatch. There may be sound reasons for making some new provision for consideration by an appropriate Government authority, for example, the Minister of Town and Country Planning, of any property offered to the Trust, before it is finally accepted ; but once accepted, that property should be inviolable by the Services or by any other department. The National Trust does not act without full and careful consideration of the real significance to the nation of the properties for which it accepts responsibility; and it should be possible to recognize acceptance by the Trust as a final decision.

A firm declaration by the Government that National Trust properties would in future be inalienable, and that all those properties which are still requisitioned would be released immediately and repaired where necessary, would do much to engender confidence and to dispel the uneasiness and atmosphere of suspicion with which proceedings and discussion on the Services' land requirements have been accompanied. If this undertaking was paralleled by action to implement the recommendations of the National Parks Committee's reports, there should be a profound change in the whole atmosphere and little difficulty in reaching an amicable agreement on particular proposals. While such action is delayed, it is well to remember the observation of the Hobhouse report, which Mr. Turton quoted in the debate: "It would be no exaggeration to say that the appropriation of a number of the particular areas now listed for acquisition of the Service Departments would take the heart out of the proposed National Park areas in which they are sited, and in certain cases render our proposals for the designation of individual National Parks entirely nugatory".

That is one of the main reasons for the alarm which the Services' proposals for training areas occasions and the opposition which they arouse. The recent instance of the rifle range at Thorpe Oland, in Dovedale, shows that the Army is quite able to come to a reasonable compromise if its real needs are recognized; but this example also demonstrates the importance of meeting such proposals with a firm body of representative opinion. Meanwhile, it will be noted that, in concluding the debate, the Solicitor-General avoided any reply to the specific questions put regarding both national parks and National Trust property. The Government will do well to think again here, particularly as public confidence in its good faith received a severe shock in the refusal in the White Paper to honour the pledges given during the War n the Stamford and Purbeck areas that persons required to leave their homes should be allowed to return at the end of the War. To refuse to regard as binding such war-time promises is bad statesmanship, and goes far to undo any good that the White Paper and the recent debates have done. The main considerations should, however, be given urgent attention. Public inquiry into disputed claims on land should be held before, and not after, any proposal comes before the Interdepartmental Committee. The position of the National Trust properties should be made unassailable and the national parks legislation ntroduced. Finally, all Government departments and other public bodies should be obliged to submit heir proposals for the utilization of land to a vigorous, independent and public scrutiny, backed by a competent authority at Cabinet-level, to ensure that national more than sectional and local interests determine the decision.

CHRONICLE AND COMMENTARY

The Intelligent Man's Guide to the Post-War World

By G. D. H. Cole. Pp. 1143. (London: Victor Gollancz, Ltd., 1947.) 21*s*. net.

Farewell to European History

Or the Conquest of Nihilism. By Alfred Weber. Translated from the German by R. F. C. Hull. (International Library of Sociology and Social Reconstruction.) Pp. xx+204. (London: Kegan Paul and Co., Ltd., 1947.) 16*s*.

THE lecturer or tutor who tries to guide his university extension or other students through the mazes of contemporary political and economic issues has long been accustomed to being asked to recommend a book which would cover the ground of his course and serve as a general reference work; and he has not infrequently named one of the books, packed with useful information, which Prof. Cole has found time and energy to produce as the offshoots of his own varied studies. Three major productions of this kind appeared before the War, and the "Guide to Modern Politics" of 1934 is still remembered. But never before has Prof. Cole produced so tightly packed a guide as has now appeared: the information it contains almost overflows as one holds the book, and the table of contents reads like an encyclopædia. There is ample material here for the study of almost every aspect of current problems —population, industrial development, international trade, unemployment, emigration, capitalism and socialism, developments in Britain, in Europe and throughout the world, the United Nations, and the future of democracy. The reader is at a loss whether to admire more Prof. Cole's width of reading or his powers of exposition. The select book-list alone, which runs to something over ten pages, would keep several tutorial classes busy for years, while there is valuable material in the long and well-devised series of tables and charts.

But while one salutes with respect the tremendous labour that has gone to the making of this vast work, only to be compared among recent books, perhaps, with John Gunther's "Inside U.S.A.", at the same time it is necessary to ask what purpose it is intended to serve. The publisher's introduction calls it "a great political self-educator", and if one accepts the view, not unknown among librarians, that the true needs of adult education can be met merely by making books available, then the description is a sound one, though the size and price of the book are somewhat forbidding. Prof. Cole himself is frank in his preface about the task he set himself. Much of the book had to be rewritten several times, he tells us, much of it discarded as centres of interest fluctuated, and in the end he let the printers have it in March 1947 in the hope that the selection of topics made "will give most readers as much of what they want as it is possible to bring between the covers of an exceptionally fat volume".

The disadvantages of this method of work are obvious, and the method itself can only be justified if the resulting book has something new to offer, whether by way of material or by way of interpretation. In the matter of material it may be doubted in this case whether anything new is presented, and it is not too much to expect that the student who would be prepared to sit down to a book of this size would be equally prepared to do the wider reading that is necessary for the study of whatever topic particularly interests him. There is no dearth of useful reading matter, as Prof. Cole's book-list alone shows. It is rather interpretation that is required, and interpretation that could reasonably be expected, from a work that proclaims itself a "Guide". But interpretation in such a work implies the illumination of historical processes. There is much of this, but it is directed less to a clarification of issues than to a statement of Prof. Cole's own views, and even Prof. Cole cannot always speak with the authority of personal investigation. Thus he frankly tells us on p. 845: "I am neither a prophet nor an expert on Indian affairs, and any comment I make can be no more than that of a diligent observer of world politics", but proceeds: "I acutely dislike the idea of a completely separate Pakistan, because it seems to me to stand in the way of effective measures to raise the standards of living among the unfortunate Indian peoples, Hindu and Moslem alike", which illuminates his own views but scarcely those of the people concerned. Again, in discussing English education, he says: "The Education Act of 1944 purports to be a democratic measure; but it will not work out democratically unless a real effort is made to staff and equip, and as soon as possible to build, the new secondary schools up to a standard of real parity with the grammar schools and the so-called 'public schools' ", which is so obviously true as scarcely to need saying but suggests that a "real effort" is not being made; while the attack that follows on "classics" and reactionary headmasters is good electioneering but not very sound as commentary on present developments. On the other hand, there are a number of revealing statements that repay careful thought, such as that "British social history was thus, like British political history, a process of gradual democratisation of what were at the outset essentially aristocratic institutions"; or again, that "there is, in effect, no real school for democracy except the school of action", which might serve as a text on English social development.

But perhaps it is in a remark on p. 288 that Prof. Cole most clearly reveals the limitations of his approach. "England", he says, "for reasons which it would take too long to explain, emerged from absolute monarchy into an aristocratic system in which the aristocracy did not form a closed caste, but mingled with, and recruited itself from, the developing plutocracy of commerce." It is precisely the reasons that are here left unexplained, and others like them, that the student needs to know if he is to make sense of the present confusion. To have the immediate background available is useful, though it can fairly easily be gathered together from a number of reliable sources; but it is in discerning processes at work over a long period that the 'intelligent man' requires guidance. In particular he will ask whether the two wars of this century have played any part in hastening or hindering recognizable historical processes, and a guide to the present discontents might well attempt to estimate the effect of the late struggle on world developments. The impact of the War, for example, on Great Britain, the United States and the U.S.S.R., on Germany, and on the peoples of Asia would repay close attention. These topics are not ignored; but the total effect emerges only indirectly from Prof. Cole's survey. It is as if he were writing only a sequel to the "Guide" of 1934 and noting that some important incidents had occurred since that book appeared; as if little distinction were to be drawn between pre-war and post-war. Without going all the way with the writer of another recent book who sees the war as a "watershed" in modern history, one may legitimately ask for some estimate of its significance, so far as that can be measured at this early stage. Yet it would almost seem that Prof. Cole is more concerned with the dangers of a Third World War than with the consequences of the Second. To say this is not to fall into the common error of blaming an author for writing his book as he saw it rather than as the reviewer would wish it to be. A work that sets out to be a "political self-educator" must seek to anticipate the questions that the intelligent student will ask.

It might be added that the book-list, from the very fact of its length, would benefit by having the guiding principles of selection stated, together with some notes on the books named, while it also needs slight correction in detail—for example, the books by Sir Reginald Coupland and Prof. E. H. Carr are wrongly described on p. 1100.

Dr. Alfred Weber's book, "Farewell to European History", stands in direct contrast to Prof. Cole's, and were it written—or translated—in an easier and less allusive style might be regarded as a valuable supplement to his. For it sets out to do what Prof. Cole has not done, to grasp the nature and spiritual content of the War seen as "an event that would fundamentally affect the further course of history".

Dr. Weber, brother of the better known Max Weber who died in 1920, was deprived of his post by the Nazis and lived in retirement until the end of the War, when, with this searching study in his hands, he turned again, in his eighties, to the task of upholding the traditional standards of German scholarship. The opening paragraph of his introduction: "For anyone endowed with historical perspective it must be clear that the catastrophe we have lived through and are still living through sets us at the end of History as we know it, that is to say, history as moulded by the civilization of the West", inevitably recalls the thesis put forward by Spengler during the First World War. But Weber's concern is with Germany's terrible part in the crimes that have been committed, and he frankly accepts her fearful load of responsibility, recognizing that "she will never again become a sovereign, autonomous, competitive Power State in the earlier sense". The origins of the horrors of recent years he traces in the developments that marked the nineteenth century, and especially in the nihilistic temper, associated in the popular mind with Nietszche, that conquered the older spirit of the West from about 1880 and eventually provided the conditions that made Nazism possible. On this theme Dr. Weber has much that is illuminating to say, and it is of particular interest that it should be said in Germany at this moment by one who represents in himself something of the older spirit that was so tragically engulfed. For the future he sees a revival of traditional Western ideas, based on "national cultures with *intellectually* free sovereignty, but no freely competing nation-states any more". In other words it is the form and not the spirit of the West that is to pass away, a conclusion that is certainly not one of despair.

The publishers are to be congratulated on making this important work available in an English translation.

MAURICE BRUCE

THE LIVING PLANT

Botany of the Living Plant

By Prof. F. O. Bower. Fourth edition. Pp. xii + 700. (London: Macmillan and Co., Ltd., 1947.) 36*s.* net.

THE veteran author of this well-known book must be warmly congratulated on the publication of its fourth edition. He has been fortunate in the selection of those who have aided him, Prof. J. M. F. Drummond and Dr. G. Bond in the third edition, and now Prof. C. W. Wardlaw in the present one. When the book first appeared in 1919, Prof. Bower was one of the few persons competent in Great Britain to write, single-handed, a general treatise on botany at the university level of instruction; but the time is rapidly approaching when the single author must give place to a team of collaborators. This difficulty has been forestalled by Prof. Bower in his admirable choice of assistants, and fortunately the homogeneity of treatment characteristic of the first edition has been maintained.

The general plan of the book remains the same as in the third edition, which was reviewed in *Nature* (144, 400; 1939), but there are considerable alterations in the section on Thallophyta, in which the terminology has been modernized and the treatment of certain groups expanded. In the chapter on the Chlorophyceæ it may be noted that the cause of red snow in high latitudes is *Chlamydomonas nivalis* and not *Sphærella pluvialis*. Attention is rightly directed to the difficulty of drawing a line between the Flagellata and the Algæ; there is an interesting new commentary on alternation of generations in the Algæ, and also a fuller discussion of this in comparison with alternation in the higher plants.

Further information is given about the multifarious spore forms of the Fungi. Included in this section is a comprehensive account of the life-history of *Puccinia graminis* in the light of modern work, though an error still persists concerning the time of nuclear fusion, which occurs during the maturation of the teleutospores and not on germination. It might have been pointed out that this fungus is now something of a rarity in Britain, although other cereal rusts occur frequently: so uncommon is it that many teachers of botany are at a loss for material. A mistake concerning *Phytophthora infestans* should be corrected: it is not true to say that the mycelium spreads through the tissues down the haulms to the tubers.

The stimulus which this book has always given to the study of plant morphology is further enhanced by a new discussion on the nature of the leaves of Dicotyledons and Monocotyledons, by insistence on the sporangia of the higher plants being organs *sui generis*, and by reference to the category of 'telome' introduced by Zimmermann. The chapter on "The Relation of Size and Form in Plants" has been elaborated, and it now contains a most interesting comparison of the apical growth of palms and ferns in relation to the vascular supply and nutritive requirements, which is contrasted with development in the Dicotyledons. This chapter also contains an illuminating statement on adaptation of form in submerged parts.

There are a few new illustrations, notably the frontispiece, which is a modern picture of the giant trees of California, replacing an older representation.

All teachers of botany will offer the heartiest welcome to this new edition, which will give the book a fresh lease of vigorous life. Among other noteworthy features which have been maintained is the unsurpassed exposition of the biological significance of the development of heterospory and the seed habit.

F. T. BROOKS

SAMPLING PRACTICE IN THE UNITED STATES OF AMERICA

Méthodes statistiques modernes des administrations fédérales aux États-Unis

Par Pierre Thionet. (Actualités scientifiques et industrielles, 1011.) Pp. 117. (Paris: Masson et Cie., 1946.) 250 francs.

THIS book reviews recent American developments in the application of sampling to the collection of economic and demographic statistics. It is divided into two parts: the development of the mathematical theory, and the applications which have been made in recent years. On the practical side, chapters are devoted to the sampling methods applied to the 1940 Population Census, the methods adopted in the construction of monthly labour statistics, and the development of sampling methods, including the master sample, in agricultural statistics. On the theoretical side, an endeavour is made to cover the whole of the modern developments of sampling theory.

The book is useful in that it gives under one cover a summary of the very impressive progress that has been made in the United States. Accounts of most of this work have only been published after the outbreak of the Second World War, and are therefore likely to be less available, and less well known, than would otherwise have been the case. The importance of making these developments widely known in Europe, where the application of sampling has lagged behind that in the United States, cannot be too widely stressed.

On the other hand, the book must be regarded as a review of what is going on rather than as a satisfactory text-book from which to learn the new methods. Although half of the book is devoted to the theory of sampling, the presentation leaves much to be desired, and it is clear that the author has not fully digested the more modern developments. Thus, for example, he appears to have no understanding whatsoever of the analysis of variance, although he devotes a section to it, and later reproduces a schema for such an analysis. He also appears to be unaware of the connexion between the analysis of variance and intraclass correlation, a point which he could scarcely have overlooked had he studied Fisher's "Statistical Methods for Research Workers", which introduces the analysis of variance *via* intraclass correlation. Again, what is one to make of the recommendations in the chapter on basic theory that, in the absence of all information on the size of the different strata, the population mean should be estimated from the mean of the strata means, and that an equal number from each stratum should be included in the sample?

Whether the book will be of much value to English-speaking readers, who can easily refer to the original papers (most of which have been published in the *Journal of the American Statistical Association*), is therefore doubtful; but for those who require an introduction to the subject in the French language it will fulfil a useful purpose.

F. YATES

BLINKING: ITS ROLE IN PHYSICAL MEASUREMENTS

By Dr. ROBERT W. LAWSON
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Introductory

A BLINK is defined as a temporary closure of both eyes, involving movements of the upper and lower lids. The process of blinking may be carried out voluntarily; but in what follows we are primarily concerned with normal *involuntary* blinking. As a result of a study of the literature on this subject I have become aware of an important consequence of this lid movement which has unexpected repercussions on many phases of human activity, and which does not appear to have been recognized or appreciated hitherto. During part of the duration of each blink we undergo a complete blackout, and this has an important bearing on the accuracy attainable in a variety of physical measurements. That it has not been taken into account in the past is undoubtedly due to the involuntary nature of the act of blinking, for I find that relatively few people are aware of the blackout interval, and those who are rarely have any idea of its duration, believing it to be instantaneous. Moreover, the normal rate of blinking or the converse inter-blink period is not generally known, except in medical and kindred circles. In physics the various subjective errors of measurement have usually been considered to be taken account of adequately by the use of the personal equation. But it is now clear that the blackout factor during blinking must also enter into the personal equation, and it has to be recognized that in certain types of measurement it is, in fact, the dominant part of that equation. Before discussing this feature of the process in greater detail, it will be helpful to summarize the literature on the subject of blinking[1], in so far as it is relevant to this discussion.

Blinking

(*a*) For the normal individual, provided that the experimental conditions remain constant, the average value of the interval between successive blinks (*inter-blink period*) is remarkably constant, though four different types of blinking have been recognized. In the first and predominant '*J*-type', short inter-blink periods are common, the average inter-blink period being *c.* 2·8 sec. for men, and somewhat less than 4 sec. for women. In the second, 'plateau type', the average inter-blink period was found to be *c.* 12 sec., though most of the observations were on women subjects. For the third, 'bimodal type' (uncommon), the average period was 3·6 sec.; and for the fourth, 'symmetrical type' (very uncommon), 5·8 sec. Dryness or humidity of the atmosphere have little effect on the rate of blinking. The value of the inter-blink period in the dark is inappreciably higher than in the light, though a sudden intense light may produce initially a few rapid blinks. The rate of blinking is more rapid when the eyes are converging on a near point than when they are focused on a distant object or moving from point to point. Attempts to stop the lid movements voluntarily lead in a short time to an almost irresistible impulse to blink.

(*b*) "The rate of blinking is closely related to the 'mental tension' of the subject at the time, and in all probability the movements constitute a kind of relief mechanism, whereby nervous energy, otherwise unutilized, passes into a highly facilitated path[1]." When the mind is in a state of relaxation, so that the mental tension is at a low level, there is little need for relief and the rate of blinking is slow, as it is also in the process of solving a mathematical problem, when, although there is intense mental activity, the mental tension is diverted into internal channels. On the other hand, when there is mental tension with no internal or external outlet for its relief, there is an "overflow of nervous energy into facilitated paths", which manifests itself in an increased rate of blinking. As instances of this enhanced rate of blinking or diminished inter-blink period may be cited impotent rage, anxiety with inactivity, suppressed pleasure or excitement, legal cross-examination, animated conversation, and frequent changes in fixation, where blinking tends to eliminate the disturbing blurring of the retinal image during the actual movements of the eyes.

(*c*) The sensory blinking reflex is brought about by an irritative stimulus such as the contact of a foreign body with the lashes, cornea, or conjunctiva, or by an irritation of these parts. The reflex time of the sensory reflex seems to be of the order of 0·04 sec., and the completion of a reflex is followed by a refractory period, lasting 0·25 sec., during which a second stimulus is ineffective. The effect of currents of air is to increase the rate of blinking, and particles of dust in the eyes have the same effect. Smoking a cigarette held between the lips may reduce the inter-blink period to less than one-half the normal value, whereas in pipe-smoking less smoke enters the eyes, and I have found that the inter-blink period in this case is only reduced by 16–40 per cent.

(*d*) The optical blinking reflex is a completely different mechanism from the sensory, being brought about by a bright light, though it is best studied by bringing an object near to the eye without touching it. Here the reflex time is greater, being of the order of 0·1 sec. or slightly more, whereas the refractory period, during which a second stimulus is ineffective, is also longer than for the sensory reflex, amounting to 0·5–1 sec.

(*e*) The aural blinking reflex is initiated by mechanical or thermal stimulation of the ear, and is accompanied by unilateral weeping. Loud noises produce a similar effect.

(*f*) Various estimates have been made photographically of the duration of a full blink, and these lead consistently to values of 0·3–0·4 sec. Ploman, Engel and Knutsson found the duration of a blink (0·4 sec.) to be resolvable into the following intervals: lowering of the upper lid, 0·05 sec.; lids closed, 0·15 sec.; raising of the upper lid, 0·20 sec. (see Duke-Elder, p. 647). From these estimates it seems fairly certain that on the evidence available the time during which the pupils of the eyes are covered by the lids cannot differ appreciably from 0·3 sec., and this value will be used in the sequence. In other words, *during each full blink there is a complete blackout for a period of* 0·3 *sec.*

(*g*) In a publication on eyeball reflex movement associated with blinking, Miles[2] writes: "It was found that synchronously with the lowering of the upper lid there was a very rapid elevation of the eyeball with a much slower reverse movement when the lid was lifted. This movement of the eyeball appears in both reflex and voluntary winking and seems not to depend on the condition of sleepiness. In cases where the lid reflex is small, practically the complete curve for the cornea movement is recorded.

The size of the movement is of the order of 10 to 15 degrees on the arc of vision." "To what extent this shifting of the line of regard modifies the efficiency of vision has not been determined. Under certain lighting conditions one can easily notice the shift in the stimulus, a tailing off downward, at the instant of winking." This last statement is expressed in a somewhat different form by Macleod[3]: "If one notices carefully, one can observe while reading, that just at the beginning of the wink reflex it appears as if the page were suddenly jerked downwards".

In regard to this downward displacement at the moment of blinking, mentioned by Miles and Macleod, I have strong experimental evidence, to be published shortly, that it is due to another cause and not to the upward rotation of the eyeball accompanying the closing of the lids. Moreover, although an opposing motion of the eyeballs undoubtedly does occur during each phase of the act of blinking, experiments that I have conducted over a number of years have convinced me that, in general, the amount of the rotation is much less than the 10°–15° stated by Miles. Thus, in the case of my left eye, there is no perceptible rotation at all, whereas the magnitude of the rotation of my right eye is between $\frac{1}{2}°$ and 1°, and I have recently met with a case in which there appears to be no rotation in either eye associated with the lid movements. Furthermore, I find that as the edge of the upper lid crosses the pupil just before and just after the blackout period, there is *mobile vision*, a variety of autokinetic perception, which lasts about 0·01–0·02 sec. in each case. In contrast, the type of vision that occurs during the inter-blink period may conveniently be termed *static vision*, and it is then that the vision is most efficient. When a single act of blinking has been completed, the eye returns to its original direction of fixation, and in my own case this occupies a time of from 0·2 to 0·25 sec. The blackout period (0·3 sec.) is thus followed by a period of 'mobile vision' of approximate magnitude 0·25 sec.

The Blackout Indices

The above results, taken in conjunction with the value of the inter-blink period, have some important consequences, and it will be found convenient in their discussion to introduce at this stage the terms 'blackout index' and 'modified blackout index'.

(1) The *blackout index*, expressed in per cent, may be defined as one hundred times the ratio between the blackout period (0·3 sec.) and the inter-blink period (2·8 sec. for the prevalent '*J*-type' eye—see (*a*) above). This means that under normal conditions a person with a *J*-type eye is 'blacked out' intermittently for 10·7 or say 11 per cent of the total time of vision.

(2) The *modified blackout index*, expressed in per cent, may be defined as one hundred times the ratio between the sum of the periods of blackout and mobile vision (0·3 sec. + 0·25 sec. = 0·55 sec.) and the inter-blink period. This means that under normal conditions a person with a *J*-type eye has uncertain vision, that is, is blacked out or has mobile vision, intermittently, for 19·6 or say 20 per cent of the total time of vision.

As the periods of blackout and mobile vision undoubtedly show variations from person to person, just as in the case of their inter-blink periods (section *a* above), it is clear that the numerical data for any individual under given conditions should be separately determined in order to be able to evaluate the blackout indices with any precision. All we can do here is to confine ourselves to the data actually available in the literature, or individually determined. In Table 1 are given the data for the main types of subject (see sections *a*, *f* and *g*), for the rapidly blinking subject *X*, whose values I determined during reading and in animated conversation (see section *b*), and for myself in daylight and in the dark (see section *a*).

TABLE 1

Subject	Inter-blink period (sec.)	Black-out period (sec.)	Mobile vision period (sec.)	Black-out index (%)	Modified blackout index (%)
J-type (male)	2·8	0·3	0·25	11	20
,, (female)	*c*.4	0·3	0·25	7·5	14
Plateau type	*c*.12	0·3	0·25	2·5	4·6
Bimodal type	3·6	0·3	0·25	8·3	15
Symmetrical type	5·8	0·3	0·25	5·2	9·5
X (reading)	1·2	0·3	0·25	25	46
X (talking)	0·8	0·3	0·25	38	69
Self (daylight)	13·1	0·1	0·25	0·8	2·7
Self (dark)	13·6	0·1	0·25	0·7	2·6

Note.—For trained observers, the shortest normal inter-blink period so far observed is 0·6 sec., and the longest 18 sec. (woman). The lower limit of the blackout period probably lies near 0·1 sec., whereas the upper limit may readily be as large as 0·5 sec., for some subjects screw their lids together during a blink.

The methods used in determining my own involuntary rate of blinking, blackout period, and mobile vision period will form the subject of a later communication. As no data on the period of mobile vision exist in the literature, the value entered in the appropriate column is that of my own eyes. From the data in the last two columns of the Table it will be seen that very wide individual variations in the blackout indices exist, and it is precisely this fact that is of great importance in physical measurements and in other spheres of human activity.

Classification of Error Types due to Blinking

Certain types of physical measurement must inevitably be in error by at least the amount indicated by the appropriate blackout index. Blackout and mobile vision errors will be present in all types of time observations, though for observers with a long inter-blink period they may be sufficiently small to be negligible, whereas for observers with a rapid rate of blinking the errors may be in excess of 50 per cent and can rarely be neglected.

In considering the subjective errors in physical measurements due to blinking, three main types call for comment, the first of these being by far the most important.

Type A: In subjective counting experiments, where the duration of the events counted is small compared with the blackout period, and especially when the succession of events is random, the results will be in error by at least the percentage indicated by the blackout index. In certain cases the period of mobile vision may still further increase the error. The counting of scintillations in radioactivity provides an excellent illustration of this type of error, for the duration of a scintillation (see Rutherford, ref. 5, p. 545) is of the order of 10^{-4} sec. (blackout period 0·3 sec.), and we shall return to it later.

Type B: When the duration of the events counted or observed is of an order comparable in magnitude with the blackout or modified blackout period, the effect of blinking is an essential part of the personal equation and must be allowed for. Moreover, the error involved will be greater the more rapid the rate of blinking of the observer.

Type C: As the duration of the events observed or the time of observation is progressively increased as compared with the blackout period, the errors due to blinking likewise become progressively less important. In other words, the uncertainty of observation resulting from blinking becomes less important as the time of observation is increased, and the effect of blinking on the personal equation is diminished. This is of importance in pendulum measurements or in observations on the fall of bodies either in the air or in a viscous medium (Stokes' law). It should also be borne in mind that in measurements by the method of coincidences, individual coincidences may easily remain unobserved should they occur during the blackout period of a blink.

In my long teaching experience I have frequently been puzzled by the fact that occasionally otherwise good students seem to be incapable of getting reasonably accurate results in experiments involving the measurement of times of the order of several seconds, and have been loath to put their misfortune down to carelessness. It seems probable that this defect may be connected with the process of blinking, and I can recall individual cases of high rates of blinking in such students. I have also noticed similar discrepancies in the measurement of Young's or Fresnel's (biprism) fringes, and a feasible explanation seems to be that such observers may have a high rate of blinking, so that their vision is blacked out or mobile during a relatively high percentage of the time of their measurements with a lateral traverse micrometer eyepiece, in addition to which occasional fringes may be skipped. In microscopy, too, observers with a high modified blackout index must find it difficult to be certain of the detailed finer structure of the specimen under examination.

In various branches of industry, also, there must be many processes and measurements in which the rate of blinking may be a handicap, and consideration of the process of blinking will surely have an important part to play in matters of vocational guidance. In particular, in mining, the irritation of the eyes produced by dust and the consequent raising of the rate of blinking (see section *c* above) may influence the safety factor, in addition to which miner's nystagmus with its accompanying mobile vision is, I understand, often associated with an enhanced rate of blinking.

Application in Radioactive Measurements

One of the most important constants in radioactivity is Z, the number of α-particles emitted per second by 1 gm. of radium and by 1 Curie of radon. Here the unit 1 Curie is used in its original sense, as the amount of radon in equilibrium with 1 gm. of radium. The value of Z has been determined on many occasions and by a variety of methods. In Table 2 a summary is given of the various methods that have been used in the determination, together with the final result for each[4]. In the words of Rutherford[4]: "Considering the difficulty of accurate measurement by some of the indirect methods, there is a fair accord". "There is no doubt that a direct determination of Z is beset with considerable difficulties, partly connected with the source of α-rays and partly with the efficiency of the electrical and scintillation methods of counting α-particles." "When we consider the care taken in the measurements, it is difficult to account for the divergence between the various values of Z, and particularly the low values in some determinations. One of the main difficulties in these experiments lies in the choice and preparation of a suitable source of α-rays which is free from all uncertainty and can be measured with precision."

TABLE 2

Method	Investigator	Date	Z
1. Electrical counting	(*a*) Rutherford and Geiger	1907	$3\cdot57\times10^{10}$
	(*b*) Hess and Lawson	1918	$3\cdot72\times10^{10}$
	(*c*) Geiger and Werner	1924	$3\cdot5\times10^{10}$
	(*d*) Ward, Williams and Cave	1929	$3\cdot66\times10^{10}$
2. Scintillation	Geiger and Werner	1924	$3\cdot40\times10^{10}$
3. Total charge	(*a*) Jedrzejowski	1927	$3\cdot50\times10^{10}$
	(*b*) Braddick and Cave	1928	$3\cdot68\times10^{10}$
4. Production of helium	(*a*) Boltwood and Rutherford	1911	$3\cdot50\times10^{10}$
	(*b*) Dewar	1910	$3\cdot69\times10^{10}$
5. Life of radium	Gleditsch	1919	$3\cdot55\times10^{10}$
6. Heating effect	(*a*) Rutherford and Robinson	1912	$3\cdot72\times10^{10}$
	(*b*) Watson and Henderson	1928	$3\cdot70\times10^{10}$
7. Volume of radon	Wertenstein	1928	$3\cdot7\times10^{10}$

It is of great interest to examine how the values obtained by the various subjective methods of determining Z may be influenced by the rate of blinking of the observer. Without exception all the methods, directly or indirectly, involve the measurement of time intervals, usually the duration of the experiment, and so the factor of blinking will enter in some small measure into the personal equation (Type *C*). But the error due to the period of blackout is likely to be disturbing only in the subjective measurements of methods 1 and 2. As Rutherford and Geiger used a long-period quadrant electrometer, their blackout error can be disregarded. This also holds for the method 1 (*d*), in which the particles were photographically recorded. We are thus left with methods 1 (*b*), 1 (*c*) and 2 in which the blackout and mobile vision errors may be of importance.

If the string electrometer used by Geiger and Werner in method 1 (*c*) was of the same type as was used by Rutherford and Geiger in their photographic recording of α-particles, its period of deflexion would be *c.* 0·01 and of return 0·02 sec., both of which times are small as compared with the period of blackout during blinking (0·3 sec.), so that the blackout error would be effective (Type *A*). Taking account of the blackout indices in Table 1, this would mean that the results might readily be low by several per cent. A short-period string electrometer thus has distinct disadvantages as compared with a long-period instrument in the subjective counting of particles, a point which has not been realized hitherto.

We may now consider Geiger and Werner's scintillation counting method (method 2). The question of the efficiency of scintillation counts has been the subject of much discussion[5], but the above workers devised an ingenious method which would appear to guarantee one hundred per cent efficiency. In this method the same area of the screen is viewed from opposite sides by the two observers, who record their counts on a drum. If N_1 and N_2 are their respective counts, and if C is the number of coincidences, then the true number of particles was shown to be $N = N_1N_2/C$. But also this method is not free from the error due to blinking, even if both observers have identical inter-blink periods and identical blackout periods, for, as already mentioned, the duration of a scintillation is *c.* 10^{-4} sec. and the period of blackout 0·3 sec. (Type *A*). Certain of their blinks would be sufficiently near to be considered practically simultaneous, especially when we remember that, after a relatively long inter-blink period, it often happens that several blinks follow in quick succession, so that an appreciable number of particles would not be counted by either observer. Without numerical data concerning the acts of blinking of these two workers, no correction can be applied to their estimates of Z, but an error of ten per cent is well within the bounds of possibility, as will be seen by reference to the fifth column of Table 1.

In regard to scintillation counts, an abstract from some work by Chadwick[6] is suggestive: "When the scintillations appear on the screen at convenient intervals, it is possible for the two observers to compare their impressions of the intensity of the scintillations. It sometimes happens, particularly when dealing with the weaker scintillations, that a scintillation which appears bright to one observer is weak to the other." There seems little doubt that the weaker scintillation was seen by one of the observers during one of his periods of mobile vision (*c.* 0·01 and 0·25 sec.). Rutherford's remark (*loc. cit.*) "that the superior efficiency of an experienced observer appears to be due to greater concentration, to control of spontaneous movements of the eye, and to practice in using the ex-central portions of the retina, thereby avoiding the insensitive fovea-centralis" now requires to be supplemented by the statement—"and above all to a low value of the blackout index".

It remains to discuss method 1 (*b*) in Table 2, and here numerical data on the act of blinking are available, at any rate for one of the observers (see Table 1). These workers used a longer period Elster-Geitel string electrometer for their work. The string took just under 0·2 sec. to be deflected, and the entire displaced period[7] was greater than 1 sec. Since these times are appreciably greater than Lawson's blackout period (0·1 sec.), it is certain, even taking account of his period of mobile vision (0·25 sec.), that this observer saw at least two-thirds of a kick which occurred at the moment of a blink, so that the blackout error can be disregarded in his case. In regard to the second observer (Hess), nothing is known of his blackout period, but it is recalled that his inter-blink period was definitely shorter than that of Lawson, so that his blackout indices would be greater. A slight discrepancy in the estimates of Z by these two observers might therefore be expected, and was in fact found[8]. Thus in the final series of observations their mean corrected values of Z were:

Hess (114 determinations): $Z = 3{\cdot}68 \times 10^{10}$,
Lawson (154 determinations): $Z = 3{\cdot}75 \times 10^{10}$.

In all, about 80,000 particles were counted in these final determinations. The accuracy to be expected from this number of particles is thus of the same order as the guaranteed accuracy of secondary radium standards (0·5 per cent), which are used in the measurement of the sources. On the evidence available at the present time, therefore, there seems to be no valid reason for suggesting a change in the accepted value of $Z = 3{\cdot}70 \times 10^{10}$, for its true value is scarcely likely to be greater than $3{\cdot}75 \times 10^{10}$.

Further Applications of the Blackout Indices

It is of interest to note the effect of the act of blinking in other branches of human activity. In the realm of sport it is of great importance. When we consider that a motorist who has a rapid rate of blinking may be blacked out intermittently for about 40 per cent of his driving time, or 40 per cent of the distance travelled, we can surely discern in this a primary cause of proneness to accident. In fast games like tennis or badminton, the ball or the shuttlecock will certainly be lost to sight during the 0·3 sec. of the blackout due to blinking. For people with a high rate of blinking, bowls is a much more suitable form of recreation. In flying, too, the airman does not appear to have been aware hitherto of the effect of blinking on his efficiency, either in bombing a target or in fighter combat, for in the period of his blackout or mobile vision he may have travelled a distance of the order of one hundred yards. The effect will be greater still for the pilot of a jet fighter. The blackout indices are also of great importance in cricket, for if they are high, the batsman or wicket-keeper may lose sight of the ball between the wickets, the fielder may readily miss what seemed a sure catch, and the umpire may give a wrong decision. In boxing, too, a damaged eye stimulates blinking and thus an increase in the blackout index, whereas the time constants involved in the sensory and optical blinking reflexes may be all-important to the boxer. Also in photography it is to be expected that, on the average, a group of people will have approximately normal time constants of blinking, and in consequence, at any moment, a definite percentage of them equal to the normal black-out index (*c.* 10 per cent) will be in the act of blinking. This prediction is confirmed by the examination of group photographs. Thus in two recent topical photographs of groups of 43 and 18 persons respectively, three had closed and three half-closed eyes in the first, and in the second two had closed eyes.

In conclusion, it may be mentioned that all electrical valve counting circuits, by virtue of their time constants, must suffer from the disadvantage of blackout, but as the effects are calculable, they need not necessarily involve serious error in the count. Another electrical analogy is to be found in the time base of the cathode ray oscillograph, in which the fly-back time corresponds to the blackout period in blinking. In this case, also, the error involved can readily be determined.

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[1] In particular, Ponder, E., and Kennedy, W. P., *Quart. J. Exper. Physiol.*, **18**, 89 (1928); Blount, W. P., *ibid.*, **18**, 111 (1928); Luckiesh, M., and Moss, F. K., *Illum. Eng.*, **35**, 19 (1940); Hall, A., *Brit. J. Ophthal.*, **29**, 445 (1945). General references: Duke-Elder, W. S., "Text-Book of Ophthalmology", **1**, 643–647 (Henry Kimpton, London, 1942); Glasser, Otto, "Medical Physics", 679–681 (Year Book Publishers, Inc., Chicago-Illinois, 1944).

[2] Miles, W. R., *Amer. J. Physiol.* (*Proc.*), **72**, 239 (1925).

[3] Macleod's "Physiology in Modern Medicine", 278 (1941).

[4] Taken from "Radiations from Radioactive Substances", by Rutherford, Chadwick and Ellis, 63 (Camb. Univ. Press, 1930).

[5] Rutherford, Chadwick and Ellis, 544–550. See also Geiger, H., and Werner, A., *Z. Phys.*, **21**, 187 (1924); Hess, V. F., and Lawson, R. W., *Phil. Mag.*, **48**, 200 (1924).

[6] Chadwick, J., *Phil. Mag.*, (7), **2**, 1056 (1926).

[7] Lawson, R. W., and Hess, V. F., *Wien. Ber.*, (IIa), **127**, 465 (1918).

[8] Hess, V. F., and Lawson, R. W., *Wien. Ber.*, (IIa), **127**, 456 (1918).

THE ECOLOGICAL APPROACH TO BOTANY

By Dr. H. GODWIN, F.R.S.
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THE last forty years have witnessed the growth and establishment of the *idea* of ecology. Twenty years ago it was possible for botanical professors to pronounce that they simply disbelieved in ecology, and it was a word of mystery to the general public. 1911 saw the publication of "Types of British Vegetation" by Prof. A. G. Tansley, and in 1913 the

British Ecological Society was founded, with its periodical *The Journal of Ecology*, to which in 1932 was added *The Journal of Animal Ecology*. In 1939 there appeared the monumental volume, "The British Islands and their Vegetation", by Prof. Tansley, which demonstrated by its advance upon "Types of British Vegetation" the tremendous extension of our ecological knowledge of British vegetation, and in 1942 Sir Edward Salisbury's book, "The Reproductive Capacity of Plants", which showed the progress of autecological investigation.

This expansion of ecology is due to the realization that natural history is not, after all, outside the scope of exact scientific inquiry, and it reflected that the eagerness of the old quest for knowledge of living organisms in the field had been coupled with new techniques and the methods of modern science. The consequence of this expansion is that ecology is now acknowledged by men of science and comprehended by most laymen.

Few, however, comprehend the power of the ecological idea, or how forceful a means it is proving to be in the expansion of knowledge, and in the advance of civilization. We have begun by the recognition that in schools and colleges the mere collection and identification of species and genera must, in educational interests, as well as scientific, give place to studies of the intimate biology of plants and animals, and of the relationships between them and their environment. The complexity and the scientific interest of the situation thus disclosed have affected scientific research in the widest fields: marine biology, with its studies of herring shoals, whale fishing, sealing, and seaweed survey; ornithology, with its intensive and extensive census and migration studies, and starling, rook, wood-pigeon, and sea-bird inquiries; entomology, with its immense fields of applied science, and locust, tsetse, wireworm and aphid investigations; vertebrate ecology of fur-bearing animals and lemming, rat, grey squirrel and coypu; forestry, with its problems of exploiting and equally of maintaining natural forest; all these and many other sciences bear witness to the penetration of the ecological idea into appropriate scientific fields, and of its fruitfulness therein.

It owes its success simply to the timeliness of the reaction against premature simplification of biological interpretation, and premature syntheses from basic generalizations. It is a study demanding constant return to the primary data, which are the observations in the field, and constant emphasis on the reaction of the organism as a whole in its environment.

The value of this approach is apparent in the quality and bulk of the results achieved, and in a demand for trained ecological research workers which far outstrips supply. Wherever biological material is involved, be it rubber, teak, penicillin, slugs, lettuces, lice, cotton, or cat-fish, there comes the need for ecological inquiry, and naturally this is most realized where great natural resources in unexploited lands are being surveyed for their potentialities. Let there be no question: only an ecological approach will now serve us in these regions. Gone are the days of the old German dogma that forests should be grown like crops of potatoes, and rapidly vanishing are the prospects for the heedless garnering of the earth's natural products. The immense destructiveness of modern exploitation has been brought home by the ghastliness of soil erosion phenomena in all parts of the world; but avoidance of such ills inevitably depends upon adequate ecological understanding of the systems of animal and plant life, soil, and climate which are involved.

There was a day when T. H. Huxley wrote and spoke with powerful effect against the neglect of biological teaching, and of biological knowledge, on the substantial ground that man himself is an animal. It needs little effort to extend this thesis, to-day so readily approved, to the understanding that we humans are not distinct from the biome; but that human communities, be they what they may, *all* form an inseparable part of the larger environment. There is no break in kind between the relationships of the great eco-systems of plant and animal communities, and those which include fewer or more human beings: the minor role of the sparse bushmen in their own forest environment grades into our own within a complex mechanical civilization. Since still the human agents remain animal in nature, sustain themselves within communities, and subsist on biological materials, they are no less part of the eco-system than were their ancestors. It is, indeed, appropriate and needful that to the complexity of the world's social problems there should increasingly be brought to bear an ecological and realistic interpretation. This is not to demand here and now the setting up of commissions, institutes or departments of human ecology, but to point out that such problems will be solved only by a generation which has been trained to adopt a sufficiently broad ecological outlook.

It is in our favour that the youth of Great Britain, more than at any time before, receives encouragement to develop such an outlook. Schools (encouraged by syllabuses of progressive examination bodies) devote increasing time to it, and are strongly assisted by the admirable organisation of the Council for the Promotion of Field Studies.

It has never escaped the attention of Prof. Tansley, who for so long has been the inspiration of British ecology, that the standard of school and university teaching in ecology depends upon the quality of the text-books available, and he has added to the debt which the science (and the country) owes him by sponsoring the timely issue of three ecological text-books, which will shape all elementary ecological study in Great Britain for some years to come. These are, first, "An Introduction to Plant Ecology"[1], written by himself, upon the basis of his well-known "Practical Plant Ecology". This keeps the general character of the older book, but also includes chapters on the modern theory of communities, succession, and life-form. The soundly balanced philosophical outlook and the clarity of style which Prof. Tansley commands would alone suffice to justify the book, which, in fact, is indispensable to all taking up the study of ecology, be they teachers or students, and at school or university level.

One of the pioneers to develop school ecological studies was E. Price Evans, who is also known for his work upon the ecology of Cader Idris. He and Prof. Tansley have combined in the writing of "Plant Ecology and the School"[2], a slenderer and more elementary work than that just mentioned, and aimed to make apparent by actual instances exactly how ecology can be practised in schools. This work rightly stresses the *integrative* influence of such ecological studies, and recommends their incorporation in studies of regional geography, and in general science courses. The authors properly observe that plant ecology is not so much a 'subject' as a method of approach to the study of plants, and this holds equally, of course, for all fields of ecology.

The last book of the trio under review, "Practical Plant Ecology", is by Prof. R. C. McLean and Dr. Ivimey Cook[3]: it gives an account of the field methods and field apparatus which have been found useful in the botanical courses of the University of Cardiff. Its matter-of-fact descriptions of apparatus and technique come down to the level of average students, and will give the means to many hitherto uninstructed folk of gratifying their desire to apply precise measurement to botanical field study. The many examples of records made by students indicate the enthusiasm which the authors have engendered in their classes. There is, of course, a danger that students may record data of temperature, light, or *p*H, without any comprehension of applicability to the ecological situation being examined; but this can be guarded against by good teaching, and by conjoint use of the "Introduction to Plant Ecology". It is the commencement of careful record and measurement that is for the moment of prime importance, and this book will go far to ensure it. Messrs. Allen and Unwin are to be congratulated upon providing schools and universities with three excellent books, so satisfactorily supplementing each other; it now remains to meet a similar need in the realm of animal ecology, and to show the way to teach the study of the biome, with its complex integration of both plant and animal life.

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[1] Introduction to Plant Ecology: a Guide for Beginners in the Study of Plant Communities. By A. G. Tansley. Entirely revised and enlarged second edition of "Practical Plant Ecology". Pp. 260. (London: George Allen and Unwin, Ltd., 1946.) 8*s*. 6*d*. net.

[2] Plant Ecology and the School. By A. G. Tansley and E. Price Evans. Pp. 98. (London: George Allen and Unwin, Ltd., 1946.) 6*s*. net.

[3] Practical Field Ecology: a Guide for the Botany Departments of Universities, Colleges and Schools. By Dr. R. C. McLean and Dr. W. R. Ivimey Cook. Pp. 208. (London: Allen and Unwin, Ltd., 1946.) 9*s*. net.

SCIENCE AND U.N.E.S.C.O.

MEETING AT MEXICO CITY

IN this article we are concerned mainly with the present results from the successful drive to put the 'S' into 'U.N.E.C.O.'. The presence of some thirty scientific men from the thirty-three countries represented at the second general conference of the United Nations Educational, Scientific and Cultural Organisation, held in Mexico City last November, was an earnest that the 'S' had come to stay; the careful preparations for the programme made by Dr. Joseph Needham and the staff of the Natural Sciences Division and the clear statements made by the representatives of the scientific working party in the plenary sessions account largely for the successful piloting of the various scientific projects past budgetary and other obstacles.

To one accustomed to the atmosphere of international gatherings of scientific men, a first impression of a meeting of the United Nations Educational, Scientific and Cultural Organisation is that, whereas science is truly international in outlook and has learnt to work along international lines, culture is essentially national or racial in outlook and is only just beginning, save on the more mechanical side of museums and libraries, to walk easily along the international path. While the eloquent protest of Sir Sarvepalli Radhakrishnan that the culture of the East is insufficiently represented on the staff of the Organisation was received with sympathy and applause, speeches which sounded as though they might have been delivered at Lake Success were seen to lie clearly outside the sphere of the Organisation's interests and activities. The temper of the meeting clearly indicated a desire for as complete co-operation as possible: political differences were barred, though in some cases national or racial differences were accepted as playing an inevitable part under present conditions.

The programme of many varied schemes for 1948 put forward in advance of the meeting by the Executive Board called for an all-over budget of 8,500,000 dollars. As a first step, this was reduced by the full meeting of delegates by 800,000 dollars, so that when the various sectional working parties met to discuss their programmes in detail, they knew approximately the size of the grant that they were likely to receive and they could modify the proposed plans accordingly. The chairman of the working party of the Natural Sciences Division was Dr. H. J. Bhabha. The programme ultimately adopted by this party and accepted by the plenary session included the following items:

(1) *Grants in Aid to Non-governmental Organisations* (for example, the International Scientific Unions and other bodies of an international character), to meet travelling expenses, publication charges, etc.; a total of 240,000 dollars was approved.

(2) *The Hylean Amazon Scheme.* The Organisation is generously supporting in its initial stages the proposal to found an international scientific institute at Belem to study the problems of the great forest zones and the basins drained by the valley of the Amazon. Physical geography, including soil science, biology, anthropology, agriculture and nutrition all provide special problems to be considered. Brazil, as the country most concerned, backs the scheme strongly. It is being supported by the other countries involved in the area—Bolivia, Colombia, Ecuador, Peru, Venezuela and the British, French and Dutch Guianas—also by the United States and at its own request by India, as a country much interested in tropical problems. The Organisation is making a grant of 100,000 dollars in 1948 for initial surveys. Of this sum, 50,000 dollars comes from the money for the Field Science Co-operation Office for Latin America; Mr. E. J. Corner will be in charge of the initial organisation.

(3) *Field Science Co-operation Office.* In addition to the Office for Latin America, which is to be assigned for the present to the Hylean Amazon, there already exist two field offices which act as links between the main centres of learning and research and countries remote from such centres. One is at Nanking, serving Far East Asia and the Philippines; the other is at Cairo for the Middle East. The officers in charge are Mr. J. Smid, of Czechoslovakia, and Dr. L. T. Thuriaux, of Belgium, respectively. An additional office for India was agreed to by the conference.

(4) *Popularization of Science and of its Social Implications.* Following upon two meetings of experts called together in Paris and in New York during October last, the United Nations Educational, Scientific and Cultural Organisation decided to stimulate research and surveys in this field by fellowships, by co-operation with existing bodies working on the subject and by the preparation and circulation of reports.

The Division of Natural Sciences will also play a part in a number of schemes supported by the Organisation, but having a wide range and affecting other branches of knowledge. These include methods of dealing with rehabilitation in war-devastated countries, exchange of personnel between countries, passage of books across frontiers, documentation, use of mass media for the spread of information, etc.; as in the case of libraries and museums, men of science are directly concerned in these projects, but only as part of a much wider group of interested people. The same applies to certain aspects of education, which provide the main body of the activities of the Organisation, and call for a separate report in itself.

With regard to the future position of science in the United Nations Educational, Scientific and Cultural Organisation, one fact must be borne in mind. The natural sciences were well organised at the start along international lines, while certain other subjects such as the humanities and the social sciences were not. As they fall into line—and the Division for Philosophy and the Humanities has already asked the Organisation to organise a central council along the lines of the International Council of Scientific Unions—they will find useful ways of spending money and will make their appeal to the Organisation for grants. Unless the income of the Organisation rises with its increased opportunities and responsibilities, the grants to science will be maintained at their present level only with difficulty.

In closing this account, tribute must be paid to the Mexican Government for its gracious welcome and generous hospitality; the Lebanese Government has been set a hard task for this year's conference at Beirut. This will be the last conference at which Dr. Julian Huxley will hold office as director-general. Dr. Needham retires from the post of head of the Natural Sciences Division this spring. Both of them have placed the scientific men of the world under a debt of obligation by the way they have initiated the scientific section of an organisation which has great possibilities for the future of the civilized world.

F. J. M. S.

THE EARTH'S SURFACE MAGNETIC FIELD AND ITS SECULAR CHANGE

By Prof. SYDNEY CHAPMAN, F.R.S.

THE Department of Terrestrial Magnetism of the Carnegie Institution of Washington renders a signal service to science by the publication of the important volume entitled "Description of the Earth's Main Magnetic Field and its Secular Change, 1905–1945"[1]. In a sense this represents the attainment (for the time) of one primary objective urged by the first director of the Department, the late L. A. Bauer, upon Andrew Carnegie, in the negotiations which led in 1904 to the institution of the Department. The volume has been prepared almost entirely under the control of the second director, J. A. Fleming, who from early days was Bauer's right-hand man in the development of the Department. The third director is to be congratulated on being able to issue so great a contribution to the science for the furtherance of which his Department was founded.

Bauer set himself with immense zeal to the task of promoting a world magnetic survey more complete than any previously attempted. As most of the earth's surface is water, the chief need was to survey the oceans. Bauer acquired a sailing vessel, the *Galilee*, for his Department, and adapted it (adding auxiliary engines) for magnetic survey work, on which it made three cruises. A non-magnetic vessel, the *Carnegie*, was then specially constructed, which made seven great survey cruises before it was overtaken by the disaster of destruction by fire in the harbour of Apia, Samoa, in 1929. These cruises form the main basis of our knowledge of the earth's surface magnetic field to-day, though supplemented by information provided by the land magnetic surveys undertaken by the principal civilized States in their own or dependent territories, and by the work of many polar and other expeditions.

Since 1929 our knowledge of the earth's magnetism has been slowly worsening. The outbreak of war halted the completion and equipment of the Royal Research Ship *Research*, a non-magnetic vessel built by the British Admiralty to resume the ocean magnetic survey work so well executed by the *Carnegie* during two decades. The fate of the *Research* is at present in doubt, but it may be hoped that the ship will soon begin her work and help to renew our current knowledge of the earth's ever-changing magnetic state.

Although Bauer intended to make a thorough theoretical study of the magnetic data obtained by his survey ships and by the land magnetic expeditions he organised or aided, along with all other available data, he actually made only slight progress in this work. But with generous wisdom he made his data quickly available for use in the construction of magnetic charts by the principal national agencies responsible for producing such charts. In particular, the early work of the *Galilee* and *Carnegie* formed the basis of the Admiralty charts when their preparation was transferred in 1917 to the Royal Observatory, Greenwich.

The supervision of this work by the then Astronomer Royal, the late Sir Frank Dyson, enhanced his interest in geomagnetism and led him, with H. Furner, to make an excellent spherical harmonic analysis of the earth's field for the epoch 1922—the only thorough analysis made during a considerable period extending before and after 1922.

The subsequent further accumulation of magnetic data enhanced the need for further study of the world-wide distribution and secular change of the field. A valuable beginning of this work was made in 1930 by H. W. Fisk (of the Department of Terrestrial Magnetism, Carnegie Institution), by his isoporic charts showing for each magnetic element the lines (isopors) of equal rate of secular change. The Department's plans for a more comprehensive treatment of this century's store of magnetic data first began to mature rapidly when, during the War, the work became the subject of a Government contract under the United States Naval Department. It was entrusted to a team of members of the staff of the Department of Terrestrial Magnetism, under the able leadership of E. H. Vestine, and has been executed thoroughly and successfully. The volume now under notice is the first fruits, and is to be followed by others giving a new spherical harmonic analysis of the field, and other developments.

The main contents of the volume indicate (i) the state of the earth's surface magnetic field for the epoch 1945·0, and (ii) the rate of change of the field at each of the four epochs 1912·5, 1922·5, 1932·5 and 1942·5. The field can be specified at any point by three elements, such as D the magnetic declination, H the horizontal magnetic intensity, and Z the vertical intensity; but other specifications are equally valid, involving one or more of these three elements, together with a choice from the further four elements, X and Y the north and east horizontal components, F the total intensity, and I the magnetic inclination or dip. All these elements are represented in this volume (though not all to an equal extent) by charts, tables and graphs. They are based on more than 100,000 individual observations, relating to nearly 10,000 stations for D and 5,000 stations for the other elements.

There are sixty-three isomagnetic charts for 1945·0, namely, fifteen large-scale sectional diagrams on Mercator's projection, with two polar charts (northern and southern) for the elements D, H and Z, and three charts (one Mercator, covering the middle belt between latitudes 73° S. and 84° N., and two polar charts, north and south) for each of the other four elements.

The isoporic charts number eighty-four, namely, three each (two polar and one for the belt 73° S. to 84° W.) for each of the seven elements for each of the four epochs.

Only the middle-belt isomagnetic charts (for X, Y, F and I) and the middle-belt isoporic charts show the background of geographical outlines.

The unusually large scale of the isomagnetic 1945·0 charts for D, H and Z enables smaller anomalies to be shown than is usual on magnetic maps, at least over the oceans. But Vestine explicitly disavows any claim that the charts represent an accurate description of the field, because there are many regions which have never been magnetically surveyed, across which uncertain interpolations had to be made.

Values for 1945·0 of each of the seven elements, scaled from the charts at 5° intervals of latitude and longitude, and of their rates of secular change at each of the four epochs, scaled from the isoporic charts at 10° intervals of latitude and longitude, are given in tables, part of which are separately published[2].

The volume also includes 214 graphs showing the time variation of each element (separately for D, H and I, and in combination for X, Y, Z and F) for a hundred magnetic observatories, and a sample of eleven repeat stations (out of about two thousand for which such graphs were prepared in the course of the work). The positions of the observatories and of the survey and repeat stations are shown on supplementary charts.

This volume is unique in geomagnetic literature not only for the extent of the underlying data and the fullness of the reduction and representation of the data; it is the first to describe at all adequately the nature of the processes of reduction and representation, with examples of the actual working sheets of computations for a typical observing station. A useful improvement in the work has also been made by rendering the X and Y charts, and the D and H charts (both isomagnetic and isoporic), mutually consistent on the hypothesis of negligible electric currents crossing the earth's surface; and also by the use of simple analytic considerations on the form of the isomagnetic and isoporic lines near dip poles.

The volume is a worthy embodiment and memorial of the first quarter-century of the observing work of the Department of Terrestrial Magnetism; may this work be emulated and surpassed during the remainder of this twentieth century. The development of methods of aerial magnetic survey seems to hold much promise for the future, though meanwhile well-tried methods should not be neglected.

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[1] Carnegie Institution of Washington: Department of Terrestrial Magnetism. Publication 578: Description of the Earth's Main Magnetic Field and its Secular Change, 1905–1945. By E. H. Vestine, Lucile Laporte, Caroline Cooper, Isabelle Lange and W. C. Hendrix. Pp. v+532. (Washington, D.C.: Carnegie Institution, 1947.) 2.50 dollars.

[2] Carnegie Institution of Washington: Department of Terrestrial Magnetism. Final Values of Elements of the Geomagnetic Field at 5-Degree Intervals of Latitude and Longitude, Epoch 1945. By L. Laporte, C. Cooper, I. Lange, W. C. Hendrix and E. H. Vestine. Pp. 73. (Washington, D.C.: Carnegie Institution, 1946.) n.p.

OBITUARY

Prof. Ludwig Becker

PROF. LUDWIG WILHELM EMIL ERNST BECKER, for forty-two years occupant of the regius chair of astronomy in the University of Glasgow, died at Merano in Italy on November 11, 1947. Becker was born at Wesel in Germany in 1860 and educated at the University of Bonn where, in due course, he took his Ph.D. degree. In 1885, after two years as an assistant in the Berlin Observatory, he was recommended to the Earl of Crawford and Balcarres, who owned a large private observatory at Dunecht, near Aberdeen, in professional charge, at the time, of Dr. R. Copeland. In the autumn of 1888 Lord Crawford presented the whole of his magnificent equipment, including his astronomical library of 15,000 volumes, to the Lords Commissioners of the Treasury for a new Royal Observatory. A site on Blackford Hill in Edinburgh was selected in 1889; Becker was included on the staff, with Copeland as Astronomer Royal. Four years later, Becker was appointed to the regius professorship of astronomy at Glasgow, occupying the chair until his retirement in 1935. The University Observatory half a century ago was well equipped for contemporary needs, and in his earlier years he extended considerably its instrumental resources.

Becker was an inspiring teacher. His 'honours-lectures' were mainly on celestial mechanics, of which he was a master. His scientific work covered a wide variety of subjects, of which the following may be mentioned: his investigation on the distribution of blue-violet light in the solar corona at the eclipse of August 30, 1905, in Tunisia; a long and careful investigation on the constant of aberration undertaken with the Glasgow transit circle; a capture-hypothesis relating to binary stars, in which he showed how such a system could capture a third star, losing in the process one of its own components, and how the hypothesis could account for the high eccentricities of binary star orbits (it may be added that this idea of capture has recently been adopted by Lyttleton in his earlier attempts to explain the formation of the planetary system); descriptions of various instrumental improvements such as a motor-micrometer for the transit circle and a new 'artificial horizon' for sextants.

Although Becker had become a naturalized British citizen before his appointment to Glasgow, this fact failed to save him from embarrassment and unmerited suspicion during the First World War; local public opinion forced his temporary retirement to Aviemore in the Highlands, where he lived in seclusion until the end of hostilities. Becker was one of the gentlest of men, modest and retiring in disposition and, whatever the outside world thought, respected and esteemed by his students both for his learning and his kindly qualities. W. M. SMART

NEWS and VIEWS

Scientific Research and Development in Northern Ireland

In accordance with its policy of encouraging the increased application of the results of scientific and industrial research by industry in Northern Ireland, the Ministry of Commerce has formed a Council of Scientific Research and Development. The work of this Council, which will be closely linked with that of the Directorate of Scientific Development of the Ministry of Commerce, will be carried out under the following terms of reference: (1) to advise the Ministry of Commerce on all scientific questions connected with the utilization and development of the natural resources of Northern Ireland; (2) to promote the increased application by industry in Northern Ireland of the latest discoveries and developments in the fields of pure and applied science with the object of improving present industrial methods and processes, creating new industries and expanding existing ones; (3) to arrange, through the Director of Scientific Development, for such investigations and research work as the Council may consider desirable in the best interests of Northern Ireland; (4) to promote the wider dissemination of scientific knowledge throughout Northern Ireland.

The composition of the Council is as follows: Sir David Lindsay Keir, president and vice-chancellor of the Queen's University, Belfast (*chairman*); Mr. D. H. Alexander, Belfast College of Technology; Prof. R. G. Baskett, professor of agricultural chemistry, Queen's University; Mr. O. F. Brown, Department of Scientific and Industrial Research; Mr. H. Bryson (Spence Bryson and Co., Ltd.); Prof. J. K. Charlesworth, professor of geology, Queen's University; Mr. M. Eitel (Stevenson and Son, Ltd.); Prof. K. G. E. Emeléus, professor of experimental physics, Queen's University; Prof. D. C. Harrison, professor of biochemistry, Queen's University; Mr. A. J. Howard, Ministry of Commerce; Prof. K. S. Isles, professor of commerce, Queen's University; Mr. B. M. Cance (Kirkpatrick Bros., Ltd.); Prof. A. H. Naylor, professor of civil engineering, Queen's University; Mr. D. Rebbeck (Harland and Wolff, Ltd.); Dr. A. J. Turner, Linen Industry Research Association; Mr. R. C. Wilson (Newforge, Ltd.); Mr. D. E. Wiseman (Short and Harland, Ltd.); and Prof. A. R. Ubbelohde, professor of chemistry, Queen's University. All inquiries in connexion with the activities of the Council should be addressed to the Director of Scientific Development, Ministry of Commerce, 20 College Gardens, Belfast.

Generation of Electricity from Wind Power

The work of the Section on Rural Electrification of the British Electrical and Allied Industries Research Association has already included research on the small-scale generation of electricity, principally by wind power. Recent shortages of power and fuel have aroused interest in the possibility of utilizing wind power on a large scale for the generation of electricity in Great Britain. Following earlier discussions with the relevant Ministries and other interested parties, the Association has established a new Section on Power Generation with the following terms of reference: "To study the technical and economic problem of large-scale aerodynamic generation in Great Britain; including the collection of all available information and evidence, the principles of the selection of sites and the wind energy derivable therefrom, the co-ordination of wind-driven generators with supply systems, the essential design features of wind-driven generators and the design problems which remain to be solved". The chairman of the new Sectional Committee is to be Mr. T. G. N. Haldane of Messrs. Merz and McLellan. The Committee is expected to comprise representatives from electricity supply, electrical manufacturers, consulting engineers, the Department of Scientific and Industrial Research and the Lord President's Office, the Meteorological Office, the Ministry of Fuel and Power and the Ministry of Supply. Representatives of the aircraft industry will also be invited, as may seem desirable. The research officer for the new Section will be Mr. E. W. Golding, who is in charge of the Association's work on rural electrification and its field station at Shinfield Green, near Reading.

Medical Research in South Africa

The annual report of the South African Institute for Medical Research for 1946 records activities so various that a short note cannot mention them all. Mr. G. H. Beatty, chairman of the Board of Management since 1939, retired in 1946 and was succeeded by Mr. E. H. A. Lawrence. The Institute's close co-operation with the University of the Witwatersrand continues. Increased attention is being given to the problem of the universal donor of blood for transfusion, and studies of the Rhesus factors have been continued. Work on the vole tuberculosis bacillus has included a continuation of immunization experiments previously carried out to include *Cercopithecus* monkeys and rodents. Two species of gerbils have proved equally susceptible to *Mycobacterium tuberculosis* and the vole bacillus, so that they cannot be used for cross-immunization work. Work on leprosy included treatment of lepers with 'Promin', a new sulphone; but blood examinations showed no significant change over a period of four months. Considerable work has been done on diphtheria, dysentery, tetanus, gas gangrene, relapsing fever, typhus fever and other diseases; a plague-like eipizoötic occurring among gerbils in the Johannesburg area was, after investigation, ascribed to *Listeria monocytogenes*, and further study of this organism, which influences the wild rodent population and is also present in domestic rats, gave interesting results which are outlined in this report. Entomologists will be interested in the list of vectors of yellow fever, which records thirty-four species of mosquito new to northern Bechuanaland, also in the work on the physiology of *Cimex lectularius* and the larvæ of *Aedes œgypti*. Standard bed bugs are being reared for the biological assay of insecticides. Work has also been done on nutrition, venoms and antivenenes, and allergy, and a considerable volume of routine work accomplished.

Evolution: An International Journal of Organic Evolution

Workers in various fields such as taxonomy palæontology, cytology, genetics, comparative anatomy, etc., besides the problems inherent in their own fields, often have to take into account and make contribution to the wider field of thought covered by the term 'evolution'. The interest in this major subject has increased noticeably in recent years, and it was with the object of facilitating this modern synthesis that a Society for the Study of Evolution was founded in the United States in March 1946. A grant from the American Philosophical Society has enabled this new society to launch a quarterly publication termed *Evolution: an International Journal of Organic Evolution*, and thus supply a noticeable want. The first number was issued in July 1947 and it is edited by Dr. Ernst Mayr, of the American Museum of Natural History, assisted by associate editors which include representatives of Great Britain, France, and the U.S.S.R. The journal is of convenient size, 25 cm. × 17 cm., well printed on paper that allows the use of half-tone blocks without undue loss in reproduction, and contains 112 pages. In general, contributions are limited to twenty pages, but shorter "Notes and Comments" are also published. They are accepted from any field of biology so long as they have a bearing upon evolution. The contributions in the first number include several papers on *Drosophila*, cytology, Hawaian birds, adaptive evolution in sticklebacks, hybrids in oak-tree populations and evolutionary rates in hypsodonty in horses and beavers. The subscription-rate for the volume is 6.00 dollars, or membership of the Society, which includes the journal, is 5.00 dollars, and the business manager is Mr. K. P. Schmidt, Chicago Natural History Museum, Chicago 5, Ill., U.S.A.

Disposal of Effluents from Harwell

THOROUGH precautions are being taken by the Ministry of Supply to ensure that the Thames water used at the Atomic Energy Research Establishment at Harwell is returned to the river free from risk of harmful radioactivity. These precautions are being adopted after close consultation between Harwell experts and experts of the Ministry of Health, the Metropolitan Water Board and the Thames Conservancy, and on the advice of the Medical Research Council's Research Committee on the Medical and Biological Applications of Nuclear Physics. A certain amount of radioactivity in drinking water can be tolerated by human beings, and the tolerances laid down by the Medical Research Council for the Thames water are such that the medical and biological effects due to the consumption of water during the life-span of human beings would be for all practical purposes negligible. Roughly one million gallons of water a day will be involved. The greater part will be used for the cooling of plant and ordinary domestic requirements at the Establishment. The remainder of the water will be used for research processes, some of them radioactive, and a carefully controlled separate water system will be installed to deal with it. The most highly active portion will be segregated and will not be returned to the river. The remainder will be delivered to storage tanks where it will be tested by medical officers for compliance with the agreed tolerances, treated for chemical impurities and then mixed with the domestic waste water before being discharged into the Thames at Sutton Courtenay.

The system of treatment and examination has been designed so that several operations have to be carried out before the water actually passes into the six-mile long discharge pipe. Moreover, a new weir is being constructed at the point of discharge into the Thames, and the Harwell water will thus be turbulently mixed with much greater quantities of river water immediately it joins the main stream. These safeguards have received the approval of the Ministry of Health. The Thames Conservancy has decided to raise no objection to the proposals, so far as their interests are concerned, in view of the safeguards agreed to be adopted and having regard to the assurances they have received from the Ministries concerned. By arrangement with the Ministry of Supply, the Thames Conservancy will be able to have samples taken at regular intervals for test purposes; the Ministry of Supply is providing facilities for testing such samples at a small riverside laboratory where Ministry of Supply scientific workers will themselves make sample tests and assist the Thames Conservancy.

Grants for Veterinary Education

THE University Grants Committee, the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland have appointed an Inter-Departmental Committee to inquire into the financial needs of veterinary education in Great Britain and to make recommendations to the University Grants Committee, in respect of universities, and to the appropriate Agricultural Minister, in respect of other educational institutions, as to the application of any moneys provided by Parliament towards meeting these needs. The Committee is constituted as follows: Dr. A. E. Trueman (*chairman*), deputy chairman of the University Grants Committee; T. Dalling, director of the Veterinary Laboratories of the Ministry of Agriculture and Fisheries; H. W. Dawes, president of the Royal College of Veterinary Surgeons; Sir John Fryer, secretary of the Agricultural Research Council; Dr. Thomas Loveday, chairman of the Joint Advisory Committee on Agricultural Education; Prof. G. W. Pickering, professor of medicine in the University of London; J. N. Ritchie, deputy chief veterinary officer, Ministry of Agriculture and Fisheries; W. L. Weipers, member of the boards of governors of the Royal (Dick) Veterinary College, Edinburgh, and of the Glasgow Veterinary College. The secretary to the Committee is Mr. E. Earnshaw Smith, of the University Grants Committee, 38 Belgrave Square, London, S.W.1. The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland will each appoint an assessor to the Committee.

French Conference on Ageing of Population

THE French National Union for Prevention of Depopulation and the French National Demographic Institute are organising a three-day conference on scientific research on ageing in the population of France, to be held in Paris during April 22–24. The programme of the conference is comprehensive: it includes sections of (1) demography, (2) economic and (3) social aspects of the problem, (4) physiology, psychology and pathology of old age, (5) organisation of work and occupation for old people, (6) rejuvenation of population. The conference will not be an international one; all reports will be by French workers, and discussions will be in French. Although only a few foreign specialists in demography, social and economic sciences, and gerontology have been invited, specialists in these subjects can attend the conference without a special invitation and, provided they will speak in French, take part in discussions. The president of the Organisation Committee is M. F. Boverat, 217 rue de Faubourg St. Honoré, Paris, 8e.

International Conference on Large Electric Systems

AN International Conference on Large Electric Systems (C.I.G.R.E.) will be held in Paris during June 24–July 3. Matters relating to the British delegation to the Conference are being dealt with by the British National Committee under the chairmanship of Mr. P. V. Hunter, at the offices of the British Electrical and Allied Industries Research Association. The official languages of the Conference will be English and French. Owing to the difficulties of accommodation, etc., intending delegates are requested to communicate with Mr. R. A. McMahon, Secretary, British National Committee, C.I.G.R.E., "Thorncroft Manor", Dorking Road, Leatherhead, as early as possible.

British Council Conference Grants

The British Council has for some time had a small fund from which grants have been made in exceptional cases to permit foreign men of science (including agriculturists, engineers and medical men) to attend national or international conferences or meetings held in the United Kingdom. The principal grounds upon which such grants have been made are: (*a*) that the application has been received from the body convening the conference or meeting; (*b*) that the Science Committee of the British Council has supported the application; (*c*) that the foreign visitor would be unable to attend without assistance. The grants cover subsistence or part-subsistence in the United Kingdom during the period of the conference or meeting. Fares to and from the United Kingdom are not included. No grants are made in respect of secretarial or other organising expenses, or for entertainment of delegates or hire of premises. Conveners of conferences or meetings to be held in the fiscal year 1948–49 are advised that it is necessary that applications for assistance to foreign visitors should be received not later than a fortnight from the publication of this notice. All applications will be considered together, and conveners will be notified of the results by the end of February. It is improbable that more than a small proportion of applications can be met from the fund. Applications with full particulars (including reasons why financial support is considered necessary) should be addressed to the Administrator, Science Group, British Council, 3 Hanover Street, London, W.1.

Coats Fellowships at Glasgow

Messrs. J. and P. Coats, Ltd., have provided funds for a research fellowship in chemistry or physics (excluding nuclear physics), tenable for two years, of the annual value of £300 and a supplement of £50 to cover research expenses. The Coats Fellowship will normally be awarded to a candidate with at least one year's experience in research work. It will be held in the University of Glasgow, but is open to graduates in science of any British university. The selection board will consist of the professors in the Departments of Chemistry and Natural Philosophy. A Coats Fellowship, similar in general conditions to that instituted at the University of Glasgow, is being offered to the Royal Technical College, Glasgow.

Biography of Sir Joseph Barcroft

Prof. K. J. Franklin, Department of Physiology, Medical College of St. Bartholomew's Hospital, Charterhouse Square, London, E.C.1, has been entrusted by Lady Barcroft and Prof. Henry Barcroft with the preparation of a biography of the late Sir Joseph Barcroft. He accordingly invites the cooperation of Sir Joseph's numerous friends and colleagues; he does not ask, at this stage, for specific information on particular aspects of Sir Joseph's life or work, but for general comments, such as mode o treatment, anecdotes, etc. Full acknowledgment wil be made in any consequent publication, and it is assumed by Prof. Franklin that, should he be prevented from writing the biography, the material may be passed on to an alternative author chosen by Lady Barcroft and her son. Communications should be sent to Prof. Franklin at the address above by April 30 next.

The Night Sky in February

New moon occurs on Feb. 10d. 03h. 02m., U.T. and full moon on Feb. 24d. 17h. 16m. The following conjunctions with the moon take place: Feb 5d. 06h., Jupiter 3° N.; Feb. 11d. 06h., Mercury 8° N.; Feb. 13d. 12h., Venus 3° N.; Feb. 23d. 13h. Saturn 4° S.; Feb. 24d. 02h., Mars 0·6° S. During the first part of the month, Mercury is an evening star, setting at 18h. 20m. and 17h. 58m. on Feb. 1 and 14 respectively, and is in inferior conjunction on Feb. 20. At the end of the month it rises about three-quarters of an hour before the sun but will not be an easy object to observe. Venus, stellar magnitude about – 3·5, is conspicuous in the western sky and sets at 20h., 20h. 40m. and 21h. 30m. at the beginning, middle and end of the month respectively—several hours after sunset. Mars, in the constellation of Leo, rises in the early evening hours and can be seen throughout the night. Jupiter does not rise until the early morning hours—4h. 47m. and 3h. 18m. on Feb. 1 and 29 respectively; but as the planet does not attain an altitude greater than 16° in the latitude of Greenwich, it is not very favourably placed for observation. Saturn, in the constellation of Leo, rises in the early evening hours and can be seen throughout most of the night. The planet is in opposition on Feb. 9. Occultations of stars brighter than magnitude 6 are as follows: Feb. 18d. 18h 37·7m., υ Taur. (*D*); Feb. 18d. 19h. 05.3m., 72 Taur (*D*); Feb. 20d. 00h. 49·9m., 125 Taur. (*D*); Feb 26d. 23h. 02·6m., γ Virg. *m* (*D*); Feb. 26d. 23h 29·7m., γ Virg. *m* (*R*); *D* and *R* refer to disappearance and reappearance, respectively, and the latitude and longitude of Greenwich are assumed. In addition to these occultations of stars, Mars is occulted by the moon on Feb. 24d. 01h. 58·9m., reappearing a 02h. 45·4m.

Announcements

Sir Edward Mellanby will deliver the Sir Frederick Gowland Hopkins Memorial Lecture of the Chemical Society at the Society's rooms on February 19 at 7.30 p.m.

A series of five lectures on aspects of atomic energy has been arranged by the London Branch of the Atomic Scientists' Association. The lectures wil be given in the lecture hall of the Royal Society o Arts, John Adam Street, Adelphi, W.C.2, at 7 p.m on alternate Fridays, beginning February 6. Tickets (2*s*. 6*d*. for one lecture; 10*s*. for the series) can be obtained from Dr. L. E. C. Hughes, 15 Avenue House, Allitsen Road, St. John's Wood, N.W.8.

An exhibition of War Office teaching aids, under the title "The Better Chance", will be open during February 3–11 in the Imperial Institute, South Kensington, London, S.W.7. This is an augmented version of the exhibition held at Eltham Palace on September 15 (*Nature*, 160, 411; 1947). It is open to the public.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Structure of Cyclo-octatetraene

We have been engaged in an investigation of the structure of cyclo-octatetraene by X-ray methods. In a previous communication[1], we gave the preliminary crystallographic data. Cyclo-octatetraene crystallizes in the orthorhombic system with four molecules per unit cell. The cell dimensions are $a = 7\cdot76$ A., $b = 7\cdot80$ A. and $c = 10\cdot66$ A. The space group is *Aba*.

The work has now been carried further to the point where the essentials of the structure are known, and accounts of the structure have been presented at several scientific conferences[2,3,4].

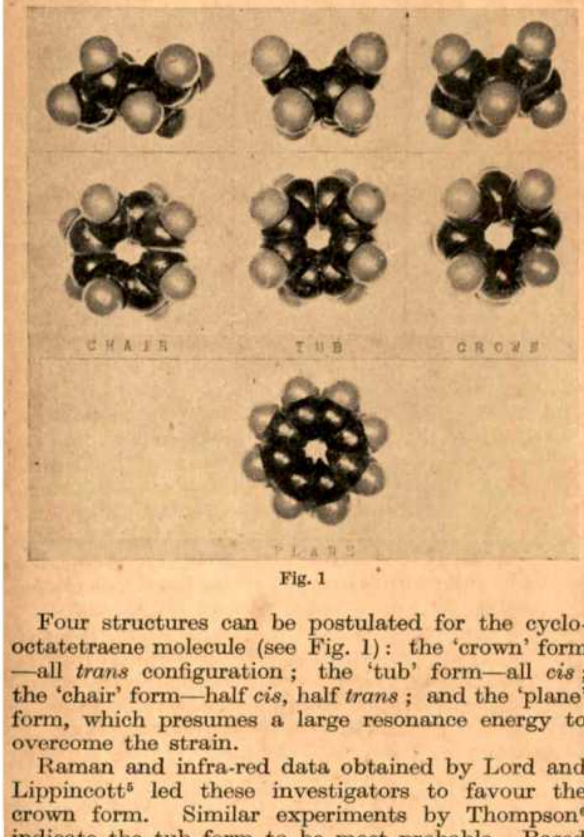

Fig. 1

Four structures can be postulated for the cyclo-octatetraene molecule (see Fig. 1): the 'crown' form—all *trans* configuration; the 'tub' form—all *cis*; the 'chair' form—half *cis*, half *trans*; and the 'plane' form, which presumes a large resonance energy to overcome the strain.

Raman and infra-red data obtained by Lord and Lippincott[5] led these investigators to favour the crown form. Similar experiments by Thompson[6] indicate the tub form to be most probable. Based on their recent electron diffraction study, Hassel[7] and co-workers conclude that the structure is the crown form with bond-lengths approximately those of benzene, suggesting a high degree of resonance.

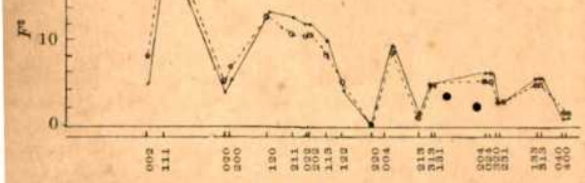

Fig. 2. COMPARISON OF OBSERVED (FULL LINE) AND CALCULATED (BROKEN LINE) F^2 VALUES

Bragg–Lipson[8] structure factor charts proved very useful in our work. It was found that only the tub form with alternating single- and double-bonds gave a good fit with the experimental data (Fig. 2). The two-fold axis required by the space group must pass through the single bonds, and the bond-lengths are typically aliphatic: double-bond length, 1·34 A.; single-bond length, 1·54 A.; and C=C – C bond angle 125°. These values indicate little or no resonance energy in the cyclo-octatetraene molecule, which is in accord with the latest thermochemical data of Rossini[9] and co-workers.

H. S. Kaufman
I. Fankuchen
H. Mark

Polytechnic Institute of Brooklyn,
Brooklyn 2, New York.
Oct. 2.

[1] Kaufman, Fankuchen and Mark, *J. Chem. Phys.*, **15**, 414 (1947).

[2] American Society for X-Ray and Electron Diffraction, Quebec (June 1947).

[3] 11th International Congress of Pure and Applied Chemistry, London (July 1947).

[4] American Chemical Society, New York (September 1947).

[5] Lippincott and Lord, *J. Amer. Chem. Soc.*, **68**, 1868 (1946).

[6] Lecture at the Polytechnic Institute of Brooklyn (March 8, 1947).

[7] Bastiansen, Hassel and Langseth, *Nature*, **160**, 128 (1947).

[8] Bragg and Lipson, *Z. Krist.*, **95**, 323 (1936).

[9] Prosen, Johnson and Rossini, *J. Amer. Chem. Soc.*, **69**, 2068 (1947).

Infra-Red Absorption Spectra of Crystals

Spectroscopic investigations on the scattering of light in crystals show very plainly that their vibration spectra have a discrete structure manifesting itself as a set of lines with sharply defined frequency shifts. That a similar discrete structure is also to be seen in the infra-red absorption spectra of crystals when examined under appropriate conditions is shown by a remarkable investigation by Barnes and Brattain[1]. These authors examined the case of magnesium oxide, which is a crystal of the cubic class with a structure similar to that of rock-salt. Plates obtained by cleavage from flawless transparent single crystals of large size were employed, and the absorption spectra of a whole series of such plates from the very thinnest obtainable to the thickest were investigated. The rock-salt spectrometer used in the study covered the wave-length range 1–15·6 μ, and the galvanometer deflexions were amplified 150 times by a photo-electric relay system. The resulting data showed the presence of some forty absorption lines in the wave-length range 6–15·5 μ. In the absorption curves reproduced with their paper, these lines are so sharply defined that their positions can be measured with high precision.

The theory of the vibration spectra of crystals worked out by me[2] leads to the result that crystals having the rock-salt structure have nine fundamental eigen-frequencies. These frequencies have now been evaluated theoretically, and their values for the case of magnesium oxide expressed as infra-red wavelengths come out as 14·2, 14·7, 15·35, 17·1, 19·0, 21·1, 23·4, 38·5 and 54·5 μ respectively. All except the first three lie outside the range of a rock-salt spectrometer. Hence, except for the first three fundamentals, the absorption spectra recorded by Barnes and Brattain represent a superposition of the spectra of various orders higher than the first, in other words, of the overtones and summations of the nine fundamental frequencies of vibration of the structure.

The changing aspect of the absorption curves with increasing thickness of the plate is readily understood on this basis. In the region of wave-lengths less than 7·1 μ, we are only concerned with the third-order absorption spectrum. This is necessarily weak and is, therefore, most marked when thick plates are used. Moreover, since the third-order frequencies are numerous and very close to each other, they are only imperfectly resolved. It is not surprising that, in these circumstances, the absorption by the thicker plates in the short wave-length region is registered as a smooth curve showing only minor fluctuations of intensity. In the region of longer wave-lengths, on the other hand, the confusion arising from the superposition of the third-order absorptions is less important. Since the infra-red activity is also much greater at such wave-lengths, thinner plates are necessary to avoid complete absorption and to enable the individual lines to be distinguished. An examination of the published curves, indeed, reveals the presence of the first three fundamentals, as also of the octaves of the first seven fundamentals with notable intensities in the theoretically predicted positions. Some twenty of the other observed absorption lines have also been identified as the summations of the fundamental frequencies taken two at a time.

Further details will appear shortly in the *Proceedings of the Indian Academy of Sciences*.

C. V. RAMAN

Department of Physics,
Indian Institute of Science,
Bangalore.
Nov. 21.

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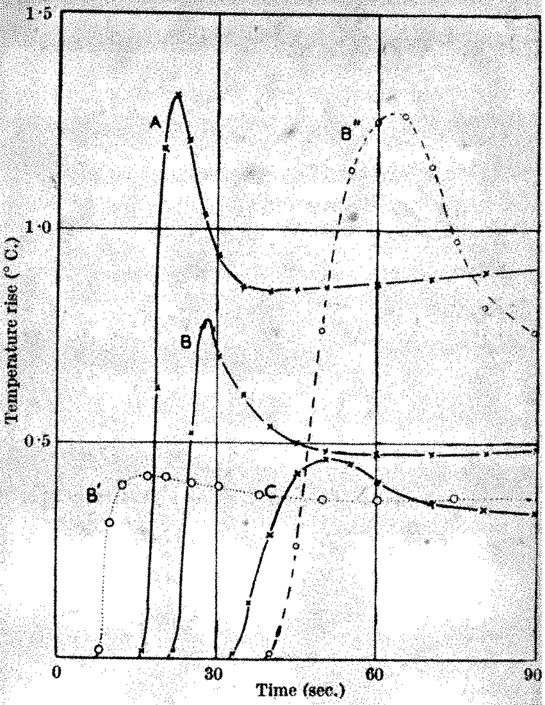
[1] *Phys. Rev.*, **48**, 582 (1935).

[2] *Proc. Ind. Acad. Sci.*, **18**, 237 (1943).

Thermal Mutual Inductance

WHEN heat is dissipated from a hot body immersed in a fluid, the flow of heat is accompanied by a mechanical circulation of the fluid in the system of natural convection currents. The stored kinetic energy bestows on the heat current a property which has been termed 'thermal inductance', and curves I have obtained[1] for the thermal transients consequent on the sudden heating of a cylindrical body, or wire, immersed in a fluid, clearly show the influence of this inductive element. Experiments of this nature may, however, readily be extended to show the influence of a property which may be referred to as 'thermal mutual inductance'. If we take two parallel wires, one vertically above the other so that the same system of convection currents link both, then any change in the heat flow from one might be expected to influence the heat flow from the other. There are two such changes possible, a transient and a permanent one. A steady change in the heat flow from the upper wire consequent on a change in the heat flow from the lower simply represents the case of a hot-wire anemometer used to explore natural convection currents. If, however, our system is to exhibit a property of thermal mutual inductance, then we expect a transient change in the heat flow (or associated temperature difference) from the upper wire to accompany any change in the heat flow from the lower.

In a system of two parallel wires, the lower constituting the thermal primary and the upper the secondary, the primary input may be computed from the current flowing in the lower wire, and the secon ary thermomotive force in terms of the temperatu difference between the upper wire and the bulk the fluid. This temperature difference can be measure by means of a fine thermocouple attached to t upper wire or by using the wire itself as a resistan thermometer. The former type of instrument may somewhat suspect in work of this nature, as t instrument essentially measures the temperatu difference between the wire and *some particular poi* in the fluid, and any asymmetry in the heated co vection current will clearly give rise to spurio thermal transients. As a matter of interest, t nature of the apparent thermal transients obtaine with such a pair of thermocouple hot wires has bee observed to vary somewhat with the size and sha of the containing vessel as well as with the natu and temperature of the fluid.



Resistance thermometer measurements are fr from any suspicion that the transient observed is du to the rising heated column reaching different part of the measuring instrument at different times, bu are complicated by the fact that the steady rise i temperature of the whole fluid will also be recorde by the measuring device. Transients obtained fro a pair of parallel nickel wires, 0·1 mm. diamete 3·0 cm. long and 1·2 cm. apart, are shown in th accompanying figure. Concentrated solutions o sucrose were used on account of the low convectiv moduli associated with these solutions[2]. The curve represent the temperature rise of the upper wi plotted against the time elapsed since switching o the primary (thermal) current. Curves *A*, *B* and refer to a 63 per cent (by weight) solution of sucros in water at 23° C.; *A* with a primary heat flow o 5·0 watts, *B* 2·0 watts and *C* 0·95 watts. The curve *B'* and *B''*, shown dotted and broken respectively also refer to results from a primary thermal curren of 2·0 watts, *B'* in distilled water, a fluid of highe convective modulus than 63 per cent sucrose solution and *B''* in 68 per cent sucrose solution, a fluid o lower convective modulus, both again at 23° C.

All curves shown on the figure are of the same form. There is no immediate change in the secondary temperature following a switching on of the primary current. When, however, the heated column of liquid reaches the upper wire, there is a rapid rise in the temperature, which attains a maximum and then falls again. A subsequent slow rise in temperature is probably due to gradual heating of the whole bulk of fluid, as this last feature was not observed when using thermocouple type hot-wire instruments. From the curves shown it appears that the time taken for the thermal secondary to respond to a change in the primary is the longer the lower the primary current and the lower the convective modulus of the fluid.

There are several features of interest in this work. The time taken for the secondary to respond to a change in the primary is clearly a measure of the speed of the convection current, which is connected with the kinetic energy stored in the natural convection current and is thus related to the magnitude of the (self) induction associated with the flow of heat in fluids. Apart from the time-lag, the change in the primary current produces both transient and steady-state changes in the secondary, so that the pair of coupled hot wires constitutes a leaky thermal mutual inductance. The transient rise in temperature when the top of the convection column first reaches a temperature-recording instrument apparently means that the top of the column is at a higher temperature than the rest. Such a state of affairs is, however, only to be expected from the phenomena of thermal (self) inductance already observed. The delay in setting up a system of convection currents around a body the temperature of which is suddenly increased means that the initial part of the convection column has remained longer in contact with the hot body and is accordingly heated to a higher temperature than subsequent sections of the same column.

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[1] Bosworth, R. C. L., *Nature*, **158**, 309 (1946); *Phil. Mag.*, **37**, 803 (1946).

[2] Bosworth, R. C. L., *J. Roy. Soc. N.S.W.* (in the press).

Solar Noise

DURING a television outside broadcast from Brands Hatch, in Kent, during the afternoon of August 31, 1947, there appeared on the screens and from the loudspeakers of two television receivers situated in Ealing, London, and Claygate, Surrey, a sudden and intense increase of fluctuation noise. The visual effect was that of a violent snowstorm of the type well known to televiewers due to motor-car ignition interference, but at a very much more intense level than seen heretofore by either of the observers. The spots of noise upon the viewing screen were of slightly greater size than a line-width and in number something like 70–100 per scanning line. The intensity of the fluctuation noise interference was of such value that both receivers lost their line synchronization, though frame synchronization still held. The sound effect emerging from the loudspeakers was in no way distinguishable from a considerable increase in the fluctuation noise level. The phenomenon lasted about forty-five seconds at an intense level and then faded slowly away during a period of about fifteen seconds, the entire effect lasting about one minute. The fact that the interference appeared to be completely random in nature and also that it faded slowly away seemed to preclude any fault on the television transmission system.

Since observing this phenomenon, one of us visited Mr. J. S. Hey, of Operations Research Group, Ministry of Supply, West Byfleet, Surrey, who very kindly showed us his charts of recorded solar noise for the time of occurrence of the interference (August 31, 1947, between 3.30 p.m. and 4.0 p.m. British Summer Time). These charts showed considerable activity from the solar noise point of view in frequency-bands around 25 Mc./s., 73 Mc./s. and higher frequencies as well. As the charts were not capable of recording solar noise greater than about 10 μV./m. for the band-width of the receivers used for the recording, it is not possible to get an exact correspondence between the actual level of measured solar noise and the degree of interference in the television receivers. However, the charts did show, on several occasions during the half-hour period mentioned, a noise-level above the 10 μV./m. limit on them. The possible extent of interference from solar noise, though this may well be rarely encountered, can be surmised from the fact that the field-strength of television signals in the Ealing area is of the order of 3 mV./m. and in Claygate of the order of 1½ mV./m.

It would seem beyond reasonable doubt that the interference observed was, in fact, solar noise, particularly when the ratio of television band-width (5,000 kc./s.) to recording receiver band-width (about 20 kc./s.) is taken into account. A complete fade-out on many circuits was recorded by Cable and Wireless, Ltd., and the B.B.C. receiving station at Tatsfield at about the same time as the interference was observed.

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Use of High-frequency Current in Surgery

IT has been remarked[1] that extended injury was caused to the brain of monkeys beyond the point of a needle electrode when using high-frequency current for surgical purposes. If the needle were of a ferrous material, such as steel, or a ferrous alloy, this may be expected, and is in accordance with our research experience over many years in experimental work on instruments for electrosurgical techniques, which involve the use of high-frequency currents, particularly for ophthalmic surgery using the Safar technique.

The main reason for the extended injury to tissues when using a ferrous wire, or needle, is due to the heating of the wire by eddy currents, and the increased resistance of the material which carries high-frequency current. As is well known, the D.C. resistance of a conducting material is given as

$$R_{\mathrm{DC}} = l\rho/A,$$

where A is the cross-sectional area, l is the length and ρ is the specific resistance. The high-frequency resistance is given by:

$$R_{\mathrm{HF}} = R_{\mathrm{DC}} \times [1 + F(z)], \qquad (1)$$

where

$$z = \sqrt{8.\pi^2.r^2.\mu.f/\rho}. \qquad (2)$$

If $z > 3$,

$$F(z) = \tfrac{1}{4}\,(z\sqrt{2} - 3). \qquad (3)$$

If, by way of example, we consider a steel wire of 0·0126 cm., radius (r); specific resistance ρ of $11{\cdot}8 \times 10^3$ in C.G.S. units; permeability μ of 375; working frequency of $2{\cdot}0 \times 10^6$ c.p.s. and length l of 5·0 cm., then

$R_{\rm HF} \doteq R_{\rm DC} \times 10{\cdot}261$, and $R_{\rm DC} = 0{\cdot}1174$. Hence $R_{\rm HF}/R_{\rm DC} = 10{\cdot}261$.

This ratio is the important consideration in assessing the difference in temperature of the needle electrode when carrying high-frequency instead of direct current.

It is well known that the heat H generated in a conductor of resistance R, carrying a current I, is proportional to I^2Rt, and since the influence of high-frequency current is to increase the resistance, as indicated, this would appear to explain the statement in the report (*loc. cit.*) that when D.C. current was used the difficulties were mostly overcome. Ferrous metal becomes hot when carrying high-frequency current, and when hot metal contacts a biological substance it sticks and often causes injury by burning.

The ideal physical condition for operating electrodes carrying high-frequency current for surgical techniques is that they should remain practically at the temperature of the operating theatre, since they are only directors of the current to the site of operation. The surgical effect depends on the thermogenic property of the high-frequency arc at the point of the electrode.

In the case of wire electrodes this is accomplished by the use of 20 per cent iridium platinum alloy. For general purposes a diameter of about 0·025 cm. or slightly less appears to be most suitable. This alloy also offers the advantage that, with the use of 'Easi-flo' solder, a perfect joint can be formed with a German silver shank when the solder is melted in a hydrogen jet to prevent oxidation and ensure chemical wetting. Such a perfect joint is devoid of cracks and crevices, and thus prevents the ingress and trapping of germs.

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[1] Glees, Wall and Wright, *Nature*, **160**, 365 (1947).

Intracellular Determination of Protein by X-Ray Microspectrography

In a recently published paper[1], the possibility of making a determination of intracellular protein *in situ* was suggested. The analytical procedure was to be based on the binding of phosphotungstic acid by the protein and subsequent determination of the tungsten by X-ray microspectrography[2,3].

In a model experiment the amount of phosphotungstic acid which was combined with varying concentrations of protein has been determined. Protamine solutions of known concentration were precipitated with 5 per cent phosphotungstic acid, centrifuged and washed several times with distilled water. The precipitates were dissolved in alkali and the absorption of X-rays by the solutions was measured. 30,000-volt X-rays (minimal wave-length *c.* 0·4 A.) were used. The solution was placed in a cuvette with parallel walls of thin glass, and the thickness of solution was approximately 0·5 cm. The same cuvette was used for all measurements. The results are shown in Fig. 1, in which extinction coefficient is plotted against the amount of protein. (Extinction coefficient $E = \log I_0/I$, where I_0 is the intensity of the incident X-rays and I is the intensity of the transmitted X-rays.) As can be seen from the figure, there is a straight-line proportionality between the amount of protein and the extinction coefficient, which is proportional to the amount of tungsten bound to the protein. The extinction for zero concentration of protein was measured with the cuvette containing alkali of the same concentration as that used for dissolving the precipitates.

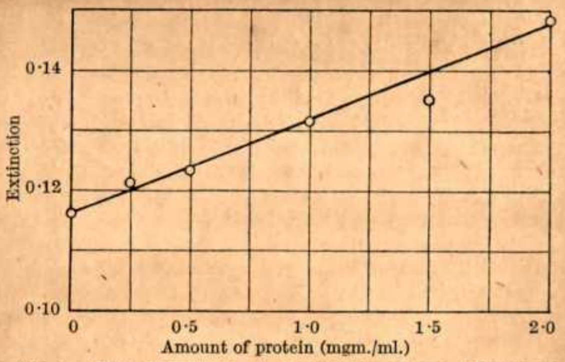

Fig. 1. THE EXTINCTION AS A FUNCTION OF THE AMOUNT OF TUNGSTEN BOUND TO PROTAMINE

Microtome sections 10 μ thick of tissues of *Helix pomatia* and *Lophius piscatorius* (tissues fixed by freeze-drying) were treated with a solution of 2 per cent phosphotungstic acid (pH 2–2·5) for one minute, washed, dried and photographed with soft X-rays on fine-grained films. 3,250-volt X-rays were used, which correspond to a minimal wave-length in the continuous X-ray spectrum of *c.* 3·8 A. In these photographs the tungsten stands out in sharp contrast to the unstained tissue. Two photographs of ganglion cells from *Helix* are shown in Fig. 2; *a* was taken on Ilford High Resolution plate, and *b* on Eastman Spectroscopic plate 649. From these photographs it can be seen that the cytoplasm binds more phosphotungstic acid, under these conditions, than does the nucleus (the light areas in the photographs represent areas in the tissue which absorb X-rays strongly). Smaller structural elements appear in the nucleus. The relative amounts of tungsten bound by the protein within the cell may be obtained by measuring the absorption in different parts of the cell. If no phosphotungstic acid were bound by the protein, the extinction coefficient for a section of the

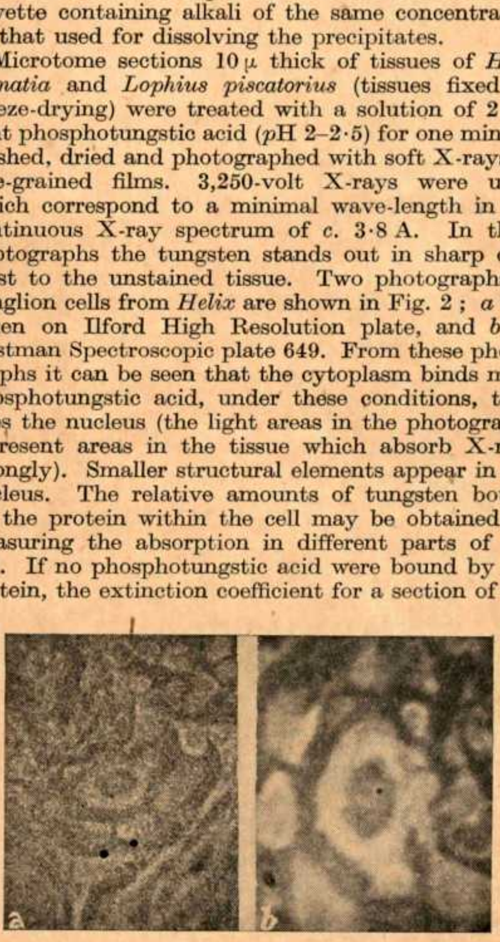

Fig. 2. MICRORADIOGRAMS OF GANGLION CELLS FROM *Helix* TREATED WITH PHOSPHOTUNGSTIC ACID. (*a*) × 130; (*b*) × 260

tissue 10 μ thick and for the X-rays used would fall in the range 0–0·04, and the contrast would be very low.

It must be emphasized that many precautions must be taken before data so obtained may be translated into concentrations of intracellular protein. Further experiments are in progress to overcome some of the difficulties involved.

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Oct. 6.

[1] Engström, A., and Lindström, B., *Experientia*, 3, 191 (1947).

[2] Engström, A., *Nature*, 158, 664 (1946).

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Micro Estimation of Amino-Nitrogen and its Application to Paper Partition Chromatography

The present interest in the quantitative estimation of amino-acids in protein and peptide hydrolysates has prompted an early description of a method which it is felt may make some contribution to this problem.

The method described by Pope and Stevens[1] using copper phosphate for determining amino- and peptide-nitrogen has been successfully adapted to the determination of micro amounts (1–25 μgm.) of α-amino-nitrogen. The essential points of the method are that after the amino-acid has been allowed to react with copper phosphate, the soluble copper complex in the filtrate is decomposed by means of sodium diethyl-dithio-carbamate, the resultant characteristic golden yellow colour is extracted into amyl alcohol and the amount of copper determined absorptiometrically. The theoretical value of 0·44 for the ratio of α-amino-nitrogen to copper in the complex A_2Cu is not obtained under the experimental conditions in use, and it is essential to construct a standard curve for each individual amino-acid. Such curves are reproducible, and over their linear portion (10–25 μgm. α-amino-nitrogen) the amino-acids methionine, hydroxyproline, aspartic acid, leucine, *iso*leucine, histidine, phenylalanine, valine, glutamic acid, tryptophane and tyrosine give ratios lying between 0·50 and 0·55; alanine, glycine, threonine, serine, cystine and cysteine ratios between 0·55 and 0·80; and lysine, arginine and glucosamine ratios between 1·25 and 1·60.

The application of the method to the paper chromatograms of Consden, Gordon and Martin[2] has enabled quantitative recoveries of the component amino-acids of simple mixtures to be obtained. The technique employed is to localize the amino-acid on the chromatogram by use of a trial strip, as suggested by Dent[3], then cut out the square of paper containing the amino-acid. The square is folded, dropped into a test tube and the amino-acid treated with a suitable amount of copper phosphate sludge. The excess copper phosphate is filtered off, the copper in the filtrate determined by means of sodium diethyl-dithio-carbamate and its equivalent in α-amino-nitrogen obtained by reference to a standard curve for the amino-acid under investigation. Using this technique, a single-dimensional chromatogram of a valine/glycine mixture using *n*-butanol/water as the solvents gave recoveries of 94 per cent for glycine and 97 per cent for valine.

It has been found possible for ninhydrin to react with glycine and valine under conditions where almost no destruction of amino-nitrogen occurs, although enough colour is obtained to determine the position of the amino-acid on the chromatogram. Such development of colour did not affect appreciably the subsequent quantitative determination of α-amino-nitrogen. With single-dimensional chromatograms of a glycine/valine mixture, recoveries of 91 per cent for glycine and 93 per cent for valine have been obtained after reacting with ninhydrin. If the principle is found capable of extension to other amino-acids, it may be possible to avoid the use of trial chromatograms altogether, and this would be a great advantage in two-dimensional chromatography.

At the present time the errors of the estimation are such as to be well within the limits required for establishing the ratios of the amino-acid components of peptides.

A fuller report of this work will be published elsewhere.

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Oct. 10.

[1] Pope, C. G., and Stevens, M. F., *Biochem. J.*, 33, 1070 (1939).

[2] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, 38, 244 (1944).

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Solvation of Hydrogen Ion in Oxygen-containing Solvents

The nature of non-aqueous solutions of the so-called 'strong' acids has received a good deal of attention; but although much information is now available regarding a number of individual solvent systems, comparatively little progress has been made in establishing quantitative scales of comparison of properties such as proton-availability in different solvents. A quantity suitable for this purpose is the acidity function first introduced by Hammett[1] to deal with concentrated aqueous solutions. The acidity function is a measure of the tendency of the medium to donate a proton to a neutral base and may be defined by

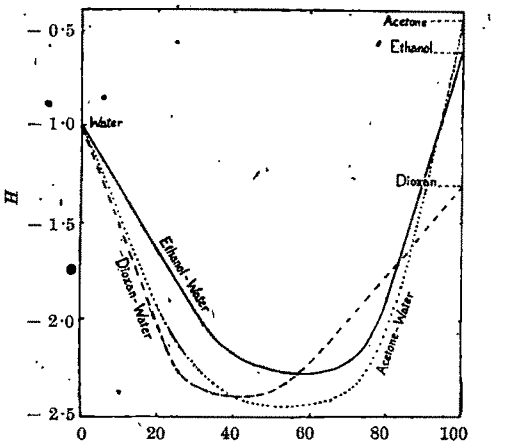
$$H = \log[BH^+]/[B] - \log K_B^{H_2O}, \quad . \quad (1)$$

where B is the proton-acceptor and BH^+ its conjugate acid, and where $K_B^{H_2O}$ is the equilibrium constant of the reaction

$$B + SH^+ \rightleftharpoons BH^+ + S \quad . \quad . \quad . \quad (2)$$

in water, SH^+ representing the solvated proton. It can be readily shown that $H = \log\,(\alpha c_A K_B^S/K_B^{H_2O})$, where c_A and α are the concentration and degree of dissociation of the acid, and K_B^S the equilibrium constant of reaction (2). The ratio $K_B^{H_2O}/K_B^S$ will be a measure of the proton-affinity of the solvent relative to water and can be calculated from H if α is known.

Using *m*- and *p*-nitranilines as proton-acceptors, H has been determined spectrometrically for solutions of hydrogen chloride in water, dioxan, ethanol and acetone, and their binary mixtures. The values of H for the four single solvents vary in the order dioxan < water < ethanol < acetone. These differences cannot be accounted for by differences in α, which can be estimated from conductivity measurements. The deduced values of $K_B^{H_2O}/K_B^S$ vary in the



ACIDITY FUNCTIONS FOR 0·1 M SOLUTIONS OF HYDROGEN CHLORIDE IN WATER – ORGANIC SOLVENT MIXTURES

order water (1·0) > dioxan (0·45) > ethanol (0·29) > acetone (0·10), which is the sequence to be expected from simple considerations of electron availability at the oxygen atom in the series ether > alcohol > water > ketone, except that the position of water is anomalous.

In water-organic solvent mixtures, H shows non-linear variations with solvent composition, passing through a minimum in the region of equal molar proportion of the two components (see diagram). This is in sharp contrast to ethanol-acetone and ethanol-dioxan mixtures, where no such minima are observed. The anomalous behaviour of the partly aqueous solutions may be explained in terms of the abnormally high proton-affinity and exceptional intermolecular structure[2] of water. In aqueous solution the protons are accommodated in the interstices of the quasi-crystalline tetrahedral lattice and simultaneously bound to four surrounding oxygen atoms. On the addition of the organic solvent, the tetrahedral structure will be gradually broken down by the interposition of organic solvent molecules, and hydrogen-bonding between neighbouring water molecules will be replaced by much weaker hydrogen-bonding with organic solvent molecules. The density of packing will increase, and the protons will be preferentially surrounded by the smaller water molecules. As a result of the decreased extent of intermolecular hydrogen bonding and the closer packing, the effective proton-affinity of the water molecules will increase, and $K_B{}^S$ and H will fall. The breakdown of the tetrahedral structure will be more rapid the larger the organic solvent molecules and, in agreement with this picture, the slopes of the left-hand parts of the acidity function – solvent composition curves (see diagram) increase in the order ethanol < acetone < dioxan. When the concentration of organic solvent is increased beyond 50 mol. per cent, organic solvent molecules begin to predominate in the medium and eventually replace the aqueous solvation shell. Since intermolecular structure and hydrogen-bonding is much less pronounced in ethanol than in water[3], and presumably almost entirely absent in dioxan and acetone, the organic solvents will only exert 'normal' proton affinities derived from the interaction of protons and discrete solvent molecules. On the right-hand parts of the acidity function – solvent composition curves, H therefore increases with decreasing water content to its value in the anhydrous solvent.

The conclusion that water has an abnormally high proton-affinity is in agreement with other evidence[4]. The variations in acidity function with solvent composition are paralleled by corresponding variations in other properties such as electrical conductivity[5], heats of transfer[6] and catalytic constants[7], which may all be similarly explained in terms of the changes in the state of solvation of the hydrogen ions.

A detailed account of this work will be published elsewhere.

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Critical Temperature and Molecular Weight of *n*-Paraffins

INVESTIGATIONS on the viscosity of liquids and gases showed that the viscosity at the critical point, η_c, should be given by

$$\eta_c = K \frac{\rho_c{}^{2/3}}{M^{1/6}} T_c{}^{1/2}, \qquad (1)$$

where K is a universal constant, ρ_c is the critical density, T_c is the absolute critical temperature, and M is the molecular weight.

A correlation of the viscosity of n-paraffins under saturation pressure with the ratio T/T_B (T is the

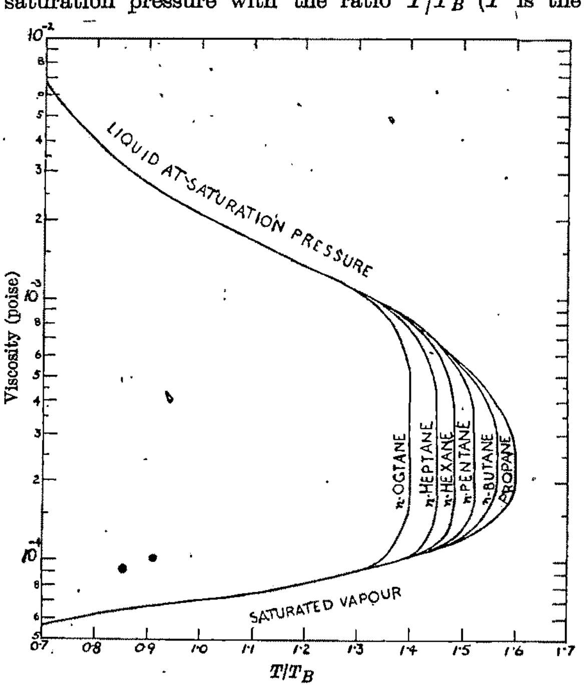

Fig. 1

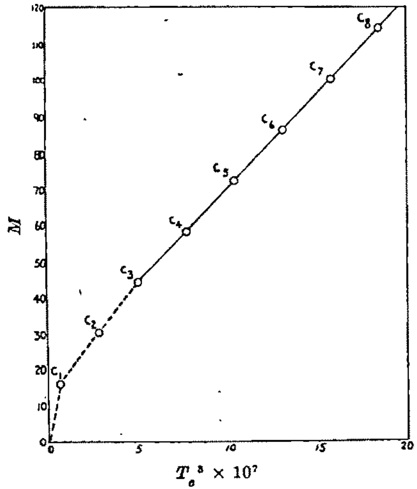

Fig. 2

absolute temperature; T_B is the absolute atmospheric boiling temperature) yielded the chart shown in Fig. 1. From the figure it seems that η_c has very nearly the same value for all the n-paraffins between C_3 and C_8. It will further be found that for these substances ρ_c has the same value of approximately 0·23 gm./c.c. From equation (1) it can be deduced that, if η_c and ρ_c are nearly the same for the n-paraffins, then $T_c^{1/2}$ should be proportional to $M^{1/6}$ or

$$T_c^3 \propto M.$$

The linear relationship between T_c^3 and M for the n-paraffins above C_3 is illustrated in Fig. 2.

Now since M is generally an additive property, T_c^3 should also be an additive property for the n-paraffins above C_3. The increment of T_c^3 equivalent to $-CH_2-$ is about 2·7 × 10^7.

It is interesting to note the position of the points for methane and ethane in Fig. 2. The increment for $-CH_2-$ between methane and ethane and between ethane and propane is 2·1 and 2·2 × 10^7 respectively, while the value of T_c^3 for methane is only 0·69 × 10^7. Thus it seems that the value of T_c^3 reflects the 'flexibility' of the hydrocarbon chain, namely, the number of internal degrees of freedom. This number is small for methane, and increases with the chain-length. For the n-paraffins higher than propane, the increase is proportional to the number of $-CH_2-$ groups present in the molecule.

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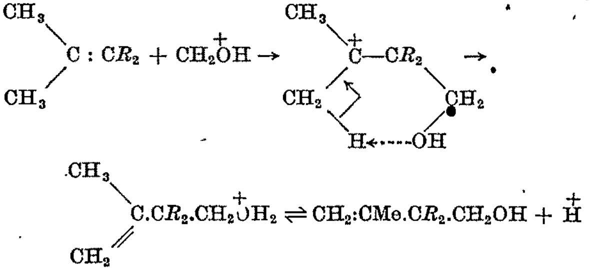
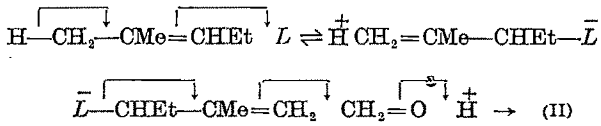
Olefine Reactions Catalysed by Lewis Acids

In a recent monograph[1], C. C. Price refers to a publication by me[2] in which reference was made to the formation of unsaturated alcohols of the general type $CR_2 : CR.CH_2.CH_2OH$ by the catalysed reaction[3] of formaldehyde with the olefines $CR_2 : CR.CH_3$. Price states, "The reaction . . . has been interpreted as involving attack at the 'active' α-position of the double bond; but it is very difficult to account for the catalytic effect of acids by such a mechanism. It seems much more likely that all the reactions involve a similar intermediate." This common intermediate is $>\overset{+}{C}-\underset{|}{CH}-CH_2OH$, formed by the addition of the formaldehyde cation $CH_2\overset{+}{O}H$ to the olefinic bond. The formation of 3-methyl-Δ^3-buten-1-ol from *iso*butylene is then formulated thus:



(I, $R_2 = H_2$)

Quite apart from the fact that such a mechanism still involves an 'active' α-methylenic hydrogen atom, there are specific objections to such a view. First, this mechanism only gives the correct structure for the reaction product when the olefine is of the type $CH_3.CR : CH_2$, because, in such cases, it is impossible to differentiate structurally between a $=CH_2$ group formed from the initial CH_3 group and the $=CH_2$ group of the parent olefine. The British patent[3] states that the reaction is valid for *all* olefines of the type $CRR' : CR''.CH_3$. Thus, 2-methyl-Δ^2-pentene should, by Price's mechanism, afford 2-ethyl-3-methyl-Δ^3-buten-1-ol (I, R_2=H, Et). The product obtained is stated to be 3-methyl-Δ^3-hexen-1-ol, $CHEt : CMe.CH_2.CH_2OH$ (II), the expected product from a mechanism

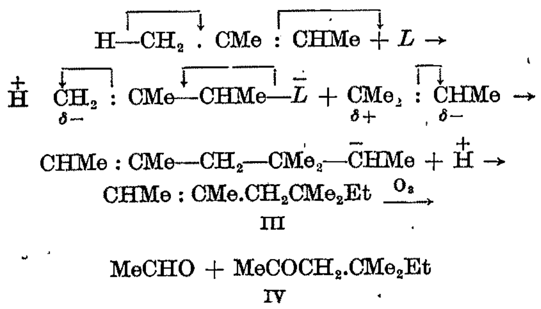


$$H-CH_2-CMe=CHEt\ L \rightleftharpoons \overset{+}{H}\ CH_2=CMe-CHEt-\bar{L}$$

$$\bar{L}-CHEt-CMe=CH_2\quad CH_2=O\quad \overset{+}{H} \rightarrow \quad (II)$$

Secondly, the British patent states specifically that "the catalyst is non-acidic", meaning by this that no *hydrogen* acid is present. The reaction is effected in aprotic solvents and the effective catalysts are molecules like stannic chloride, etc., which are strong acids in the Lewis sense[4].

The validity of this argument has been challenged[5] on the grounds (i) that no evidence for the structure of the unsaturated alcohol (II) is given in the British patent, and (ii) that minute traces of the proton-donator, water, might well be present under the experimental conditions employed. The essential feature of the mechanism which is challenged by Price is that addition of a Lewis acid to an olefine can cause direct separation of a proton from the olefine in the presence of a proton-accepting reagent[6]. In the reaction between phenyl *iso*cyanate and trimethylethylene in the presence of stannic chloride under conditions which were proved to be rigorously anhydrous[6], considerable stannic chloride-catalysed polymerization of the olefine also occurs. The dimeride fraction of this polymeride, on ozonolysis, affords *only* acetaldehyde (: CHMe end-group) and a mixture of two isomeric methyl hexyl ketones, separated by fractional crystallization of their semicarbazones into two pure products, m.p. 174° and 154°, respectively. The ketone giving the semicarbazone, m.p. 174°, has now been proved, by direct comparison with a synthetic specimen, to possess the structure (IV), derived from the dimeride (III), in which one molecule of trimethylethylene has added on as the fragments $\overset{+}{H}$ and $\overset{-}{C}H_2.CMe:CMe_2$ to a second molecule, polarized in the normal direction. It is difficult to explain the formation of a dimeride of structure (III) except by a mechanism which involves the direct separation of an α-methylenic proton from the olefine, already activated by hyperconjugation[7], under the influence of the Lewis acid ($L = SnCl_4$), thus:



$$H—CH_2 . CMe : CHMe + L \rightarrow$$

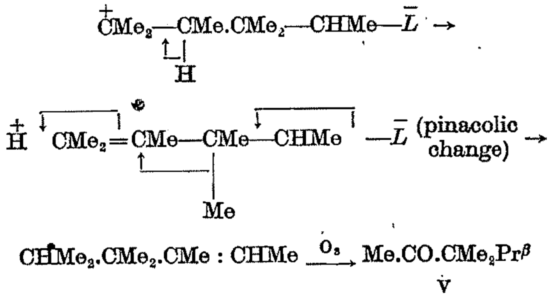
$$\overset{+}{H}\ \underset{\delta-}{CH_2} : CMe—CHMe—\overset{-}{L} + \underset{\delta+}{CMe_2} : \underset{\delta-}{CHMe} \rightarrow$$

$$CHMe : CMe—CH_2—CMe_2—\overset{-}{C}HMe + \overset{+}{H} \rightarrow$$

$$\underset{\text{III}}{CHMe : CMe.CH_2CMe_2Et} \xrightarrow{O_3}$$

$$\underset{\text{IV}}{MeCHO + MeCOCH_2.CMe_2Et}$$

If, as required by Price's mechanism, the sole function of the Lewis acid catalyst were to produce a carbonium cation $\overset{+}{C}Me_2—CHMe—\overset{-}{L}$, the initial dimerization should occur to give the intermediate $\overset{+}{C}Me_2.CHMe.CMe_2.CHMe_2—\overset{-}{L}$, which could not give the structure (III) by any acceptable proton migration. The most probable rearrangement of such an intermediate would be



$$\overset{+}{C}Me_2—CMe.CMe_2—CHMe—\overset{-}{L} \rightarrow$$

$$\overset{+}{H}\ CMe_2{=}CMe—CMe—CHMe\ —\overset{-}{L}\ \text{(pinacolic change)} \rightarrow$$

$$CHMe_2.CMe_2.CMe : CHMe \xrightarrow{O_3} \underset{\text{V}}{Me.CO.CMe_2Pr^{\beta}}$$

Although the structure of the second ketone (semicarbazone, m.p. 154°) has not yet been established, it has been proved by direct comparison with a synthetic specimen that it is *not* identical with the ketone (V), which, incidentally, gives a semicarbazone, m.p. 153°, depressed to m.p. 139–140° by admixture with that of the ozonolysis ketone.

A fuller account of this work will be published elsewhere when the structure of the second methyl hexyl ketone has been established.

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Sept. 25.

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[1] "Reactions at Carbon-Carbon Double Bonds", 45 (Interscience Publishers, Inc., New York, 1946).

[2] Baker, *J. Chem. Soc.*, 296 (1944).

[3] Brit. Pat. No. 545,191 (1942).

[4] *J. Franklin Inst.*, 226, 293 (1938).

[5] Price, private communication.

[6] Baker and Holdsworth, *J. Chem. Soc.*, 724 (1945).

[7] Baker and Nathan, *J. Chem. Soc.*, 1844 (1935). Baker, *J. Chem. Soc.*, 1150 (1939). Mulliken, Rieke and Brown, *J. Amer. Chem. Soc.*, 63, 41 (1941).

Formation of Hydroxy Peroxides

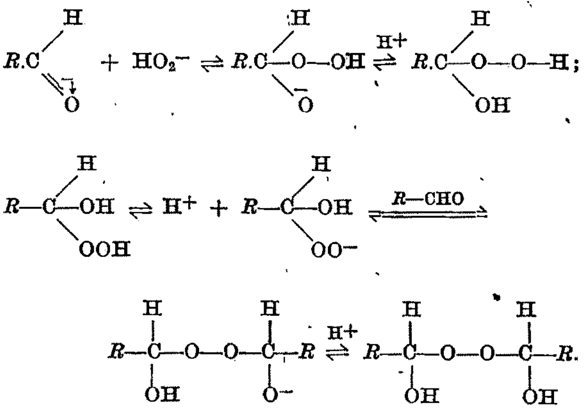
The reactions of hydrogen peroxide, and alkyl hydrogen peroxides, with organic compounds are usually regarded as homolytic processes. This note outlines evidence which suggests that the peroxidations of aldehydes are almost certainly of a heterolytic character. In such reactions, hydrogen peroxide behaves as a nucleophilic reagent, attacking through its anion HO_2^-, just as hydrogen cyanide attacks[1] through its anion CN^-.

As evidence in favour of this mode of attack, we find, using a spectroscopic method, that the formation of hydroxy alkyl peroxides from aldehydes with hydroperoxides is catalysed by bases such as pyridine, and by acids, and proceeds more rapidly in organic solvents such as ether than in the gas-phase; the reaction is insensitive to illumination by daylight. Various workers[2] have shown that, with reservations regarding formaldehyde, these reactions are reversible.

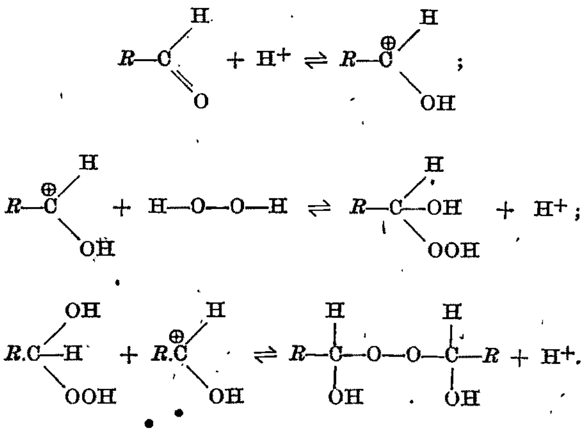
We formulate the reactions thus:

In basic or neutral solutions:

$$H_2O_2 \rightleftharpoons HO_2^- + H^+ ;$$



In acid media:



Further investigations of these and other nucleophilic reactions of hydroperoxides are in progress.

It has come to our notice, immediately before this letter was submitted, that Dr. Style and his co-workers at King's College, London, are investigating the reactions between hydrogen peroxide and aldehydes in water.

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Sept. 30.

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[1] Lapworth, *J. Chem. Soc.*, 995 (1903); 120 (1904).

[2] Ghijsen, Dissertation, Delft (1942). Reiche, "Alkylperoxide und Ozonide" (Leipzig, 1931).

Reaction between Manganous Ion and Manganese Dioxide

The decrease of manganous ion concentration which occurs when a manganous salt is shaken with manganese dioxide has been known for a long time. Being most marked with freshly precipitated oxides, it is not surprising it should first have been considered an adsorption. For some time this observation has found practical application in the removal of soluble manganese in water supplies[1], while recently it has been shown of significance in the chemistry of the dry cell depolarizer[2], and also in the oxidation-reduction cycle of manganese in the soil[3,4].

In all instances the primary reaction is probably

$$MnO_2 + Mn^{++} + 4H^{+} = 2\,Mn^{+++} + 2H_2O.$$

Except in the presence of concentrated acid, the equilibrium is such that the amount of Mn^{+++} is very small. In the presence of pyrophosphoric acid, which forms a stable complex anion with trivalent manganese[5], the reaction may proceed far to the right[4]. In the absence of complex-forming substances and in neutral and slightly alkaline solutions, a new solid phase appears, the reaction again proceeding to the right. One solid phase which has been observed at *p*H values as low as 4·5 has been identified as manganite[2]. Its formation may be shown by rewriting the above equation so as to assume hydrolysis of the manganic ion, thus

$$MnO_2 + Mn^{++} + 2H_2O = 2MnOOH + 2H^{+}.$$

Dion and Mann[3] state the reaction proceeds only in the reverse direction. This is contrary to the above findings[2] and to our own. In seeking a cause for potential drift with a manganese dioxide electrode[7], we have found that some such reaction proceeds even when the dioxide has the dense heat-stable pyrolusite structure; that it leads to the production of a lower oxide even at *p*H values as low as 1; and that this oxide has a structure not previously described.

Half-gram portions of dioxide obtained by heating pure manganous nitrate were allowed to stand for two days at room temperature with 50 ml. of the solutions shown in the accompanying table. The solid residues after washing and drying at room temperature *in vacuo* were examined by one of us (J. M. C.) by both the X-ray and electron diffraction methods. In each instance the X-ray powder pattern showed only the lines of pyrolusite. However, the electron diffraction pattern from the sample treated with hydrochloric acid and manganous chloride had rings distinctly different from those of pyrolusite. The other treated samples gave a pyrolusite pattern, but in addition showed weakly the stronger rings of the new pattern. When manganese dioxide is dissolved in concentrated hydrochloric acid and the manganese tetrachloride hydrolysed, this new pattern is not obtained, but rather the pattern of γMnO_2 or of pyrolusite[6].

Reactants	X-ray diffraction pattern	Electron diffraction pattern
Original MnO_2	pyrolusite	pyrolusite
MnO_2, $MnCl_2$ 0·1 *M*, HCl 0·1 *M*	pyrolusite	pyrolusite and new oxide (strong)
MnO_2, HCl 0·1 *M*	pyrolusite	pyrolusite and new oxide (weak)
MnO_2, $Mn(ClO_4)_2$ 0·1 *M*, $HClO_4$ 0·1 *M*	pyrolusite	pyrolusite and new oxide (weak)

The rings of the new pattern given by the sample treated with hydrochloric acid and manganous chloride show arcing when the specimen is tilted, most of the arcs lying along one diameter. This indicates that the substance is in the form of thin flakes, of the order of 100 A. or less in thickness, lying flat on the supporting film of collodion. It seems probable that these flakes were formed by the breaking-off of an altered surface layer from the particles during the process of grinding the sample under secondary butyl alcohol. Lattice spacings and ring intensities are given below.

D	Int.	*D*	Int.
5·1	W	1·74	M
4·39	S	1·62	M
4·12	S	1·58	MW
3·34	W	1·50	W
2·46	S	1·30	W
2·35	M	1·27	MW
2·06	MW		

This pattern is similar to that of goethite, $\alpha FeOOH$, and there is good agreement between the observed spacings and those calculated for an orthorhombic cell with dimensions $a = 4{\cdot}42$, $b = 10{\cdot}4$, $c = 2{\cdot}83$ A., which are close to the dimensions of the goethite cell. However, interpreted on this basis, some reflexions are present which are not permitted by the space group of goethite, and some reflexions given by goethite are absent. Hence the substance cannot be considered as truly isomorphous with goethite. The data are not sufficient to allow a more definite determination of structure. Recently Gruner[8] has briefly described a new mineral (groutite) found in Minnesota which has the cell dimensions $a = 4{\cdot}56$, $b = 10{\cdot}70$, $c = 2{\cdot}85$ A. It is considered, however, that these dimensions differ significantly from those of the oxide described here. No manganese analogue of goethite is reported by Dana, who lists the groups:

goethite ($\alpha FeOOH$), diaspore ($\alpha AlOOH$),
lepidocrocite ($\gamma FeOOH$), boehmite ($\gamma AlOOH$),
manganite ($\gamma MnOOH$).

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Aug. 15.

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[1] Tillmans, J., Hirsch, P., and Häffner, F., *Das Gas und Wasserfach.*, **70**, 26 (1927).

[2] McMurdie, H. F., Craig, D. N., and Vinal, G. W., *Trans. Electrochem. Soc.* (Preprint), **90**, 31 (1946).

[3] Dion, H. G., and Mann, P. J. G., *J. Agric. Sci.*, **36**, 239 (1946).

[4] Heintze, S. G., and Mann, P. J. G., *Nature*, **158**, 791 (1946).

[5] Kolthoff, I. M., and Watters, J. I., *Indust. Eng. Chem. Anal. Ed.*, **15**, 8 (1943).

[6] Cole, W. F., Wadsley, A. D., and Walkley, A., *Trans. Electrochem. Soc.* (Preprint), **92**, 2 (1947).

[7] Wadsley, A. D., and Walkley, A., unpublished work (1947).

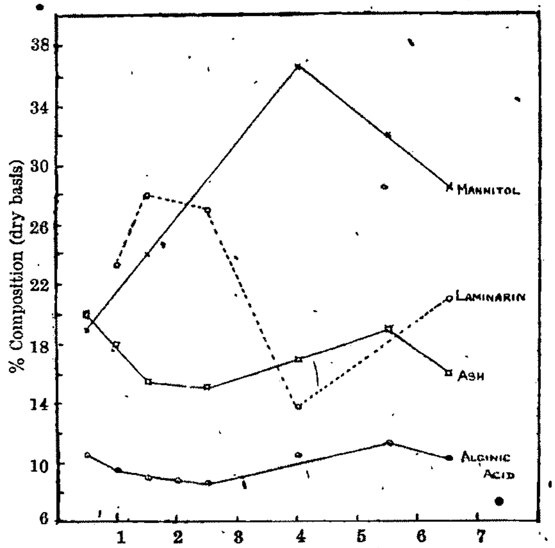
[8] Gruner, J. W., *Amer. Min.*, **30**, 169 (1945).

Seasonal Variation in Chemical Constitution of some Common British Laminariales

It is well known that seaweed, vast quantities of which grow around the coast of Scotland, undergoes wide seasonal variation in chemical constitution. Very little use has been made of these seaweed resources, which may be due to the fact that in Britain they have never been studied intensively from a chemical point of view, and no simple analytical methods have been available for the estimation of the various constituents. The future of any seaweed industry now depends on a thorough knowledge of the organic constituents, which are mainly polysaccharide in nature, and it is the latter which are subject to such wide seasonal variation. It is important, therefore, that the variation of the chemical constituents throughout the year be known, so that the seaweed may be harvested at the appropriate period in order that the constituent required will be at its maximum.

During the past three years, the Scottish Seaweed Research Association has each month been collecting, off the west coast of Scotland and in the Orkneys, samples of the principal British Laminariales. Before drying and preparing the plants for analysis, they are separated into fronds and stipes and analysed individually. Previous workers[1] have apparently analysed the whole plant, and they give no details of the methods of sampling, drying, etc., which are of great importance in plant analysis. During our investigations, every effort has been made to collect the plants from the same habitat and to dry and prepare the samples for analysis under controlled conditions.

Our results have shown that the wide seasonal variations in constitution previously recorded are due almost entirely to variations in the composition of the fronds, which are annual, whereas the stipe is perennial, and it is in the frond where most of, if not all, the photosynthesis occurs. In the spring of each year the frond is renewed, when its composition is approximately the same as that of the stipe; that is, high in mineral matter, proteins and alginic acid; low in mannitol, and containing no laminarin. As photosynthesis proceeds, the mannitol accumulates in the frond and reaches a maximum about midsummer, while laminarin reaches a maximum in the late autumn when the mineral matter is at a minimum and the dry-weight content at a maximum.



Variation in composition of *L. Cloustoni* fronds from Orkney with depth of immersion (August, 1946)

It is interesting to note that, in all the samples analysed, very little or no laminarin was found in the stipes; and it is quite probable that it is entirely absent.

Variation in chemical composition, however, depends on another important factor, the depth of immersion of the seaweed. The relationship between the depth of immersion of Algæ and their metabolism, as expressed by their chemical composition, has previously been noted by Haas and Hill[2] and Barbara Russel-Wells[3], who found a direct increase of fats and fat-like substances with degree of emergence and an increase in the unsaponifiable residue with depth of immersion. No other work appears to have been carried out on this important aspect.

In August 1946, samples of *L. Cloustoni* were taken from the Orkney waters at depths of ½–6½ fathoms (dead low water ordinary spring tides), and the analysis of the fronds, given in the accompanying graph, show remarkable variations.

The mannitol content (36·7 per cent), even when expressed on the whole plant, is considerably greater than any figure previously recorded. In addition, the iodine content increases with depth of immersion and reaches the remarkable figure of 1·25 per cent (on the anhydrous basis) at 7½ fathoms.

Further samples of the *Laminaria Cloustoni*, *Laminaria digitata* and *Laminaria saccharina* have been taken in Orkney in May and July of this year, and the results so far obtained support the previous findings.

This work is being continued and a more detailed report will be published later.

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Oct. 14.

[1] Lapicque, M. L., *C.R. Acad. Sci. Paris*, **169**, 1426 (1919). Colin, H., and Ricard, R., *C.R. Acad. Sci. Paris*, **190**, 1514 (1930). Ricard, R., *Bull. Soc. Chem. Biol.*, **13**, 417 (1931). Lunde, G., *Z. ang. Chem.*, **50**, 731 (1937); *Papir J.*, **28**, 147 (1940). Dillon, T., *Chem. Age*, **49**, 279 (1943).

[2] Haas, P., and Hill, T. G., *Ann. Bot.*, **47**, 55 (1933).

[3] Barbara Russel-Wells, *Nature*, **129**, 654 (1932).

Aerobic Mesophilic Bacteria in Composts

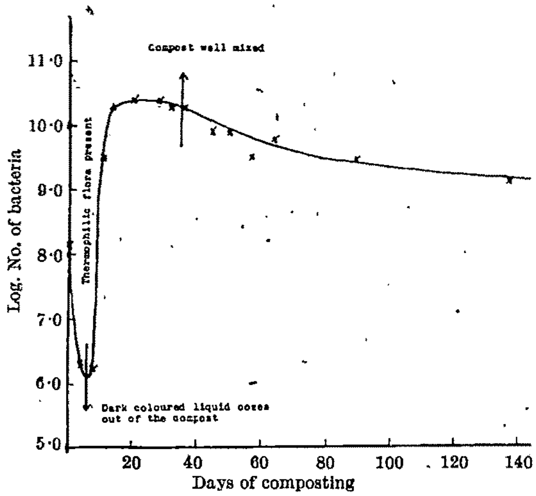
In a previous communication[1], an account was given of the activity of the thermophilic flora which develops in composts made from grass cuttings (lawn mowings). This thermophilic flora can be seen as a white coating on the cuttings, particularly in the upper layers during the high-temperature phase. From it true and facultative thermophilic bacteria were isolated. Recently, in addition, evidence of the presence of a thermophilic actinomycete has been obtained (cf. Waksman *et al.*[2]).

The object of this communication is to give a general account of the behaviour of the aerobic mesophilic bacterial flora of this type of compost. The accompanying table gives the results of bacterial counts using the dilution plate technique (plates incubated at 25° C. for seven to nine days) obtained from samples taken from the centre of composts at different times during the composting period. The moisture content remained practically constant throughout this period.

No. of days of composting	Internal temp. of compost	Bacterial numbers (millions per gm. fresh material)
0 (fresh cuttings)	20° C.	155×10^6; 117×10^6; 87×10^6; 35×10^6
2	65° C.	$2{\cdot}2\times10^6$; $2{\cdot}16\times10^6$; $3{\cdot}7\times10^6$
4	54·4° C.	$17{\cdot}48\times10^6$; $3{\cdot}68\times10^6$; $3{\cdot}84\times10^6$
11	30° C.	$3{,}275\times10^6$
28	15° C.*	$13{,}000\times10^6$; $12{,}100\times10^6$; $5{,}750\times10^6$
64	15° C.*	$10{,}385\times10^6$; $11{,}815\times10^6$; $11{,}500\times10^6$

* Reached outside temperature

It will be seen that there is a reduction of the mesophilic bacterial flora present on the fresh material at the high-temperature phase (65–55° C.). When the temperature of the heap falls below this, there is a very striking development of the mesophilic flora. The general picture of the bacteriology of this type of composting can best be shown by plotting the logarithm of the bacterial numbers against the days of composting.



CHANGES IN THE AEROBIC BACTERIAL FLORA (DEVELOPING ON NUTRIENT AGAR) DURING THE COMPOSTING OF GRASS CUTTINGS. CURVE REFERS TO MESOPHILIC BACTERIA

A similar course of events has been found with the mesophilic flora of a straw compost prepared following the principles of Hutchinson and Richards[3]. In the case of straw, however, no liquid appears during the composting (at least under our conditions), and the development of a thermophilic bacterial flora is not so obvious.

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Craigiebuckler,
Aberdeen.
Sept. 24.

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[1] Webley, *Nature*, 159, 35 (1947).

[2] Waksman, Umbreit and Cordon, *Soil Sci.*, 47 (1), 37 (1939).

[3] Hutchinson and Richards, *J. Min. Agric.*, 28, 398 (1921).

Pre-erythrocytic Stage in Mammalian Malaria Parasites

Shortt and Garnham have announced [*Nature*, January 24, p. 126] the discovery of plasmodial masses in the livers of two monkeys six and seven days respectively after inoculation with sporozoites of *Plasmodium cynomolgi*. These plasmodial masses apparently form the long-sought pre-erythrocytic stage of mammalian malaria parasites, and it is to be expected that human malaria parasites will show similar developmental changes in the incubation period of an infection. Prof. Shortt has very kindly shown me his preparations, and I write to confirm his discovery by the finding of similar parasites in my own laboratory.

For several years we have studied the life-cycle of avian and simian malaria parasites, and biological information has been collected about development of *P. cynomolgi*. After the injection of sporozoites into the skin of monkeys, sporozoites have been demonstrated microscopically at the site of injection for 4½ hours but not longer; these sporozoites lie extracellularly and probably represent forms which fail to develop further. By subinoculation, sporozoites have been demonstrated in the blood of a limb (in which circulation had been arrested by a tourniquet) as late as two hours after intradermal injection. Following this initial period (as is well known) the blood ceases to be infective on subinoculation for approximately eight days. The time at which infectivity returns is sharply defined. Monkeys inoculated with blood taken at 7 days 21 hours, at 7 days 15 hours, and at many shorter periods never became infected; monkeys inoculated with blood taken at 7 days 23 hours, 8 days 4 hours, or longer periods did become infected. Meticulous examination of blood films between the eighth and thirteenth day of the infection showed that the entry of parasites into the blood stream was not synchronous but that it was a continuous process spreading over several days. Subinoculation of tissues (including liver) from monkeys during the inoculation period was done repeatedly; but no transmission was ever achieved with tissue removed less than 7 days 23 hours after the injection of sporozoites. The tissue forms were not transmissible by this means.

Our attempts to locate and identify the tissue forms were unsuccessful until Prof. Shortt's kind demonstration of this preparation. On re-examination of our sections, forms similar to those he has described have been found in the livers of three monkeys. In one experiment, a three months old rhesus monkey was inoculated intravenously and parenterally with the glands from 120 infected mosquitoes. It was killed 7 days 23 hours later. The blood, liver, lung and spleen respectively were infective to other monkeys, but other organs did not produce infection. Large plasmodial masses (average diameter about 28 μ) have been found in the liver; this monkey had been bred in the laboratory, so there could be no question of some other natural infection acquired in India. Similar forms have been found in the liver of a monkey killed 7 days 15 hours after the intravenous injection of the ground-up thoraces of 1,000 infected mosquitoes; the blood and organs were not infective for other monkeys. A third monkey was inoculated intravenously with a suspension of 40 infected mosquitoes (ground up), and it was killed exactly five days later. The blood, liver and other organs did not infect monkeys into which they were sub-inoculated, but parasites (average of longest diameter 14 μ) have been found in the parenchymatous cells of the liver.

In all these cases, parasites are much more scanty and difficult to find in smears than in sections. Further investigation is proceeding.

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Jan. 22.

Variations in Spermatogenesis of Oligospermic Men

In two cases of barren marriage due to severe oligospermia of the husbands, pregnancy occurred notwithstanding spermatic counts of 5,200,000 and 10,000,000 per c.c. Owing to the fact that both couples were extremely religious Jews, extra-conjugal relations could be excluded. Since fertilization with such low spermatic counts seemed improbable, it occurred to us that variations in the spermatogenetic function occur in certain cases of oligospermia. Thus, fertilization might take place at a time when higher spermatic levels are reached.

We have, therefore, examined a group of twenty-one men selected on the basis of a very low spermatic count on first semen examination (less than 10 million per c.c. in twelve cases, less than 20 million per c.c. in five cases and less than 30 million per c.c. in four cases). The total number of spermatozoa in the ejaculate was less than 90 million per c.c. in each. In all these cases the wives were excluded as responsible for barrenness. In order, to study the spermatogenic function, five to seven semen analyses were performed in each case. Each specimen was taken after a period of abstinence of five days.

These semen analyses revealed two types of spermatogenesis in this series. In the first type (thirteen cases) the spermatozoal count was fairly constant, and the differences between any two spermatic counts did not exceed 12 million per c.c. The other seminal characteristics associated with spermatogenesis (sperm motility and percentage of normal spermatozoa) were also quite constant. In the second type (eight cases), extreme variations in the spermatozoal count were observed on repeated examinations. These variations in the spermatic density were as much as 43·5 million per c.c. in the same patient, at different examinations. In five of these cases values as high as 60 million per c.c. were reached. The other spermatic characteristics (motility and morphologically normal spermatozoa) also showed significant variations, although not so striking as the spermatic density.

During the period of observation (4–23 months) conception occurred in two of these barren marriages. In both cases the husbands belonged to this second type of oligospermia.

These observations lead us to distinguish between two types of oligospermia: (1) constant oligospermia, characterized by constancy of a poor spermatogenetic function; and (2) periodic oligospermia, characterized by periodic variations in spermatogenic characteristics; so that in one or more of a series of semen analyses normal values may be reached. Fertilization in this type of oligospermia may well occur.

The value of any therapeutic agent in the treatment of oligospermia should be studied only in cases of constant oligospermia. In view of the above reported observations, many therapeutic reports in cases of oligospermia might be considered as doubtful.

A detailed report of this study will be published elsewhere.

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Oct. 12.

Honeydew on Lime Trees

The dry summer of 1947 led to the accumulation of large amounts of honeydew secreted by the aphis *Therioaphis tiliæ* (L.) on the leaves of European lime trees. Sufficient often dripped to the earth to give a hard coating to the surface.

Portions of leaves (40 gm. dry weight) were gathered by tearing off the edges bearing the honeydew, which had sometimes dried to form a white solid. The leaves were steeped in cold water for 30 min. and the extract (440 ml.) filtered, giving a clear, slightly green liquid. Soil (230 gm.) was scraped from beneath a lime tree and extracted with 200 ml. water. After being heated on the water bath for 45 min. the extract was centrifuged and filtered, yielding a clear, green-brown solution.

Total fructose was estimated in these extracts by the method of Corcoran and Page[1], and reducing sugars were determined, before and after 15 min. hydrolysis at 100° C. in $N/2$ hydrochloric acid, by the method of Somogyi[2]. It was assumed that the hydrolysable non-reducing sugar was sucrose, and that reducing non-fructose sugar before and after hydrolysis was glucose.

Sugars excreted by aphis on European lime tree

	Gm. sugar/100 gm. leaf or soil			
	Sucrose	Glucose	Fructose	Total sugars
Leaves	12·3	8·3	9·2	29·8
Soil	4·7	1·5	1·4	7·6

The results given in the accompanying table show that the amount of sugars secreted by the aphis on to the leaves of lime trees is surprisingly large, and must amount to several kilograms for an average-sized tree. About half the total solids of both extracts consisted of sugars.

My thanks are due to Prof. C. H. O'Donoghue for his interest in this work.

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[1] Corcoran, A. C., and Page, I. H., *J. Biol. Chem.*, **127**, 606 (1939).

[2] Somogyi, M., *J. Biol. Chem.*, **160**, 61 (1945).

Structure of Cyclopropane

Although I am pleased to note that Dr. A. D. Walsh has made a final contribution to this discussion, it may nevertheless be possible to correct a mis-statement. He says[1] that I take the usual formula to represent only the position in space of the atoms involved. What I actually wrote was[2]: ". . . to the usual formulæ. These represent nothing more than the mode of linking of the atoms in the molecule, combined with an indication of the degree of symmetry of the statistical distribution of electrons". Or again[3]: "The formula represents only the mean position in space of the atoms (kernels) and the mode of binding (that is, the structure disclosed by analysis, synthesis, X-ray crystal evidence, etc.)".

R. Robinson

Dyson Perrins Laboratory,
University of Oxford.

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[1] Walsh, A. D., *Nature*, **160**, 903 (1947).

[2] Robinson, R., *Nature*, **159**, 400 (1947).

[3] Robinson, R., *Nature*, **160**, 162 (1947).

COMPLEXITY OF FRESH *HEVEA* LATEX

By Miss L. N. S. HOMANS, J. W. van DALFSEN

AND

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ALTHOUGH under difficult conditions, the work at the Netherlands Indies Rubber Research Institute at Buitenzorg (Java) was continued during the Japanese occupation. Since it will be a long time before the accumulated results of the years 1942–45 can be published in detail, some points of general interest are reported here.

It is common knowledge that upon addition of small amounts of salts of bi- or poly-valent cations to fresh latex, a partial coagulation follows. The yellow-coloured coagulum generally contains 10–30 per cent of the rubber and gives after drying a yellow rubber, rich in proteins and having a high acetone extract. The high acetone extract and the colour are produced by the yellow particles, first observed by Frey-Wyssling, which although generally called 'resin particles', contain mainly lipoids. What, however, is the reason of the high protein content?

In 1941 it was observed by one of us (L. N. S. H.) that when fresh latex is centrifuged in tubes, a separation occurs into a heavy yellow fraction, taking up a tenth to a third of the total volume, and a lighter white fraction. The yellow fraction is more viscous and often in itself consists of various layers, bright yellow, grey yellow, orange or even green coloured. Much information was obtained by studying separately the chemical composition, colloid-chemical and enzymological properties of these fractions.

The difference in composition is evident from the following example:

	Original latex	White fraction	Yellow fraction
Ratio of weight	100	76·3	23·7
Specific gravity	0·977	0·966	?
Viscosity (centipoises)	11·7	9·2	?
Dry rubber content (%)	34·8	43·7	9·0
Total solids (%)	37·4	45·8	14·3
Nitrogen content (%)	0·24	0·22	0·33
Ash content (%)	0·60	0·47	1·11
pH (fresh)	6·3	6·9	5·7
Crepes prepared from the sample had:			
Nitrogen content (%)	0·37	0·34	0·73
Ash content (%)	0·15	0·13	0·50
Acetone extract (%)	2·42	2·10	6·99

It is clear that a large part of the non-rubber constituents of the latex assembles in the yellow fraction, whereas the white fraction is a purer rubber dispersion than the original latex. In spite of its higher rubber content, the white fraction is less viscous, even after ammoniation, and consequently it has better creaming properties.

Another important difference is in their behaviour on standing. Whereas the original latex coagulates spontaneously after about twelve hours, the white fraction may stay fluid for days. The yellow fraction, on the other hand, coagulates within a few hours. This probably is a consequence of the fact that all enzymatic reactions in the yellow fraction are much more pronounced than in the white fraction, giving rise to accelerated splitting of large-molecule complexes and the formation of free fatty acids which, in their turn, in the presence of magnesium ions, effect spontaneous coagulation[1]. The addition of a freshly made pancreas lipase extract accelerates the spontaneous coagulation of the yellow fraction considerably, is less active in the original latex and has scarcely any influence on the white fraction.

A clear demonstration of the greater activity of enzymes in the yellow fraction is given by the dark discoloration on the surface, which is caused by oxidizing enzymes. On standing exposed to air, latex sometimes becomes discoloured on the surface, turning grey or greyish-purple. The white fraction never becomes discoloured; but the yellow fraction always becomes dark grey or purplish-black, often very quickly. Gas formation occurs in the yellow fraction earlier and to a much greater extent than in the white fraction.

Microscopic observations. The complexity of fresh latex, caused by the existence of the yellow fraction, is even observable under the microscope provided the latex is examined in a thin layer and with a small magnification (60–200) and that it is not diluted. The rubber dispersion then is visible as a highly absorbent mass; the rubber particles are not visible separately; but the whole mass is constantly glittering and twinkling in consequence of Brownian movement. The yellow fraction, on the other hand, appears as irregular shaped transparent 'islands' with an irregular structure. The great difference in viscosity is evident. By pressing on the cover glass, streaming of the rubber dispersion is easily effected; but the bright 'islands' are viscous and change their shape only slowly and with difficulty. The phenomenon is especially clearly observable in latex from twigs and from young trees, since in such lattices the yellow fraction takes up a large, even the larger, part of the volume.

Stability. In old ammoniated latex the yellow fraction is no longer present. Resin particles may be observed, but not the viscous matter just described. This is easily understood by observing under the microscope the picture which appears when alkali diffuses into fresh latex: the transparent viscous islands dissolve. Sometimes, however, the viscous matter is more resistant and in exceptional cases it was still present in ammoniated latex several weeks old. Not only the amount but also the properties are dependent on all kinds of biological factors, such as age and strain of the tree, place and frequency of tapping; possibly the season, the weather, even the soil may be of influence.

Very much in contrast to the influence of alkali is the action of distilled water. Now the viscous matter may be observed to stiffen and flocculate under the microscope. From this observation puzzling effects such as the rise in viscosity upon dilution of fresh latex with water, and the forming of clots upon dialysing, now become clear. The behaviour of the yellow fraction of *Hevea* latex upon addition of water is analogous to that of *Cryptostegia* latex[2], since coagulation results.

Dilution of the yellow fraction without a change in the consistency of the viscous matter is possible with a salt solution containing a monovalent cation of about 0·1 normality. With such a solution it becomes possible to wash the yellow fraction by repeated centrifuging, decanting and diluting. Moreover, under suitable conditions as to pH and the concentration of the monovalent cation, it is possible to separate the yellow fraction without centrifuging but simply by gravity. The fact that the addition of salt reduces the viscosity of the fresh latex very considerably is one of the reasons for this.

The true nature of the viscous matter in fresh latex is not yet known, but the properties resemble those of coacervates[3] very much; thus it seems probable that fresh latex contains a micro-coacervate which by centrifuging or under favourable conditions as to the viscosity goes over in a macro-coacervate.

The progress of our research work has been slowed down, first by the War and later it was interrupted by the unhappy conditions in Java; it is expected, however, that work at our Institute will be resumed in the near future.

[1] Compare v. Gils, *Arch. Rubbercultuur*, 25, 395 (1941).

[2] Symontowne, *Ind. Rubb. W.*108.148259 (1943).

[3] See Kruyt and Bungenberg de Jong, *Koll. Z.*, 50, 39 (1930).

STUDIES IN STOMATAL ACTION

Adequacy of the Porometer in the Investigation of Stomatal Aperture

IN the usual form of porometer a small cup is permanently attached to the leaf surface, air is drawn through the leaf into the cup under reduced pressure and either the rate of air flow is measured[1,2] or, in the 'resistance porometer'[3,4], the fall in pressure across the leaf and also that across a standard capillary resistance in series is found; from these pressure gradients the resistance to flow through the leaf is calculated. The rate of flow or the resistance to flow are functions, though very complex ones, of stomatal aperture. In earlier work porometers were used for the purely qualitative purpose of showing whether the stomata were opening or closing. Interest in the dynamics of stomatal movement[5,6] and in the relation between stomatal movement and carbon assimilation[7,8], however, made it desirable to attempt to estimate from porometer readings the resistance to viscous flow of the stomata alone, thus eliminating the confusing effects of the irrelevant internal resistances in the leaf. Hence, ultimately, making use of the less convenient 'diffusion porometer'[9] to calibrate the 'resistance porometer', the resistance to diffusion through the stomata might be estimated. With this end in view a mathematical theory of porometers was elaborated[10,4] and used to estimate stomatal resistances in *Pelargonium*[4].

During a recent investigation of shock-induced stomatal movements[11], it was found that with stomata open in the light, strips of epidermis taken by Lloyd's[12] method within the cup area showed very much wider apertures than those taken just outside the cup. This was at first attributed to the lack of shock sensitivity of the stomata within the cup[11]. The possibility existed, however, that the stomata outside the cup were not showing 'shock closure' on stripping of the epidermis, but actually had smaller apertures on the intact leaf than those within the cup. This, if true, would have an important bearing on the quantitative use of porometers, for the theory mentioned above demands the assumption that the stomatal apertures are the same inside and outside the cup.

A considerable number of experiments, carried out separately after consultation between us, has left no doubt that illuminated leaves, both of *Pelargonium zonale* and *Triticum vulgare*, have, in fact, much wider stomatal apertures where the surface is enclosed in a cup than elsewhere. This has been shown by a modification of Molisch's[13] injection technique using gentian violet in absolute alcohol (*Pelargonium* and *Triticum*) as well as by Lloyd's method and direct microscopical observation (*Pelargonium*). If part of the lamina of a *Pelargonium* or wheat leaf is merely placed between two glass strips and then, after two or three hours illumination, flooded with alcohol, heavy injection indicating wide open stomata is found where the leaf has been enclosed, and little or none elsewhere. Darkened portions show no injection either within or outside the enclosed area. Similar results are obtained using small chambers resembling porometer cups.

The conditions within a porometer cup differ from those outside in the following respects: (1) The air inside the cup is of restricted volume and at rest between readings (if the porometer is disconnected); it thus rapidly becomes saturated with water vapour, a process which is hastened by the drawing of air from the intercellular space system of the leaf into the cup during readings. In the case of *Pelargonium*, the concentration of ethereal oils must also be higher within the cup; with any species other gaseous substances may diffuse out of the leaf, and the oxygen and carbon dioxide tensions in the cup will also be affected. (2) The upper surface of the leaf above the cup is (normally) touching a glass plate. (3) The temperature within the cup may be slightly higher. (4) The leaf in the cup area is (usually) illuminated from above only, the cup shading the lower surface from any *direct* light.

The possible effects of these differences may now be considered.

(1) Experiments, each with a pair of porometer cups on the same leaf, one cup containing a desiccating agent (silica gel or calcium chloride) and the other empty or with moist broken porous tile, show similar wide stomatal opening in both cups, whether judged by porometer readings or Lloyd's method. These results seem to dispose of high humidity as the factor causing the wide opening within the cup. The ethereal oils of *Pelargonium* also seem unlikely to be important in this respect, for similar effects are found with wheat. The question of other variations in the composition of the air in the cup is discussed elsewhere[14].

(2) It is found that similar wide stomatal opening occurs when *Pelargonium* or wheat plants are enclosed in a bell jar, in a saturated atmosphere, with the leaves not in contact with the glass. Thus pressure of the glass plate on the leaf is not concerned. Similar plants outside the bell jar show little opening except where the leaves are enclosed between glass plates, as above.

(3) In the bell jar experiments just cited the difference in temperature inside and outside does not exceed $1\frac{1}{2}$° C. Thus the differences in aperture can arise in the absence of appreciable temperature differences.

(4) These experiments have been carried out with moderate light intensities—a 100-W. or 150-W. lamp, with running water screen, at 3–7 in. distance. It seems improbable that *reducing* the illumination of the lower surface of the leaf would cause wider stomatal opening. In all cases the usual closing response to darkening the upper surface has been found.

Whatever the cause of the wider opening within the cup, and this is the subject of a further communication from one of us[14], it is essential to overcome it if the porometer is to be used other than to show in a purely qualitative manner whether the stomata are opening or closing. The ideal to aim at is obviously to make the conditions within the cup the same as those outside. This has been to a large extent achieved by a simple modification of the form of resistance porometer used by Heath[4]. Air of the same composition and humidity as that surrounding the leaf is supplied to the porometer at a constant *increased* pressure by a simple aspirator working on the 'gasometer' principle. To avoid alteration of the humidity, medicinal paraffin is used in the aspirator and a light grade of the same in the manometers. As compared with the normal type of resistance porometer the pressure gradients are all reversed, but the manometer readings are used in the usual way, only the signs being changed. A hole in the glass or 'Perspex' plate pressing the leaf against the cup washer leaves all the upper leaf surface above the cup area open to the air. Between readings the cup is swept with a stream of the same air that surrounds the rest of the leaf, and during readings such air is being forced from the cup into the leaf through the stomata. There is therefore no tendency for water vapour or other gaseous substances from the leaf to accumulate in the cup. Using this modification of the porometer, preliminary tests with *Pelargonium* have indicated that the stomal apertures inside and outside the cup, as shown by Lloyd's method, are of similar magnitude. A preferable alternative to sweeping air through the cup would be the use of a detachable cup. Maskell[7], using the smooth-leafed cherry laurel, was able to use a cup with a gelatine washer which was simply pushed against the leaf and could be completely removed between readings. For hairy leaves such as *Pelargonium*, however, it is necessary to use a special design of detachable cup which leaves the washer in position on the leaf between readings. Such cups have been used previously for *Pelargonium* in the Research Institute of Plant Physiology, and the method is at present in use in experiments with wheat. A similar cup will now be tried with *Pelargonium*, which is easier than wheat to examine by Lloyd's method, to see whether it gives similar apertures within and outside the cup area.

It is likely that with readings of short duration a normal (reduced pressure) resistance porometer might safely be used; but the modification described above reduces the risk and does not appear to have any disadvantages. The 'gasometer' type of aspirator, which can, of course, be used for either increased or reduced pressures, has the important advantage over the usual type that there is no bubbling of the air through a liquid and hence the menisci in the manometers are absolutely steady and readings can be made instantaneously.

It should be emphasized that data obtained with the more usual type of porometer and a permanently fixed unswept cup are valid for the enclosed stomata so far as qualitative indication of opening or closure in response to light or darkness is concerned. The stomata within the cup do respond to light, and open much wider than those outside. It may be noted also that when used with double 'leaf chambers'[8], in which a considerable area outside the porometer cup is maintained under identical conditions, the normal type of porometer yields data which as an approximation at least may be treated quantitatively in the manner indicated elsewhere[4].

This work is continuing and will be published in detail in due course.

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[14] Heath, O. V. S., following communication.

Control of Stomatal Movement by a Reduction in the Normal Carbon Dioxide Content of the Air

To account for the much wider stomatal apertures found within a porometer cup than elsewhere on an illuminated leaf[1], the hypothesis was examined that some volatile substance produced by the leaf itself caused opening of the stomata in light when in high concentration. On testing this hypothesis a considerable amount of experimental evidence was obtained in its favour. Thus detached leaves in water of *Pelargonium* or wheat, enclosed together with entire plants in a saturated atmosphere under a bell jar and illuminated for a few hours, showed wide stomatal opening when tested by the injection technique of Williams[1]; single leaves similarly enclosed by themselves, also in a saturated atmosphere and illuminated, showed little or no injection. On the other hand, similar single leaves of wheat each enclosed in a *small* volume of saturated air in a glass tube showed very heavy injection, as in the leaves from the crowded bell jars. When such tubes were swept continuously with a slow stream of humid air, little or no injection of the leaves was found.

The following statistically significant effects were thus obtained: (1) Heavier injection (wider stomatal opening) with many than with few or single leaves in the same large volume of humid still air; (2) heavier injection with single leaves in a small than in a large volume of humid still air; (3) heavier injection with single leaves in a small volume of humid still air than in humid moving air. Porometer experiments with *Pelargonium* showed that sweeping the cup with moving air, whether dry or humid, caused considerable stomatal closure as compared with still air. Similar results have been obtained with wheat, using dry air, by Mr. Milthorpe in this Institute. Darwin's[2] finding that removal of plants from a (presumably crowded) greenhouse to the laboratory caused stomatal closure, but that enclosure of the plants in bell jars caused the stomata to remain open or re-open, also seemed to support the hypothesis, although he himself attributed these effects to humidity changes.

There existed, however, the seemingly remote possibilities that all these effects were due either to the removal of carbon dioxide or the increase of oxygen concentration brought about by photosynthesis. The crucial experiments were therefore performed of sweeping porometer cups, attached to illuminated leaves of *Pelargonium* and wheat, with either carbon dioxide-free or ordinary air, both dry and humid conditions being investigated. It was at once found that moving carbon dioxide-free air, whether humid or dry, caused stomatal opening, sometimes even where the full opening in still air had been reached. This last implies sensitivity to extremely low carbon dioxide concentrations. Ordinary air at the same rate of flow caused very considerable closure. Rate of sweeping had virtually no effect between one and eight litres per hour (*Pelargonium*), and four litres per hour was adopted as standard. The effects of carbon dioxide-free and ordinary moving air in the dark were also investigated (*Pelargonium*). It was found that although carbon dioxide-free air would *prevent* complete closure in darkness and would also cause partial further opening of stomata which were not completely shut, if the stomata had been completely closed (resistance approx. infinity) by ordinary air they would not reopen in carbon dioxide-free air. This would seem to show that the effect of carbon dioxide is due to its concentration in the sub-stomatal cavities and not at the outer surface of the guard cells. In all these porometer experiments the modified resistance porometer[1] was used; the stomata were allowed to attain their equilibrium opening for each set of conditions before the conditions were altered, except in a few cases with saturated air, in which equilibrium was attained much more slowly than with dry air.

Supporting evidence for the 'carbon dioxide' hypothesis has been obtained from experiments in which single detached leaves of *Pelargonium* or wheat have been enclosed under bell jars, with or without a dish of $2N$ caustic soda solution, and illuminated for a few hours. Significantly heavier injection has been found for both species in the leaves from the bell jars with caustic soda, the effect being particularly striking with *Pelargonium*.

The porometer experiments not only dispose of the 'volatile substance' hypothesis, for such a substance should be equally swept away by either carbon dioxide-free or ordinary air; they similarly dispose of the 'oxygen' hypothesis. The only remaining possibility, apart from a carbon dioxide effect, seems to be that closure is caused by some other substance present in the air supply. Such a substance would have to be absorbed by caustic soda or soda lime but not by silica gel, phosphorus pentoxide or calcium chloride; nor by a solution of sodium thiosulphate, which was used to remove chlorine from humid air supplied by a water pump. Furthermore, such a substance must be of wide occurrence, for similar partial closure of stomata freely exposed to the air has been found at Bedford College[1,3] and in two laboratories in the Research Institute[1]. In the latter there was no gas supply nor tobacco smoke. On the present evidence, therefore, the 'carbon-dioxide' hypothesis seems by far the most plausible.

The effects of carbon dioxide on stomata have been investigated in a sporadic manner for more than fifty years, but the comparison has almost always been made between carbon dioxide-free or ordinary air and very high concentrations or even pure carbon dioxide. Darwin[2], using his 'horn hygroscope', found that the stomata in light "remain open in an atmosphere free from carbon dioxide". In pure carbon dioxide they were found to close slowly. He criticized Schellenberger's[4] finding, that in carbon dioxide-free air the stomata closed slowly, as being due to the use of relatively dry air; but the present work renders this explanation improbable, and many other factors, such as a diurnal rhythm of stomatal movement[5,6], may have been involved. Lloyd's[7] data for *Verbena ciliata* rather suggest that the stomata do not close readily in darkness in carbon dioxide-free air, but if already shut will remain closed; in light they open in carbon dioxide-free air. These results resemble some of the present findings but Lloyd does not direct attention to them. Linsbauer[8] investigated the effects of carbon dioxide-free air both in light and darkness, and found that in all experiments the removal of carbon dioxide favoured the opening of stomata in the dark. The effect in the light was stated to be the same but less pronounced owing to the stomata being already partly open. These entirely correct results have seemed suspect owing to the very crude technique by which they were obtained, for leaf fragments were held against a moist filter paper over solid caustic potash or a strong solution, and Linsbauer himself noted that the tendency of the leaf fragments to dry gave much trouble. High carbon dioxide concentrations were found to cause closure or failure to open in both light and darkness. Stahl[9] also found that high carbon dioxide concentration caused closure. Scarth[10] investigated the effects of high concentrations of carbon dioxide (10–50 per cent) and found in darkness closure followed after many hours by opening. In the light, opening was prevented. Carbon dioxide-free air was apparently not investigated.

The importance of the findings here reported would seem to lie in the discovery of the extreme sensitivity of the stomata to very small variation in carbon dioxide concentration (between *c.* 0·03 per cent and zero). This is found to furnish a plausible explanation of a number of hitherto obscure phenomena observed in the course of many years research on stomata in this Institute. Such a mechanism may well have the biological advantage for the plant that the stomata tend to close in wind and thus reduce the risk of desiccation due to excessive transpiration. That such stomatal control of transpiration in wind can occur is shown by moving air experiments at present in progress in this Institute, and is strongly suggested by the work of Wrenger[11].

The present work again raises the possibility that the light response of the stomata may be entirely due to the removal of carbon dioxide by photosynthesis, and the dark response to its accumulation inside the leaf, as has been suggested by Stahl[9], Sayre[12], Scarth[13] and others. Clearly, however, not only the carbon dioxide of respiration but the external supply also is of great importance, especially in the light, and much further work is needed.

The mechanism by which the carbon dioxide concentration controls movement of the guard cells also calls for much further investigation. The opening force in the stoma has been shown to be supplied ultimately by the turgor of the guard cells[14], but the intermediate steps between this and the carbon dioxide concentration in the substomatal cavity are quite uncertain. The evidence for the usual starch $\rightleftarrows$ sugar hypothesis, whether controlled through pH change or in any other way, is not convincing so far as the dark – light response is concerned[15].

This work will be continued and detailed publication will follow in due course.

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SOCIAL AND SCIENTIFIC DEVELOPMENT OF THE WEST INDIES

THE considerable report by Sir John Macpherson, recently issued*, contains much valuable information relating to the work of the Development and Welfare Organisation in the West Indies. The report at once conveys an impression of how much is being done (or is under consideration) and how much there is yet to do. The contemporary situation in the West Indian Colonies, whether agricultural, economic, social or political, is complex. It has been long in the making, and wise foresight, good management, patience, industry and optimism will be needed before matters are put right. It is probably true to say that, in this region, there is now a general demand for conditions which will enable the local populations to enjoy a fuller and better life. In practice this means that improvements must be effected in almost every walk of life and in every branch of official activity.

The report opens with an informative general survey of West Indian affairs. Particular attention is given to such topics as agriculture, forestry, fisheries, education, public health, housing, town planning, labour conditions, social welfare, public works, etc. A special Welfare Fund, granted by the Exchequer of the United Kingdom, is available for promoting schemes for the general improvement of education, health services, land settlement, and the hundred-and-one projects which collectively will make for better conditions and opportunities for the native population of the West Indies.

Space does not admit of an adequate review of the contents of this report. But as an example of the treatment accorded to one major theme, agriculture may be selected. Here, as elsewhere, Sir John is direct and to the point. It is most sincerely to be hoped that his words will be heeded throughout the length and breadth of our Caribbean Colonies. The ideas are not new, but it is good to hear them forcibly restated at this time :

"The greatest need of the British West Indies to-day is the most intensive use of the land according to methods of good husbandry, both for export crops and local food crops. In no other way can a growing population be supported or the demands for higher standards of living be met. The intensive and balanced use of the land calls for far-reaching reforms in the basic methods now employed, and for improved education facilities and efficient advisory services. The reforms require special measures, some of which cannot be successfully applied until new knowledge acquired through scientific investigation has been made widely available. The work of the Development and Welfare organisation has been constantly guided by these fundamental facts."

It is heartening to read that the need for soil conservation is being more widely understood, that grass is being introduced as a rotational crop, and that there is an increasing disposition to realize that land, water and forest resources are "the foundation upon which better standards of life can be established".

As improvement in agriculture will necessarily depend on an advance in agricultural education, measures to achieve this end are in hand. Measures to assist peasant agriculture, to promote mixed farming adapted to West Indian conditions, to test communal and co-operative farming, and to improve livestock, etc., each has its place in the new agricultural outlook. The essential place of a wide system of researches, duly co-ordinated, is recognized. This matter has been given much attention, and a number of schemes have already been approved. Some of these, including problems of sugar technology, soil science, the improvement of cacao, genetics of tropical crops, including bananas, etc., will be centred at the Imperial College of Tropical Agriculture in Trinidad, while related investigations will be carried out in some of the other islands because of their special suitability for the work.

These notes give but a small sample of the contents of this document as they relate to agriculture. Attention is also given, in due measure, to the several other major topics mentioned above. The text, clearly but closely written, contains much interesting and valuable detail and should be carefully read by all who follow with interest and sympathy the new movement that is undoubtedly afoot in the Colonies.

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* Development and Welfare in the West Indies. By Sir John Macpherson. Col. 212. Pp. 162. (London : H.M. Stationery Office 1947). 3*s*.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 2

FARMERS' CLUB (at the Royal Empire Society, Craven Street, London, W.C.2), at 2.30 p.m.—Dr. W. G. Ogg : "Soil and the Farmer".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 4.30 p.m.—Prof. A. C. Frazer : "The Metabolism of Fats" (Cantor Lecture).

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Dr. D. G. Tucker and Mr. F. Scowen : "Modern Approach to Transmission Networks".

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. E. E. Turner : Presidential Address.

Tuesday, February 3

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. L. S. Penrose : "Human Genetics".*

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Papers.

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Rev. Prof. E. O. James : "The Social Function of Anthropology".

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1) at 5.15 p.m.—Mr. W. L. Stevens : "Control by Gauging".

CONWAY DISCUSSION CIRCLE (at Conway Hall, Red Lion Square, London, W.C.1), at 7 p.m.—Dr. J. A. C. Brown : "Group Psychology in Industry".*

Wednesday, February 4

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Lieut.-Colonel L. Urwick: "Education for Management".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. H. H. Merriman and Mr. R. W. White: "The Application of Frequency Modulation to V. H. F. Multi-Channel Radio-telephony".

Royal Statistical Society, Birmingham Group of the Industrial Applications Section (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. K. Brownlee: "The Design of Experiments with Special Reference to the Chemical Industry".

Society of Public Analysts and other Analytical Chemists (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Messrs. D. W. Kent-Jones, A. J. Amos, P. S. Elias, R. C. A. Bradshaw and G. B. Thackray: "The Micro-analytical Test for Purity in Food, with special reference to Cereals".

Thursday, February 5

Royal Society of Arts, India and Burma Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Colonel D. J. Atkinson: "The Forests and Forests Resources of Burma".

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. C. H. Kellaway, F.R.S.: "The Wellcome Research Institution".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, February 6

Institution of Chemical Engineers, North-Western Branch (at the College of Technology, Manchester), at 3 p.m.—Annual General Meeting; Dr. D. T. A. Townend: "Coal Utilisation".

Physical Society (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. M. Blackman and Mr. J. L. Michiels: "Efficiency of Counting Systems"; Mr. N. F. Astbury: "The Moving-Coil Galvanometer as a Circuit Element".

Institute of Navigation (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.30 p.m.—Dr. G. N. Harvey: "A New System of Compass Correction".

King's College (Strand, London, W.C.2), at 5.30 p.m.—Prof. I. L. Kandel: "American Universities and their Place in American Life".*

Geologists' Association (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. W. N. Croft: "A Year in Graham Land".

Royal Statistical Society, London Group of the Industrial Applications Section (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. Geiss: "Quality Control in Europe".

Society of Chemical Industry, Manchester Section (at the Engineers' Club, 17 Albert Square, Manchester), at 6 p.m.—Dr. Herbert Levinstein: "Raw Materials for Rayon".

Society of Instrument Technology, Midland Section (at the Chamber of Commerce Buildings, New Street, Birmingham), at 7 p.m.—Mr. D. E. Edmundson: "Magnetic Materials as Applied to Instruments".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Prof. S. Loria and Mr. J. G. Crowther: "Science in Poland".

Society of Chemical Industry, Chemical Engineering Group (joint meeting with the Glasgow Section of the S.C.I., at Glasgow).—Mr. A. G. White: "The Manufacture of Explosive Substances".

Saturday, February 7

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Prof. H. J. Fleure, F.R.S.: "Ploughs and Soils—a Study of some Foundations for European Life".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Lecturer in Aerodynamics, a Senior Lecturer in Mathematics, a Responsible Lecturer in Physics, a Lecturer in Mechanical Engineering, a Lecturer in Production Engineering, and a Responsible Lecturer in Electrical Engineering—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (February 7).

Principal of the School of Electronics, Malvern—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs, quoting 5/138/JFA (February 7).

Senior Lecturer in Physics and Electronic Engineering at the School of Electronics, Malvern—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs quoting 5/188/JFA (February 9).

Lecturers (2) in Mathematics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (February 14).

Experimental Officer (graduate with knowledge of field plot technique and statistical analysis of experimental results), Horticultural Advisers (2, with recognized qualifications in horticulture), and Instructresses in Dairying and Poultrykeeping (2, with recognized qualifications in these subjects)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (February 14).

Research Assistant in the Department of Pharmacology and Therapeutics—The Registrar, The University, Sheffield (February 21).

Physicist in the Department of Meteorology—The Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7 (February 21).

Lecturers in Mathematics and Science (including physics, mechanical or electrical engineering, chemistry, or biology)—The Director of Studies, Royal Military Academy, Sandhurst, Camberley, Surrey (February 21).

Senior Research Officer in the Tobacco Branch of the Division of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (February 27).

Assistant Technical Officers (2) in the Royal Mint—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2091 (February 28).

Lecturer in Statistics in University College, Dundee, and in the Conjoint Medical School, Dundee—The Secretary, The University, St. Andrews (February 28).

Chair of Genetics—The Secretary, The University, Edmund Street, Birmingham 3 (March 8).

Readership in Physics at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 9).

Professor and Head of Metallurgy Department, Indian Institute of Science, Bangalore—The High Commissioner for India, India House, Aldwych, London, W.C.2 (Bangalore, March 10).

Lecturer in Economic Statistics in the Faculty of Economics, University of Sydney—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Sydney, March 31).

Scientific Officer (University graduate with 1st or 2nd class honours in Chemistry) in the Spectrographic Department—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

Chemist in connexion with the study of problems of fruit and vegetable preservation—The Director, University of Bristol Research Station, Campden, Glos.

Research Chemist—The Director of Research, Research Association of British Flour-Millers, Cereals Research Station, St. Albans, Herts.

Senior Research Chemist, a Senior Technological Chemist, Junior Research Chemists, and a Junior Research Physicist—The Director of Research, British Leather Manufacturers' Research Association, 1–6 Nelson Square, London, S.E.1.

Divisional Analyst, and Scientific Technologists (or Grade III Scientists), in the Coke Oven Laboratories—The Divisional Chief Scientist, National Coal Board (South-Western Division), Ystrad Mynach, Hengoed, Glamorgan.

Chemists and Physicists—The Director, Research Association of British Paint, Colour and Varnish Manufacturers, Paint Research Station, Waldegrave Road, Teddington, Middx.

Agricultural Zoologist in the Malayan Union—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Board of Trade. Working Party Reports—Wool. Pp. vii + 232. (London: H.M. Stationery Office, 1947.) 3*s.* 6*d.* net. [135

Physical Society. Catalogue of the Thirty-first Exhibition of Scientific Instruments and Apparatus, April 1947. Pp. 298 + A86. (London: Physical Society, 1947.) To non-Members, 5*s.* net. [135

Institution of Mining and Metallurgy. Annual Report of the Council. Pp. 16. Presidential Address on Geographic Changes in Mineral Producing Centres, delivered at the Annual General Meeting of the Institution on 15th May 1947. By W. R. Jones. Pp. 9. (London: Institution of Mining and Metallurgy, 1947.) [155

British Rubber Producers' Research Association. Publication No. 76: The Interaction between Rubber and Liquids, 8, A New Examination of the Thermodynamic Properties of the System Rubber + Benzene. By Geoffrey Gee and W. J. C. Orr. Pp. 12. Publication No. 79: The Interaction between Rubber and Liquids, 9, The Elastic Behaviour of Dry and Swollen Rubbers. By Geoffrey Gee. Pp. 14. Publication No. 80: The Structure of Polyisoprenes, 6, An Investigation of the Molecular Structure of Dibenzyl by X-Ray Analysis. By G. A. Jeffrey. Pp. 16. (London: British Rubber Producers' Research Association, 1947.) [155

Other Countries

Malayan Forest Records. No. 14: Dipterocarp Timbers of the Malay Peninsula. By H. E. Desch. Pp. x + 171 + 63 plates. 7.50 dollars; 17*s.* 6*d.* No. 15: Manual of Malayan Timbers. By H. E. Desch. Vol. 1. Pp. vii + 328 + 69 plates. 10 dollars; 24*s.* No. 16: Forester's Manual of Dipterocarps. By C. F. Symington. Pp. xliii + 244. 10 yen. (Kuala Lumpur: Director of Forestry, 1941–1942.) [125

Sveriges Geologiska Undersökning. Ser. C, No. 477: Agnostidea of the Middle Cambrian of Sweden. By A. H. Westergård. Pp. 140 + 16 plates. 5 kr. Ser. C, No. 478: Blekingemoränens blockhalt. Av G. Lundquist. Pp. 20. 1 kr. Ser. C, No. 479: Svenska stenindustriområden 1–2. Gatsten och kansten, 1, Allmän översikt; 2, Specialundersökning av det för 1937 års granitutredning insamlade materialet. Av Bror Asklund. Pp. 187 + 8 plates. 5 kr. Ser. C, No. 480: The Classification of the Hornblendes and the Solid Solution Relations in the Amphibole Group. By N. Sundius. Pp. 36. 2 kr. Ser. C, No. 481: Nya bidrag till kännedomen om Härnögyttjan. Av Henr. Munthe. Pp. 16. 1 kr. (Stockholm: P. A. Norstedt and Söner, 1946–1947.) [125

Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Serie Plankton, Bind 4, Nr. 1: Reproduction and Larval Development of Danish Marine Bottom Invertebrates, with Special Reference to the Planktonic Larvae in the Sound (Øresund.) By Gunnar Thorson (with a section on Lamellibranch Larvae, by C. Barker Jørgensen). Pp. 523. (København: C. A. Reitzels Forlag, 1946.) [125

NATURE

No. 4084 SATURDAY, FEBRUARY 7, 1948 Vol. 161

CONTENTS

Page
Regional Development Organisations in Britain . . 183
Greek Fishes. By Sir John Myres, O.B.E., F.B.A.. . 185
The Race for Oil. By H. B. Milner 186
"When the Pie was Opened." By Prof. E. H. Neville. 186
Oscillatory Time-Series. By David G. Kendall . . 187
Recent Mosquito Eradication Campaigns. By Dr. J. R. Busvine 189
Scientific Research in the British Zone of Germany. By Prof. F. A. Paneth, F.R.S. 191
Water Movements and Earth Currents : Electrical and Magnetic Effects 192
Obituaries :
  Prof. David Enskog. By Prof. S. Chapman, F.R.S.. 193
  Mr. W. H. Pick 194
  Mr. John Lister 194
News and Views 195
Letters to the Editors :
  Formation of Siphons in Lamellibranchia.—Prof. C. M. Yonge, F.R.S. 198
  Aspects of the Locomotion of Whales.—Prof. J. Gray, F.R.S. ; Dr. D. A. Parry. 199
  Bacterial Flagella and Motility.—Prof. Adrianus Pijper 200
  Elminius modestus : Another Imported Pest of East Coast Oyster Beds.—E. W. Knight Jones . . 201
  Shrinkage of Animal Cells Due to Fixatives.—Dr. Daya Krishna 202
  The Iron Alum Acetocarmine Method for Algæ.—Dr. M. B. E. Godward 203
  Amphibian Tissue Cultures for Biophysical Research.—M. M'E. Preston 203
  Submicroscopic Structure of the Red Cell.—Dr. M. F. Perutz 204
  Weight of the Rat Thymus.—L. R. C. Agnew . 205
  Brain Lactate in Emotion.—Dr. D. Richter and R. M. C. Dawson 205
  Starches of the Wrinkled and the Smooth Pea.—Dr. S. Peat, Dr. E. J. Bourne and Mary J. Nicholls 206
  Nature of the *C*/*D*-ring Union in the Oestrogenic Hormones.—Dr. C. W. Shoppee . . . 207
  p-Hydroxybenzil.—John H. Gorvin . . . 208
  Auroral Activity in Southern Norway from the Middle of August to the Middle of October, 1947.—Prof. Carl Störmer 208
  Lorentz-like Transformations.—P. T. Landsberg ; Prof. Herbert Dingle 208
Dosage/Response Relationships in Mould Inhibition. By J. N. Phillips and J. M. Vincent 210
Nitrogenous Constituents of the Potato. By Dr. E. B. Slack 211
New Chemical and Physical Laboratory of the Royal Aircraft Establishment, Farnborough, Hants . . 212
Government Research in Britain 214
American Awards to British Men of Science . . 215

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REGIONAL DEVELOPMENT ORGANISATIONS IN BRITAIN

THE able study of local and regional development organisations in Great Britain made by Mr. M. P. Fogarty and published last year under the slightly misleading title, "Plan Your Own Industries" (Oxford : B. Blackwell, 1947. Pp. viii+320. 25*s.*), is of interest to the scientific worker from several points of view. His appreciation of the contribution which such bodies can make in bringing local initiative, enterprise and interest into regional planning, whether it be of industry, water-supply, housing, or any other social service, is valuable in the debate on local government reform and the decisions of the Boundary Commission, as well as in discussing the position of the development areas and of the utilization of land in Britain. Certain bodies of this type, notably the West Midland Group on Post-War Reconstruction and Planning, have made important contributions in this field, and Lord Rennell has already powerfully urged that the Boundary Commission should take adequate account of the scientific study of Herefordshire, for which the West Midland Group was responsible.

It seems clear from Mr. Fogarty's study that such bodies can materially assist in making the industrial development of a town or county a matter for genuine local discussion and decision, whatever changes in the organisation of local government may be instituted or regional organisations established. Any new system will require time to build up the essential local and regional advisory bodies ; and in the meantime the existing development organisations should have a most important part to play in preventing friction or misunderstanding as the Board of Trade panels considering the distribution of industry and the new Town and Country Planning Act come into full operation. In facilitating the Government approach and dealing with local plans and projects, and in making known, locally and regionally, the purpose of Government proposals and the reasons for them, development organisations could do much to facilitate the understanding, approval and co-operation which are the essence of genuine democracy at the local as at the regional level.

It would be too much to expect the development associations to make major contributions to the larger national problem, which, as Mr. George Gibson pointed out to the Manchester Statistical Society last autumn, is no longer that of bringing the work to the workers in the development areas, but increasingly of bringing the workers to the essential jobs where those jobs are now located. That contention is supported by the whole trend of the report on the Northern Region —Northumberland, Durham and the North Riding— which the North-East Development Association issued in May 1946. But some of the development organisations have also been responsible for pursuing exactly the kind of research advocated by the Barlow Commission on the geographical distribution of population and industry, and although the Government has not seen fit to implement the main recommendation of that Commission's report for the establishment of a central authority to control industrial location, the recommendations on the need for unified research appear to have been accepted implicitly, although action has not proceeded further than the appointment by the Board of Trade of a joint committee with the universities to deal with questions of research.

In the meantime, the study of land classification in the West Midland region issued last year by the West Midland Group shows how far such bodies have already gone in the prosecution of the required type of research. The West Midland Group has succeeded in bringing geographers and agricultural scientists together in a conference where agreement was reached on a system of classification based on the physical properties of soil and site. An expert committee then spent three years reconnoitring the land resources of the region; and the resultant study is a valuable contribution to the general problem of classifying land so as to distinguish the areas best suited for new settlement and industrial development from those best reserved for various agricultural purposes or for recreation and enjoyment.

Clearly such voluntary work has an interest and an importance far beyond the area in which it is being prosecuted, and it is well that an attempt should be made to assess both its extent and quality, and the relation of such efforts supported by private sources —like the Bournville Village Trust in the West Midland Group—to existing or projected national or regional efforts. For example, Sir Edward Appleton and others have strongly advocated the formation of joint research councils on the lines of that established two years ago in Manchester. There is at least some risk that, without co-ordination and consultation, effort may be duplicated in different regions or even in the same region by the different organisations.

It is accordingly important that an effort should be made to assess the value of the research work carried out by the development organisations and its place in the national organisation of research. Such an appreciation is essential to determine the proper apportionment of our resources of man-power in research and to avoid waste of both material resources and trained man-power. This is the aspect of these organisations which is of most interest to the man of science.

Examining the research activities of development organisations, Mr. Fogarty distinguishes three types of service which they render to industry and to their region. First, there is what may be described as general economic and social research—the study of social and economic facts and potentialities in a region against their wider national or even international background. Second comes the solution of technical or scientific problems arising in development, production problems, the study of new processes or inventions and the investigation of natural resources. Both these factors may clearly be described as research; but the third type of service would not usually be included under that head. This is the function of collecting and supplying factual information about, or to, an area on industrial or tourist facilities, openings for trade, the effect of new laws and regulations, local industrial organisation and the trend of public opinion in the area.

Although there are some exceptions—and Mr. Fogarty instances the second Industrial Survey of South Wales as a conspicuous example—the social and economic research conducted by development organisations has not been of high standard. Mr. Fogarty's review of their results and resources leads him to believe that at best the results of research conducted by such organisations are likely to be of limited value on account of the lack of staff and inadequate financial resources. For example, the University of Bristol Reconstruction Research Group has an annual income of about £3,000; but the total resources of the Bristol Development Board, which is not a conspicuously poorly endowed organisation as development organisations go, amount to little more than that sum.

The angle of approach is another factor to be considered, and this may be too narrow. Mr. Fogarty's considered opinion is that the smaller agencies will best serve research by promoting and encouraging the supply of detailed information and by efforts to improve its utilization. Reports from recent 'working parties' of the Board of Trade have pointed significantly to the need for improvement in this respect, and the gap between the discovery of new knowledge and its utilization in industry is already a matter of concern to the Department of Scientific and Industrial Research.

Here then is a point at which the development organisations may be able to offer an important and continuing service to the research effort of the country. Even the larger development organisations, in Mr. Fogarty's opinion, should not be expected to undertake general economic or social research on their own. The main responsibility for this should be carried by Government departments, the universities and regional authorities; the unique position and constitution of the West Midland Group should preclude it being quoted as typical of the type of organisation desired Much more research is required in this field from the universities and Government departments, as well as from regional authorities, which have scarcely commenced to discharge this responsibility even where they exist.

In regard to the second type of research considered by Mr. Fogarty, the larger development organisations such as the Welsh Reconstruction Advisory Council the Scottish and Welsh Development Councils, the National Industrial Development Council of Wale and Monmouthshire, and the Cumberland Development Council, have a good record for scientific and technical research. Despite their achievements in coal utilization, mineral survey, and the development of producer gas vehicles, it must remain a matter of opinion whether the development organisations do not here intrude on a field which is best left to industry and the research associations. They could undoubtedly help in some fields to discover and fill in the gaps in research effort; but from the national point of view it seems likely that their best contribution is mad by assisting to close the gap between research and commercial development, and supporting the work of the joint research councils.

In the field of research, development organisations, Mr. Fogarty concludes, are generally interlopers and at best stop-gaps. They are primarily executive bodies and unsuited, except in emergency, to conduct research. They can stimulate research, and have a valuable part to play in improving the utilization of research and in ensuring that results of economic and social investigations are turned to practical account.

These conclusions are not without significance for the research association movement in Britain. They emphasize the importance of adequate endowment of a research association to enable research to be prosecuted effectively: there are minimum standards below which it is waste of resources and of man-power to look for results. Mr. Fogarty's comment in regard to social and economic research, that by doing such research badly development organisations may make it impossible for better qualified agencies to do it at all, is relevant in considering the development of new, or the expansion of existing, research associations, as against the establishment of other co-operative agencies of the type of the Mellon Institute in the United States or the Fulmer Institute in Britain.

The point is of interest because there was nothing in Mr. Herbert Morrison's speech at Letchworth on January 14 (see p. 214) to indicate that the Advisory Council on Scientific Policy or the Committee on Industrial Productivity is considering this question of the type of research structure which will best serve our needs and make the most effective use of the available scientific man-power. The Lord President of the Council said that the Government had decided that the new town at Stevenage should be given preference in considering the sites of new scientific establishments in the London region, and although he could not state what actual research would be located at Stevenage or when it would come, he indicated that a number of research stations had outgrown their present sites and would have to move. He visualized Stevenage as becoming one of the most important scientific centres of Britain.

The Lord President was clearly alive to the importance of scientific research being well distributed over the country, and referred to the location in Scotland of the largest of the new scientific stations, that for mechanical engineering research. At the same time, he recognized that many of the research establishments must of necessity be in the London region. What was lacking in his speech was any clue to the reasons which had led to the choice of Stevenage as a scientific centre; the occasion may not have been appropriate, but men of science at least would find it reassuring if some indication was given of the considerations on which this decision is based.

The matter is important because criticism of the research association movement in Britain has centred around a tendency to locate the associations in the neighbourhood of London, where many are distant from the centre of industry they serve. Whatever substance there may be in such criticism —and the success of the Institute of Paper Chemistry at Appleton, Wisconsin, is frankly attributed to the location of the Institute in the midst of paper mills as well as to its close association with Lawrence College—the location of research institutions is a matter which might be well worth inquiry by, for example, the joint research councils and like regional bodies, if not by national organisations such as the Department of Scientific and Industrial Research. Considerations of man-power at least are likely to force it on the attention of the Advisory Council on Scientific Policy, if it has not already done so.

In his final conclusion, Mr. Fogarty comes back to a crucial factor which impels a review of the whole structure and location of the research effort in Britain at the present time, namely, that of staff. The success of the development organisations depends upon the quality of the staff they employ, and the initial problem is how to deploy to the best advantage in the national interest those limited resources of trained man-power which we possess. If encouragement of development organisations to continue and to expand their research activities means dissipation of the nation's research effort, waste of man-power and duplication, at a time when severe limitations have been imposed by the Government itself on capital expenditure, it may still be a wise measure to use the interval to turn to the task of promoting the utilization by industry of existing knowledge. That is a matter to be considered by the development councils as well as by higher authorities.

GREEK FISHES

A Glossary of Greek Fishes

By Sir D'Arcy Wentworth Thompson. Pp. vi + 302. (London: Oxford University Press, 1947.) 21*s*. net.

MORE than fifty years ago appeared "A Glossary of Greek Birds", which has been a treasure and a joy to two generations of scholars and naturalists. To the same learned and versatile writer, and the same 'blameless drudgery of lexicography', we owe now this companion volume, "A Glossary of Greek Fishes"—"a work of love and predilection all along". Doubtless with longer labour the "Glossary" might have been clothed in introduction and appendixes for the varied general problems and inquiries which it suggests; but the author has done well to ensure the publication of what is, after all, the essential compendium of facts; and some of the more difficult or more important items run to three or more pages, and the tunny has eleven.

Greeks knew much about fishes, as a maritime and insular people should, and revelled in names for them, and in legends, folk-lore, and acute observations; they were—and are—also connoisseurs of fish as food, and talked about what they ate and enjoyed. Even the almost fish-less "Epic" has its fishing similes and glimpses of marine life; how much it had forgotten or by-passed, we know from Minoan art. Herodotus had a quick eye for exotic fishes. Alexander disclosed a new ocean of tropical wonders, as well as the Nile with vocabulary and fishing-stories of its own. The western colonies transmitted Greek fish-lore, and added to it. Italian sailors brought their own names into Greek waters, without displacing the old vocabulary; and many modern fish-names are still Greek. Our own 'trout' may be a Greek name misapplied (p. 271). A dozen or more of names in this "Glossary" are printed in roman characters, being only preserved in Latin authors, though certainly known to the Greeks. It is interesting to note how many names defy derivation, and may well be pre-Hellenic; others seem to be borrowed from Egyptian. Almost none are from Phœnician, and the same applies to Greek shipping vocabulary; a devastating commentary on the old myth of Phœnician influence on Greek culture.

How fully the author has covered the field is evident from his 'addenda' (p. 297)—only three items. He has inevitably included much besides 'fishes' in the strict sense; for many molluscs and other *frutta di mare* shared the same names, or were otherwise connected with fisheries; lobsters, crabs, octopus and squid, oysters and 'purple-shells' are examples. There were also observations of fossil fishes and molluscs, and geological inferences, undeterred by Archbishop Usher. The picturesque accounts of fishes' characters and mode of life are not so fanciful as they seem; some are confirmed by modern observers. The female *scarus* may not insert its tail in a fish trap to enable its mate to escape; but the writer of these lines has seen the decoy fish in its bucket ready to be paraded along the rocky refuge of the *scarus*-shoal. Many fishes, too, make noises; if not calls, and perform extraordinary feats of agility, and of endurance on land. In this mass of minute detail there are almost no misprints: p. 191, *aestate* for *aetate*; p. 205, πήγανον for ῥήγανον; p. 239, *weel* perhaps for *creel*.

The picture of the tunny-seller on a Campanian vase (frontispiece) exactly confirms the dissection of the tunny described on p. 88. There are many line drawings, from Yarrell and other standard works, and from Egyptian frescoes.

May the author long enjoy the grateful appreciation of fish-lovers and etymologists. J. L. Myres

THE RACE FOR OIL

American Oil Operations Abroad

By Leonard M. Fanning. Pp. ix+270+93 plates. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 20*s*.

"IT is even probable that the supremacy of nations may be determined by the possession of available petroleum and its products." This quotation, from President Coolidge, appeared on the title-page of a book by Ludwell Denny published in the United States in 1928 under the challenge "We Fight for Oil". This caused a sensation at the time, largely because it developed in no uncertain, often hostile, terms the theme of Anglo-American rivalry ('oil war' that author called it) in a race to secure the world's major oil resources outside the United States. Much has happened since this supposed 'menace' to world peace was so bitterly proclaimed, and those who remember the stir caused at the time by this strongly anti-British thesis will read with considerable interest another American's survey of how that fight has been carried on since the end of the First World War up to the present time.

"American Oil Operations Abroad" again has for its purpose the "most vital issue before the world and the American nation to-day—the international oil situation"; but the story is told, on the whole, with more carefully balanced facts and less Anglophobia than pervaded the earlier volume mentioned.

To appreciate fully the purpose of this book, one must try to read it wholly through American eyes. The atmosphere created by the author, probably intentionally, is one of 'look what we have done in the teeth of unmitigated opposition'. Implicit in this is the underlying theme that 'nobody else could have done anything like so much and so well'. Accept this for the moment as the reviewer's over-statement and see where it leads. The record is impressive.

The United States must look abroad for oil, partly in fear of declining home resources, mainly to expand foreign business and to acquire political, military and defensive advantages as widely spread over the world as possible. But oil only occurs in restricted regions, many of these in countries where wide open spaces prevail and standards of civilization are, to say the least, scarcely those of the western hemisphere. Once foreign oil invasion starts, political risks are taken by all nationals concerned. Even expropriation and seizure of oil properties by governments within the domain of which foreign operations are in full swing must be faced. Economic risks revolve mainly around the time-lag between prospecting operations and actual oil production: millions of dollars are involved in this phase alone. Struggle for a share of the world's oil centres mainly in the Caribbean countries and Middle East: it still goes on. Participation in foreign oil markets is part of an international trading treaty worked out by the United States and Great Britain, but so far not ratified. Aside from these aspects, however, are enormous economic, social and educational advantages to foreign nationals when successful enterprise opens up their countries' storehouses of oil. These are the main considerations of this book. Its perusal leaves one with confirmed feeling that the international oil war is indeed on, with yet one more protagonist in the field than Denny counted upon.

In much the author writes, there will be wide understanding by British petroleum technologists and economists. But perhaps the real picture of the situation will remain blurred until someone writes a counterpart volume on what British oil interests have done abroad, over a longer period of time than American interests, with at least all the same hazards faced and overcome, and with far less experience of an indigenous oil industry to work on than our more fortunately placed friends overseas.

H. B. Milner

"WHEN THE PIE WAS OPENED"

Mathematische Werke

Von Johann Heinrich Lambert. Band 1: Arithmetik, Algebra und Analysis, 1. Herausgegeben von Andreas Speiser. Pp. xxxi+358. (Zürich: Orell Füssli, 1946.) 25 Swiss francs.

VERSATILITY is the most delusive of the fairy gifts; the men of genius on whom it was bestowed otherwise than in subtle malevolence can be counted on the fingers. In the age of Euler himself, Johann Heinrich Lambert shone by his own light, not as a reflexion of the great luminary, and had he consented to be only a mathematician, the course of mathematical history would have been different. But condemned by the humiliations of his early life to demand intellectual submission from everyone he met, Lambert could not bear the thought that there were branches of learning of which he was not a master, or stimuli to which his mind did not respond. Asked by the King of Prussia, "What do you know?" he answered, "Everything, sire"; and to the further question, "How did you learn ?", the reply was, "I taught myself". His contemporaries were duly impressed by the range of his knowledge, and if the solipsistic manner of which we are told suggests that he often knew that he was relying on a bluff which might easily be called, his portrait, which we can study for ourselves, suggests that he thoroughly enjoyed the sensation of carrying off the bluff.

An edition of Lambert's writings has now been planned on a generous scale; pure mathematics is to be followed by applied mathematics, geometrical drawing, astronomy, physics, philosophy, and logic, and the finest workmanship in Switzerland is being employed on the production. The first volume is a delight to handle and to read. It contains Fermey's *Éloge*, and papers on elementary trigonometry, on continued fractions, on the solution of equations, on rectification and quadrature, and on interpolation, introduced by Prof. Speiser in a brilliant critical commentary. The celebrated series for the power of a root of the equation $x^m + px = q$, which moved Euler to enthusiasm, is in the first paper. Lambert's first paper on the quadrature of the circle, which is well known from Rudio's reprint of 1892, is here, with its fallacies neatly exposed by the editor; the paper in which Lambert did establish the irrationality of π is to come in the next volume.

One complaint must be made. With one exception, the papers are reprinted from the collection prepared by Lambert himself (Berlin, 3 vols., 1765–72), and the references are to this edition, with no indication of the date of composition or first publication; the omission deprives us of any time-scale for the development of Lambert's ideas, and will be even more serious when we come to correlate his work in pure mathematics with his other investigations.

In conclusion, the directorate of the Schnyder von Wartensee Foundation and Dr. R. G. Bindschedler are to be applauded for meeting the costs of this undertaking. The time has perhaps gone when a wealthy patron could usefully build a telescope, or a charitable institution could found a chair, for if telescope or professorship is wanted a modern community is not slow to provide it from public funds. There are worse ways of buying a claim to be remembered in the republic of letters than the endowment of a worthy definitive edition; a bid in the grand manner has been made on behalf of the Schnyder von Wartensee Foundation, and we commend the example to puzzled decimillionaires.

E. H. Neville

OSCILLATORY TIME-SERIES

Contributions to the Study of Oscillatory Time-Series

By Maurice G. Kendall. (National Institute of Economic and Social Research Occasional Papers, No. 9.) Pp. viii + 76. (Cambridge: At the University Press, 1946.) 7*s*. 6*d*. net.

The classical approach to time-series was a search for hidden periodicities, observational error being considered the only obstacle to accurate prediction, and there is no doubt that it was the striking success of the associated methods in astronomy and tidal theory which led to the confident belief that they might be equally relevant to the study of social phenomena. Now, however, in this and many other fields one prefers to work with a quite different model, in which the time-series is generated by a linear operator supplied with a random input. (A pleasing example is the music made by a sea shell.) The resulting series, though in general oscillatory, will not be periodic, and the possibility of prediction will be severely limited by the continued occurrence of random changes in phase and amplitude.

Mr. Kendall's monograph discusses all existing methods of time-series analysis in relation to one of the simplest of these models, Yule's autoregressive scheme defined by

$$u_t + au_{t-1} + bu_{t-2} = \varepsilon_t.$$

Here u_t describes the time-series and ε_t the random input; a and b are constants and the linear operator can be found by solving the difference equation. The book contains much useful computational advice together with a new set of tables for harmonic analysis. The correlogram and periodogram analyses of four artificial series of great length supply the first empirical evidence about the relative value of these two methods, and this part of the work is sure to stimulate much further research. The labour involved in the work must have been very great, and the debt already owed to its author by the statistical world has been correspondingly increased.

Mr. Kendall's chief conclusion is that the periodogram analysis of autoregressive series is misleading and not worth the labour involved, but his case seems to me to be overstated. The greater share of condemnation really belongs not to the periodogram itself but to the classical (here inapplicable) method of interpretation. Recent work by the late Prof. P. J. Daniell[1] suggests that a *smoothed* periodogram might be of much diagnostic value, and one would like to see Mr. Kendall's sample periodograms compared with their expectation forms. Daniell also showed[1] that the *sample* periodogram and correlogram are algebraically equivalent, so that each contains exactly the same information; a very interesting consequence of his identity is that the smoothed periodogram depends mainly on the first few sample autocorrelations. Mr. Kendall's observations should also be compared with recent work by Prof. M. S. Bartlett[1] on sampling properties of the correlogram, which explains the failure to damp according to expectation when the series is of finite length.

The present debate about the best definition for the 'period' of an autoregressive series seems to me of doubtful value. What we need in practice is not a period of recurrence so much as an estimate of the time from the present boom to the next slump (and conversely). This might well be measured by the location of the principal negative minimum in the correlogram, and the ordinate there would indicate the degree to which the series was oscillatory. (Bartlett[2] has already pointed out the need for distinguishing between *oscillatory* series and those which are merely *fluctuating*—Kendall's series 2 is an example of the latter type.)

I am puzzled by equation (6·8) for the "m.d. (peaks)", because the latter expression has several possible meani[illegible] number of peaks per unit length of se[illegible]be the quantity actually determined, [illegible] course, equal to the reciprocal [illegible]sion.

[illegible]avid G. Kendall

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[1] Bartlett, M. [illegible]*Supp.*), 8, 27 (1946).

[2] Kendall, M[illegible]945), especially p. 136.

Advanced Calculus

By Prof. David V. Widder. (Prentice-Hall Mathematics Series.) Pp. xvi + 432. (New York: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1947.) 36*s.* net.

THE subject-matter contained in this volume is, broadly speaking, that encountered by a student taking an honours course in pure mathematics, and within some four hundred pages the author has succeeded in discussing a wealth of valuable material. Considerable care has been taken with the mode of exposition, particularly as regards the framing of the definitions and the arrangement of the theorems, in each of which the hypothesis, proof and conclusion are elegantly presented.

In addition to the usual topics which feature in books of this kind (such as partial differentiation, infinite series, limiting forms and the various types of classical integral), there are chapters dealing with vector methods, applications of the calculus to differential geometry, Stieltjes integrals, Fourier series, and the Laplace transform. The notation employed, being that now current in the United States, differs quite substantially in many places from that used in Great Britain as do, to a less extent, some of the methods of proof. No serious disadvantage, however, need result from these causes, as any student for whom this book was designed would inevitably possess considerable skill in elementary manipulation and should, in consequence, experience no difficulty in following Prof. Widder's lucid and concise arguments.

Although present-day austerity precludes the use of paper of a quality worthy of such a work, the printing is of a very high standard. A large collection of valuable examples, many of which are worked as illustrations in the text, is also provided.

J. H. PEARCE

Good Health to the Garden

How to Combat the Pests, Diseases and Weeds of Vegetables. Pp. 48. (Yalding: Plant Protection, Ltd., 1946.) 3*s.* 6*d.* net.

THIS is an attractive book, well printed, and beautifully illustrated from water colours by Dorothy Fitchew. It deals with the commoner pests, diseases and weeds likely to be encountered among vegetables in the home and allotment garden. The brevity of its text should also appeal to amateur horticulturists, who are often overpowered by a compendious treatment of garden difficulties alone. Eleven pests and the same number of diseases are described, with control methods based on general treatment and 'Plant Protection' products. One short section deals with friends of the garden, while general pests such as wireworms, millepedes, cutworms and leather jackets are also discussed and figured in colour. This is one of several such books projected by Messrs. Plant Protection, Ltd.

Wild Flowers of the Chalk

By John Gilmour. (King Penguin Books, K.37.) Pp. 31 + 16 plates. (Harmondsworth and New York: Penguin Books, Ltd [illegible]) 2*s.* 6*d.*

THIS is another of [illegible]ng Penguin series depicting wil[illegible]ng to their habitat. J. S. L. Gilm[illegible]s formerly assistant director at [illegible]c Gardens, Kew, and is now di[illegible]rticultural Society's Gardens[illegible]ches have been mainly ecological, so it can be taken for granted that the text is authoritative and up to date.

Gilmour discusses the origin of the chalk flora, both 'characteristic' and 'non-characteristic', then considers in more detail such chalk habitats as downs, dykes and earthworks, grassy knolls, cliffs and chalk pits, beechwoods, roadsides and hedgerows. Though a few species are comparatively rare, the reader should have little difficulty in finding most of the flowers in their season. It is impossible to rate too highly the sixteen-colour plates prepared by Irene Hawkins. No one could fail to identify a plant thus illustrated; but apart from this, each plate is a work of art. This book, small though it is, is one which every field naturalist should possess.

A Handbook of Sociology

By Prof. William F. Ogburn and Prof. Meyer F. Nimkoff. (International Library of Sociology and Social Reconstruction.) Pp. xi+644. (London: Kegan Paul and Co., Ltd., 1947.) 25*s.* net.

PROFS. OGBURN and Nimkoff's contribution to the well-known International Library of Sociology and Reconstruction maintains the high standard which one has learned to expect from this series and, in many respects, may be rated as the most useful source-book in sociology yet produced. Looking at social life as the interaction of four factors: the biological organism, geographical environment, group processes and cultural heritage, the authors first discuss the principal conclusions of biology, psychology, geography and other disciplines in their relations to sociology, and then proceed to the fundamental facts, basic concepts and theories which form the body of sociology proper. In the latter section the book touches its highest level and, in the chapters on the family and religious institutions, the rational approach to subjects which are usually clothed with emotion and sentiment deserves careful study by all who are seeking to unravel the complexities of the behaviour of individuals in groups.

T. H. HAWKINS

Mammals of Eastern Asia

By G. H. H. Tate. (Pacific World Series.) Pp. xv + 366. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 20*s.* net.

THE ill wind has blown its proverbial good. Until now there has been no general work on mammals of eastern Asia, and it took the War to produce one: Dr. Tate wrote this book for the benefit of soldiers interested in natural history. The scope of the book is the mammal fauna found from north-eastern Siberia to Singapore, and from the Gobi Desert and Lake Baikal to the western shores of the Pacific. The mammals of the Japanese islands are also included, but not those of the East Indies, which have already been dealt with in a companion volume, "Mammals of the Pacific World", 1944, by Dr. Tate in conjunction with T. D. Carter and the late J. E. Hill.

"Mammals of Eastern Asia" is really an illustrated, descriptive checklist, and with its help the amateur naturalist should be able to identify most mammals occurring in the area. This book, though it sets out to cater for the amateur, will be found invaluable by the professional zoologist, since it contains much information which is only to be found otherwise in scattered papers.

T. C. S. M.-S.

RECENT MOSQUITO ERADICATION CAMPAIGNS

By Dr. J. R. BUSVINE
London School of Hygiene and Tropical Medicine

UNFORTUNATELY, it is exceedingly difficult to exterminate insect pests over a large area (not to mention the whole world), because of their enormous numbers, small size, and powers of proliferation. Therefore, we have come to be satisfied with 'control' as an objective; and so far as mosquitoes are concerned, control measures are considered satisfactory if they reduce the mosquito population below the 'critical density' necessary for the propagation of disease.

In recent years, however, the feasibility of eradication of mosquitoes from large areas has been demonstrated by the remarkable work directed by Drs. F. L. Soper and D. Bruce Wilson in Brazil. Their two original campaigns seem to have been entirely successful in achieving their objectives; by a few years of intensive work it has been possible to replace widespread and continuous control measures by a relatively small and inexpensive 'quarantine' service.

It will be recalled that the two insects attacked were *Aëdes ægypti*, the yellow fever mosquito, and *Anopheles gambiæ*, the dangerous African malaria vector. Both these mosquitoes are comparatively restricted in their choice of breeding sites to places in, or close to, the haunts of man. Furthermore, *An. gambiæ* was not indigenous in South America (though it appeared to thrive in Brazil). For these reasons the problems were simpler than they might have been. This should not be taken to belittle the many difficulties of organisation, which were overcome so successfully as to provide a model for subsequent eradication schemes.

General Organisation of an Eradication Campaign

The first essential is a survey of the territory by an entomologist with experience of anti-malarial work. This survey is particularly important when the object of eradication is a mosquito not normally present, and where the area invaded must be defined. On the basis of the preliminary survey, and with the aid of large-scale maps, estimates must be made of the staff, equipment and supplies necessary.

The main attack is made against the larval stage of the mosquito. Every suitable breeding site in the entire eradication area must be treated periodically, to prevent breeding for a sufficient period to ensure extermination of the species concerned. Success depends upon the continued thoroughness of a large number of workmen recruited locally (and, possibly, of doubtful reliability). These men can seldom be directly supervised for more than a small fraction of their working time, owing to the vast scale of the operations. The only workable solution is to make each larviciding team (possibly consisting of only one man) responsible for a defined zone, and to have an independent checking service to assess the progress of the work in each zone. The zones are grouped together in sections, and these again into divisions in the charge of a small hierarchy of officers. The lower grades can be recruited locally and trained, whereas the higher ones should be experienced malariologists or at least biologists, medical men, or engineers. All officers must be able to speak the local language.

A highly important part of the organisation (which absorbs about 25–30 per cent of the expenses) is the checking staff, whose duties consist in continually searching for larvæ or adult mosquitoes. Those 'scouts' seeking larvæ systematically check the work of the larviciders; the scouts seeking adults visit suitable 'catching stations' such as human or animal houses likely to be frequented by mosquitoes. The reports of the searching staff provide a means of independently checking the efficiency of the larviciders and assessing the progress of the campaign; negative reports are, of course, as important as positive ones, but require more careful verification. Arrangements are made for specimens of larvæ or adult mosquitoes to be preserved and sent to an entomological laboratory at headquarters for identification.

In order to systematize methods and records, a considerable series of printed instructions and recording forms is necessary. Regional chiefs are required to know exactly what all their subordinates should be doing on any day, so that their activities can be checked by random visits from headquarters. The headquarters staff inevitably become largely occupied with ordering and distribution of equipment and supplies, the engagement and promotion of staff and the solving of difficulties which arise in the work. Once the methods have been decided upon, eradication becomes an exercise in administration rather than an exclusively scientific or technical occupation.

It may now be of interest briefly to describe and compare three recent eradication undertakings, which display some evolution towards more ambitious objectives. I was privileged to witness the latest one (in Sardinia) in its comparatively early stages.

Anopheles gambiae in Upper Egypt

In 1942 there was a severe epidemic of malaria in upper Egypt, followed by another in 1943. Conservative estimates place the number of cases at 200,000, with a death-rate around 10 per cent. The vector was found to be *An. gambiæ*, which does not normally occur in this region, though it is found in the Sudan. There is a possibility that the northern range of this mosquito fluctuates from time to time, and it may thus penetrate into Egypt. The invasion prior to the 1942 outbreak was very considerable, for the mosquito was found to be breeding along a strip of the upper Nile 850 km. (530 miles) long, and varying from 1 to 30 km. (20 miles) wide. The mosquito had some difficulty in maintaining itself in this area; the winter (December to March) is too cold, and the summer (April to August) is too dry. However, the autumn is warm and moist, and there is great proliferation during September to November. *An. gambiæ* certainly survived from 1942 until 1945 in upper Egypt.

To combat the mosquito, the Gambiæ Eradication Service was formed with funds supplied by the Egyptian Government, administered by Dr. S. Madwah, the eradication programme being directed by Dr. J. A. Kerr, of the Rockefeller Foundation. In addition, there we[illegible]t various times thirty to fifty medical men or [illegible]rs supervising the work, the senior ones i[illegible] of the ten main divisions. Smaller are[illegible]r the control of inspectors (senior sa[illegible]) and foremen. The earlier treat[illegible]hanged to Paris Greening, wh[illegible]ler in the circumstances. S[illegible]lied the insecticide, each m[illegible] cover, in which all [illegible]y. The area of the zones varied from 0·2 to 9·2 sq. km. The eradication campaign depended basically on the anti-larval attack, but, in addition, there was some house-spraying with pyrethrum against adults in malarious areas, and also spraying of vehicles to prevent insect transport. The progress of the work was watched from the reports of an army of 'larval scouts' and 'adult searchers'.

The Paris Green treatments began in August 1944, and reached a peak in October; the last specimen of *An. gambiæ* was found in February 1945. Treatments were continued for six more months, and then stopped in the most favourable mosquito season. A careful search was continued for three months, but no more *An. gambiæ* were discovered. It is important to note that whereas the invading *gambiæ* was eradicated, other mosquitoes native to the region gradually reappeared. They are evidently more difficult to exterminate.

Anopheline Eradication in Cyprus

The mosquito eradication campaign in Cyprus, organised by Mr. Mehmed Azis, is novel in two respects: it aims at extermination of all *indigenous* mosquitoes from the island, and it was begun without the impetus of a disastrous malaria epidemic. The programme was undertaken as a measure of permanent improvement of the state of the colony; since, in spite of its arid appearance in summer, Cyprus is highly malarial. The chief vectors are *An. superpictus*, which breeds in very small shallow pools, often difficult to find; *An. sacharovi*, a marsh breeder; and *An. bifurcatus*, which breeds in wells. The last-mentioned species presents a special problem, for the local people often resent the application of larvicide to their only source of water.

The eradication programme in Cyprus was different from the other operations discussed in that it was planned to cover the island in three sections, one in each year, with an overlapping protection fringe to prevent reinfestation of the zone under treatment. As a consequence, a smaller staff was required. The eradication was based on anti-larval measures, and *D.D.T.* solution was used for the first time in an eradication project. Treatments were applied weekly in the plains and fortnightly to sites above 2,000 ft. The areas covered by each larvicider were 25–80 sq. km. (10–30 sq. miles); these were divided into sections for treatment on the various days of the week. Only one or two litres of spray were required for each day's work, and the small amounts required were applied by hand atomizers. In addition to the larvicidal work, a limited amount of drainage work was done to eliminate marsh-breeding forms. There was an attempt to prevent transport of mosquitoes in vehicles by spraying them regularly at certain points on the main roads. The progress of the work was assessed, as usual, by an independent checking staff. In the first year (1946) the work was confined to the long narrow Karpas peninsula, which constitutes a seventh of the total area of the island. This relatively easy task was chose[illegible]r the first year to accustom the workers to th[illegible]k. The Karpas peninsular was apparently c[illegible] mosquitoes in the first season and, at the ti[illegible] about half the remainder of the island [illegible]ith in the second season.

Mosquito Era[illegible]

Moderately serious [illegible], about 10 per cent of [illegible]; this is worse than anywhere in Sicily or Italy. The only important vector is *An. labranchiæ*, which is found at greater altitudes than on the mainland. In 1946 it was decided to use certain funds acquired from the United Nations Relief and Rehabilitation Administration, and controlled by a commission of the Italian Government, to create a mosquito eradication organisation. This project was directed by Dr. J. A. Kerr* of the Rockefeller Foundation, International Health Division, with a British, American, and Italian headquarters staff. The island was surveyed in 1946 and eradication work begun in 1947. As before, the chief reliance was placed on anti-larval work which, as in Cyprus, is being done with 5 per cent *D.D.T.* solution applied from hand atomizers. The average-sized zone for treatment by one man is 10 sq. km., and this is divided into six sections, to be visited on successive weekdays. In contrast to earlier campaigns, an extensive *D.D.T.* house-spraying programme has been employed. About 90 per cent of all dwellings on the island have been spray-painted with a *D.D.T.* emulsion to give a residual insecticidal film. This will be repeated again in the early spring of 1948 and, possibly, in 1949.

The anti-larval work of the first year was confined to an area in the south-west, comprising about a fifth of the area of the island. This is for the training of operators and to test the organisation. In the following year it is proposed to cover the entire island and treat all breeding sites weekly throughout a thirty-six-week breeding season. The progress of the work will be judged from the reports of the usual checking staff, and in the third year of the planned programme, after the cessation of the anti-larval spraying, they will continue to search for mosquitoes to verify the eradication.

Discussion

The success of the earlier campaigns and the experience gained in them has led to the more ambitious objectives of the two latest projects. These involve three new difficulties: (1) the mosquitoes attacked are indigenous; (2) the mosquitoes attacked breed in sites remote from human habitations, and are quite ready to feed on mammals other than man; (3) in both areas there are considerable tracts of rough country, far from roads, to be treated.

To balance these formidable difficulties, there is the introduction of the powerful new synthetic insecticides and the fact that both areas are islands. The value of *D.D.T.* in the larviciding work is very great, for it substantially reduces the amount of equipment which may have to be carried all day over difficult country. The only insecticidal impedimenta required for a day's work is a hand atomizing gun and a litre or so of 5 per cent *D.D.T.* solution. *D.D.T.* has also been used for residual treatment of houses throughout the experimental area; but it appears to me to be of somewhat doubtful value in eradication, when the vectors can be found breeding in large numbers in sites remote from houses. The disadvantage consists in the fact that all treated buildings are lost as catching stations; and, in eradication, the whereabouts of the last surviving mosquitoes is important. House treatment with *D.D.T.* is, admittedly, clearly of value in malaria control and it also has the advantage of killing other insect pests; the latter fact sometimes ensures the co-operation of the inhabitants.

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* I understand that Dr. Kerr has retired for reasons of health and that Dr. J. A. Logan has taken his place.

APPROXIMATE OVERALL STATISTICS CONCERNING ANOPHELINE ERADICATION PROJECTS

Zone	Anopheline species	Area involved	No. of men employed	Total time	Cost £1,000's*
Brazil	*gambiæ*	?	2000	3½ yr.	530
Upper Egypt	*gambiæ*	4,100 sq. km. 1,500 sq. miles	4000	2 ,,	800
Cyprus	*superpictus*, *sacharovi*, etc.	9,300 sq. km. 3,600 sq. miles	100	3 ,,	15 (7 months)
Sardinia	*labranchiæ*	23,000 sq. km. 9,000 sq. miles	6000†	3† ,,	more than 500† a year

* On the basis £1 = 4 dollars = 2,000 lira.

† Estimates.

Some overall statistics of the anopheline eradication campaigns are given in the accompanying table. It should, however, be pointed out that such operations are very difficult to compare by the use of such overall figures, or by examining small-scale maps. For example, the area which can be covered by a single larvicider will depend not only on the number of breeding sites present and the ease of travelling, but also on accessibility from sleeping quarters. Some labourers may be unwilling to leave their homes and enter a temporary unusual occupation, especially if they have relatively lucrative local employment. For such reasons as these, there may be manifold differences in the difficulties encountered in such operations in different areas; nevertheless, it cannot fail to be noticed that the Cyprus venture appears to be very much less expensive than the other ones.

It is too early to give an estimate of the chances of ultimate success of the campaigns now in progress. My visit to Sardinia strongly impressed me with the difficulties of adequately supervising work over such a large and inaccessible area. These latest eradication schemes demand all the faith and energy, as well as the technical and administrative skill, which are being devoted to them.

SCIENTIFIC RESEARCH IN THE BRITISH ZONE OF GERMANY

By PROF. F. A. PANETH, F.R.S.
University of Durham

FOR the second time within a period of thirty years, science in Germany is struggling for its existence; but the problems of to-day are different from those of 1918, and so are the ways and means by which a solution is being attempted.

When, after the First World War, Germany had collapsed, the greatest menace to the maintenance of its scientific standing was, besides the financial weakness of the country, the severing of all international relations. German men of science had done more than their colleagues in other countries to help their Government, and especially the systematic study of the possibilities of poison gas as a method of warfare was deeply resented by the Allies. It took a long time before Germans were permitted to participate again in international meetings, the delay being largely dependent on the share taken in war-work; German astronomers were admitted years before German chemists. In these circumstances, only a national effort could save the position of German science; but the complete exhaustion of all the usual financial resources seemed to present an insurmountable obstacle. It was mainly the foresight, energy and organising genius of one man, Fritz Haber, to which the preservation of the high level of German science was due: while traditionally only the 'Länder' were the supporters of university activities, he convinced the authorities of the 'Reich' that in this emergency they had to provide ample funds for scientific work of every kind. Under his influence the Notgemeinschaft der Deutschen Wissenschaft came into being, and science in Germany continued to flourish.

To-day the material position of the scientific institutions in Germany is infinitely worse than it was after the First World War; but, on the credit side, it can be stated that there is little sign of any moral discrimination between men of science inside and outside Germany. This is no doubt due to the fact that this time support of the Governments was certainly more whole-hearted in the Allied field, right up to the perfection of the most powerful weapon of aggression. Immediately after the armistice, contacts were made between the scientific workers of the Allied countries and their German colleagues. The first object was to obtain all possible information for the benefit of the Allies; but these discussions could not fail to result in the awakening of the old spirit of international solidarity so sadly interrupted during the War, and to-day it is very pleasant to see the efforts made by the occupying Powers to reactivate scientific life and research in Germany. There are differences between the four zones of occupation, and in some regions the endeavour went mainly in the direction of uprooting and transplanting scientific installations and workers, instead of giving them a fresh opportunity in Germany. Moreover, it seems that even members of the universities who had been dismissed as a consequence of the unfavourable verdict of a denazification tribunal were often tempted by offers of employment in other countries, previous enthusiastic support of the Nazi war machine now being no obstacle. Much more evident, however, at least in the British Zone, is the understanding help given by the Allies to all attempts at reviving the scientific activities inside Germany.

As a consequence of the country's unconditional surrender it was entirely for the Allies to decide how much scientific research should be permitted in Germany. The rules were laid down in the Allied Control Council Law No. 25, the object of which is "to prohibit for military purposes scientific research and its practical application, to control them in other fields in which they may create a war potential and to direct them along peaceful lines". A number of subjects are specifically mentioned as prohibited: for example, applied nuclear physics; applied aerodynamics; ship construction; the detection of objects by electromagnetic radiation. Work on other problems requires prior permission, as, for example, research on broadcasting and television, electronic valves, ball bearings, and radioactivity other than for medical purposes. Detailed regulations have been issued for the procedure according to which applications for permission, and periodical reports on the work done, have to be submitted to the Control Council.

It is clear that the effect of Law 25 on German science will depend on the spirit in which it is interpreted; and that spirit, in the British Zone, is very favourable. Göttingen, one of the few university towns in Germany where war damage has been negligible, has been chosen as scientific headquarters. Here the office of the Research Branch of the Economic Subcommission of the Control Commission has been set up; its scientific adviser is Dr. R. G. J. Fraser. Plans are under way to create in Göttingen a substitute for the former research centre of Berlin-Dahlem, where a great number of the famous institutes of the Kaiser Wilhelm Gesellschaft were situated, and which no longer exists. The Allgemeine Versuchs-Anstalt (AVA) in Göttingen is not only using existing buildings but also planning to erect new ones to house institutes for physics, fluid flow, brain research, instrument design, and particularly medical research, to which special assistance will be granted.

The support given by the Research Branch and its officials to German science is by no means confined to the Göttingen complex. A new institute for the standardization of physical quantities, in the tradition of the former Physikalisch-Technische Reichsanstalt, is in course of formation in Volkenrode (near Brunswick). Another sphere of the Research Branch's activities is in the newly created learned societies; because of their official Nazi affiliations the German Physical Society, the German Chemical Society, and many similar ones were disbanded; but a new German Physical Society in the British Zone held its second conference in Göttingen at the beginning of last September (see *Nature*, November 22, 1947, p. 723), to be followed a month later by a meeting in Bonn of the Society of German Chemists in the British Zone. Both meetings were attended by a number of foreign scientific workers.

It is well known that in certain branches of chemical documentation Germany had been leading for many decades; no reference work on organic chemistry can compare with "Beilstein", none on inorganic chemistry with the eighth edition of "Gmelin", both of which are publications of the German Chemical Society. Both are still incomplete, and it is very gratifying to learn that, after a period of uncertainty following Germany's collapse, provision has now been made for their continuation. "Beilstein" will be re-organised in the American Zone, but some difficulties may be expected owing to the loss of a few of the senior members of the original editorial staff; "Gmelin", on the other hand, is fortunate in that practically the entire staff is now re-assembled in the British Zone, as the Gmelin Institute for Inorganic Chemistry and Related Subjects. Its new organisation presents some interesting features, so a few more words may not be amiss.

In Clausthal, near Göttingen, buildings of a munition factory had been scheduled to be blown up by the army; thanks to the intervention of the Research Branch, the administrative block was spared, in which at the moment the chief editor of "Gmelin", Prof. E. Pietsch, and about fifty of his old helpers have not only their offices but also living quarters for themselves and their families. The great hardships of life in present Germany are thus mitigated; the housing problem is solved, and the purchase of fuel and food is a community affair. The beneficial influence on the scientific productivity of the "Gmelin" staff is very obvious; and as, fortunately, a photographic copy of the 900,000 odd reference cards which the staff had prepared in the course of twenty years has been saved (although the originals were destroyed by fire), the editor's hope of completing the new edition of "Gmelin" in ten years may well come true.

There is probably no scientific worker in Germany who would not appreciate the help given by the Allies in the revival of the various scientific activities, though some seem to think that the possible control of their work by international committees is no unmitigated blessing. It would certainly be regrettable if control, or even advice, should go so far as to make work appear international which is, in fact, due to the efforts of German specialists. In this connexion we should like to refer again to the very different situation which existed in Germany after the First World War, when the necessity of keeping science in Germany alive by its own exertion, against international detachment or even hostility, proved to be in itself a potent force in its recovery. One can understand that to-day there is in some quarters a slight resentment against too much patronizing from outside; but what seems to some justified national pride may easily be denounced by others as a remnant of Nazism. All the steps taken by the British Control Commission with respect to scientific activities in Germany have to be viewed against a very complex psychological background; considering that such difficulties are added to those due to the hard material conditions, everyone will gladly acknowledge that, thanks to the Research Branch of the Control Commission, a great deal has already been achieved, and that one can cherish very good hopes for the future.

WATER MOVEMENTS AND EARTH CURRENTS: ELECTRICAL AND MAGNETIC EFFECTS*

It is a consequence of Faraday's law of electromagnetic induction that when a large body of water moves in the presence of the earth's magnetic field, an electromotive force is set up across the direction of motion. Faraday himself said that the tidal streams in the English Channel would generate electric currents across the channel, through the sea, and returning through the land beneath the water. Twenty years later (1851) he was satisfied that fluctuations observed by Charlton Wollaston on the first submarine cable between England and France were due to this effect. Other early observations tended to confirm the connexion of the tides with earth currents in submarine cables and in coastal regions.

No serious study of the subject was made at the time, but a great step forward was made in 1918 when Young, Gerrard and Jevons made a series of experiments with electrodes in the sea at Dartmouth, and Decheverens demonstrated the dependence of the fluctuating earth-current on the tides in one of the Channel Islands. Another striking contribution was made by Cherry and Stovold, who observed fluctuation of tidal periods between the English and French coasts when Post Office cables were being renewed after the Second World War, the largest differences being as much as 0·8 volt. Several Admiralty departments have also observed submarine fluctuations of tidal period, and the subject is being studied at the Admiralty Research Laboratory. A possible application is that once a suitable calibration has been made, the potentials, in sea or land, may serve as a routine method of measuring tidal streams or other water flow.

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* Substance of papers by N. Barber and M. S. Longuet-Higgins, Admiralty Research Laboratory, read at a Geophysical Discussion on "The Electrical and Magnetic Effects of Marine Currents" held at the Royal Astronomical Society on November 27.

The gradients are detected by a high-resistance galvanometer the terminals of which are connected to non-polarizing electrodes placed a mile or so apart on the sea bottom, or down wells near the coast. The potential gradients are of the order of 10 millivolts per kilometre. Evidence that the tidal potential gradients and the electric current associated with them are due to the motion of the tidal streams through the earth's magnetic field is provided by the following observations : (1) The potential gradient in the sea is directed approximately at right angles to the direction of water flow. (2) The times of maximum potential gradient coincide with the times of maximum velocity of the tidal stream. (3) The English coast is positive with respect to the French coast when the tidal stream is flowing east. (4) The potential gradient in the land is directed in the opposite sense to the potential gradient in the sea : when the potential of the English coast is positive, the point of highest potential is on the coast and the potential is less at points farther inland or out to sea.

If the moving water in the Channel acts as a tidal dynamo, the electromotive force to be expected can be estimated from the known velocity of the tidal streams and the vertical intensity of the earth's magnetic field. The estimated electromotive force between the English and French coasts at the time of maximum stream is 3 volts, which is about four times as much as the observed potential difference. The reduction can be attributed to the flow of electric current : when the English coast is at a positive potential the current flows northwards through the water, and after spreading outwards and downwards into the land returns in a southward flow below the sea bed, so that the tidal dynamo is short-circuited. In the water the electric current density is estimated to be about 10^{-8} amp. per square centimetre when the tidal streams have their maximum velocity ; but in the land, and below the sea bed, the current density is presumably very much less.

If the magnetic field produced by this presumed flow of electric current could be measured, it would give further valuable evidence of the phenomenon ; but since the flow of current is solenoidal it can be expected to produce little or no magnetic field on the earth's surface. On the sea bed in the English Channel at a depth of 100 metres, the flow of electric current may produce a tidal variation amounting to ± 10 gamma in the east–west component of magnetic field ; but in the land near the coast at a depth of 1,000 metres the variation of magnetic field may amount to less than 1 gamma, since the current density in the land is so much smaller. No observations of this nature have yet been made.

The observation of tidal potential gradients is usually complicated by more rapid and irregular variation of potential gradient due to earth currents associated with magnetic storms. These earth currents are observed in the sea as well as on land, and they tend to be concentrated in estuaries and channels, presumably because these provide preferential paths of low resistivity.

The magnetic fields of these concentrations make important contributions to the vertical magnetic intensity in the neighbouring coastal regions. This possibility was recognized by Van Bemmelen, who made a survey of the character of the sudden commencement of magnetic storms at a large number of observatories, and showed that the sudden changes of vertical intensity are usually of opposite signs at the Greenwich and Paris Observatories, although the two observatories are only 200 miles apart. He suggested that the difference in sign might be due to earth currents induced by the magnetic storm being concentrated in the English Channel between the two observatories.

An example taken from measurements of the east–west potential gradient in the sea off Plymouth for a minor magnetic storm with a sudden commencement at 2240 hr. on August 30, 1946, when the horizontal intensity changed by 65 gamma in an interval of about three minutes, shows that the east–west potential gradient in the sea increased by 60 millivolts per kilometre at the same time. Assuming that such a potential gradient was present in the whole of the English Channel, it can be inferred that a current of about 3,000 amp. was flowing at the time. Such a current flowing fifty miles from the Observatory at Abinger would produce there a vertical magnetic field of 7 gamma, an appreciable part of the 12 gamma which was actually measured.

Although there is some indication that earth currents localized in the English Channel may produce appreciable magnetic changes at Abinger when the period of the change is as long as an hour, the effect of earth currents should be more important in variations of shorter period. Experiments in the narrow channel between Cumbrae and Bute in the Clyde estuary suggest that earth currents in this and neighbouring channels are the main source of fluctuation of magnetic field as far as periods less than 10 min. are concerned ; but for longer periods (greater than 30 min.), the direct magnetic effect of the overhead electric currents becomes of increasing importance relative to that of the earth currents. The study of short-period variations in the earth's magnetic field must, therefore, take account of possible secondary effects due to earth currents concentrated in a channel or arm of the sea.

OBITUARIES

Prof. David Enskog

We learn only now, with much regret, of the death on June 1, 1947, of David Enskog, professor of mathematics and mechanics at the Kungliga Tekniska Högskolan, Stockholm, since 1930.

Born in 1887, Enskog was a student at Uppsala from 1906 until 1911, in which year he obtained his licentiate, partly for experimental work on gas diffusion. In the same year he published a short paper on the kinetic theory of gases, which contains a brief mention (the first so far as I know) of the phenomenon which since 1916 has been called thermal diffusion. In 1912 he published another paper dealing with a gas composed of electrons and molecules ; H. A. Lorentz had shown that the mean free-path phenomena for such a gas could be accurately calculated ; for this case Enskog made the first accurate calculation of the thermal diffusion coefficient.

Enskog sought without success to obtain a travelling studentship to enable him to continue his studies and research ; instead he became a schoolmaster, first at Stockholm, and later at Skövde and Gävle. He married in 1913. During the First World War he was exempted from military service on medical grounds. His years of school teaching continued until 1930, with an interlude of nine months in 1922, during which he held a travelling scholarship of the Swedish Academy of Sciences at Göttingen and Munich. During these seventeen years of school teaching, he produced a long series of papers, mainly on gas theory, but also on integral equations, nuclear structure, and radioactivity. His transfer to a university chair seemed rather to bring him new duties than increased leisure, and this, with renewed ill-health, reduced his productivity in his later years, though he continued to think and write on gas theory; one of his last papers was concerned with the absorption of sound in gases and liquids, owing to viscosity and thermal conduction.

Enskog's most distinguished work was done on the kinetic theory of gases; in his 1917 dissertation, and in a more detailed paper of 1921, he extended Boltzmann's work on entropy and the mean free-path phenomena, solving Boltzmann's integro-differential equation for any moderately rare gas constituted of spherically symmetrical molecules. His exposition was not easy, but his work had great mathematical elegance. The results were substantially the same as those that I had published in 1915 and 1916, following Maxwell's line of approach. In a subject so complicated it was advantageous to have the two independent treatments, the close agreement of which helped others to have confidence in the results. This work forms the main subject of "The Mathematical Theory of Non-Uniform Gases", by Prof. T. G. Cowling and myself, in which we expounded the theory on his lines rather than on those I had followed; the book was, therefore, appropriately dedicated to Enskog.

Enskog also did important work, yielding valuable results, on the kinetic theory of dense gases and liquids; his interest in this difficult subject was shown over many years. It seems likely, however, that the line of future progress lies along another path, recently opened up by Prof. Max Born and Dr. H. S. Green.

In 1946 the Royal Swedish Academy of Science bestowed on him its Svante Arrhenius Medal, in well-deserved recognition of the distinction of his contributions to gas theory.

Enskog was a friendly man of engaging simplicity and great modesty. His home life was very happy. He is survived by his wife and children (a son and two daughters) and grandchildren.

S. CHAPMAN

Mr. W. H. Pick

WITH the death of William Henry Pick, a principal scientific officer in the Meteorological Office, which occurred on December 26, 1947, the Meteorological Office and the Royal Air Force lose one who combined to an exceptional degree meteorological and educational ability.

Pick was born in 1891 and after graduating in science at the University of London became a teacher. He showed his interest in meteorology first by maintaining with his pupils at Queen Mary's School, Basingstoke, a climatological station sending returns to the Meteorological Office. He joined the Meteorological Section, Royal Engineers, in 1917, and after serving in France was placed in charge of the meteorological detachment with the North Russian forces in 1919; then in 1920 he joined the Meteorological Office. For the next eight years he was meteorological officer at the Royal Air Force College, Cranwell. He wrote for the cadets his book "A Short Course in Meteorology", which soon found appreciation in a much wider circle, edition after edition being called for.

After nearly four years as a senior forecaster at Meteorological Office headquarters, he was meteorological officer at Andover during 1932–38, and in the earlier part of that period was closely and fruitfully associated with twelve special investigations carried out by the R.A.F. into cloud flying with its risks of ice accretion. Advisory duties at H.Q. Bomber Command during 1938–40 were followed, after a short interlude in the Air Ministry, by duties in connexion with the meteorological aspects of smoke screening, first with the Ministry of Home Security and then with H.Q. Anti-Aircraft Command. From early 1945 until a very few days before his untimely end, he was in charge of the meteorological station at South Cerney meeting the requirements of several R.A.F. stations.

Pick wrote numerous papers published by the Meteorological Office or in the *Quarterly Journal of the Royal Meteorological Society* on visibility as affecting aviation, on the forecasting of night minimum temperatures and the persistence of types of pressure distribution. The thesis "The Teaching of Meteorology in Secondary Schools" for which, with his "Short Course", he was awarded the fellowship of the College of Preceptors particularly exemplifies his two main interests. He served on the council of the Royal Meteorological Society during 1931–36.

Pick will be missed by many members of the Royal Air Force, especially his old Cranwell pupils, to whom he had been a wise teacher and friend, and by his colleagues in meteorological circles. He was married in 1944 and leaves a widow.

Mr. John Lister

MR. JOHN LISTER, formerly head of the Mathematical Department, Chelsea Polytechnic, died at Gawsworth, Cheshire, on December 5. Born at Stockport in 1876, he went to the Royal College of Science, London, in 1895, and took his associateship in 1898 with first-class honours in mathematics, physics and chemistry as his main subjects. After two years teaching at West Ham Technical Institute, he was appointed lecturer at Chelsea Polytechnic, where he spent the rest of his teaching career, being eventually head of the Mathematical Department, until his retirement in 1927.

His wide knowledge of cognate subjects gave colour and interest to his teaching of mathematics, and the admirable lucidity of his expositions will be remembered by many generations of Chelsea students.

WE regret to announce the following deaths:

Prof. T. D. A. Cockerell, emeritus professor of zoology, University of Colorado, on January 26, aged eighty-one.

Dr. H. A. Deslandres, For.Mem.R.S., formerly director of the Observatory of Meudon, on January 15, aged ninety-four.

Mr. Orville Wright, a pioneer with his brother, Wilbur Wright, of the aeroplane, on January 30, aged seventy-six.

NEWS and VIEWS

Scientific Civil Service: Promotion of Individual Research Workers

In *Nature* of April 5, 1947 (p. 464), some details were given of a number of members of the Scientific Civil Service who, as individual research workers of exceptional quality, had been appointed to special posts created under provisions included in the Government White Paper on the Scientific Civil Service (Cmd. 6679) published in 1945. It has now been announced that, on a further review, the undermentioned members of the Scientific Civil Service have similarly been promoted to the grade of senior principal scientific officer (inclusive salary scale £1,320–£1,520) with effect from January 1, 1948.

H. Barrell (Department of Scientific and Industrial Research), the authority in Great Britain on the determination of standards of length in terms of wave-lengths of light; he has carried out much work in interferometry and its application to the measurement of accurate gauges; W. Binks (Department of Scientific and Industrial Research), who has made important contributions on the measurement of the intensity of the ionizing radiations produced by X-rays and radioactive substances; he was largely responsible for work which led to the internationally accepted recommendations for the protection of workers in this field; H. Carmichael (Ministry of Supply), who has carried out important investigations into cosmic rays and is at present engaged on instrumentation for atomic energy research; Dr. C. M. Cawley (Department of Scientific and Industrial Research), a chemist who has carried out outstanding work during the last eighteen years on the mechanism of hydrogenation of tar, oils, and pure compounds; on the production of toluene from cresol; on the development of gelled-fuels for flame throwers; and on the extraction of benzol from coal gas, and on wax from British peats and lignites; I. Fagelston (Admiralty), a chemist who has made outstanding contributions on propulsion problems in relation to torpedoes and surface and underwater craft; A. Forster (Ministry of Supply), an organic chemist and engineer with outstanding knowledge of high explosives and propellants, and of their manufacture; J. K. Hardy (Ministry of Supply), an engineering physicist who has made important contributions to the study of de-icing and to many other subjects; A. W. Hothersall (Ministry of Supply), who is a leading authority on electro-deposition of metals, with particular reference to resistance to wear and erosion; B. Pontecorvo (Ministry of Supply), who was responsible for pile development in Canada and is now conducting fundamental atomic energy research in nuclear physics; Dr. R. H. Purcell (Admiralty), a physical chemist who has been concerned with the practical application of physics and chemistry to a very wide field of engineering problems; H. A. Sloman (Department of Scientific and Industrial Research), who has carried out pioneer work on the production and properties of pure beryllium, and, recently, on the analysis of gaseous impurities in metals, especially in steel and by the development of the now widely used vacuum-fusion method; A. G. Tarrant (Department of Scientific and Industrial Research), a physicist who has contributed outstandingly to the solution of research problems in road construction, specializing particularly in the development of equipment for studying the deterioration of road surfaces; during the War he developed novel types of accelerometer for examining the movement of gun mechanisms and the flight of bombs and underwater projectiles.

British Somaliland and its Development

The report on the general survey of British Somaliland, 1945 (Burao: General Survey. 3*s*. 6*d*.), prepared following the approved scheme under the Colonial Development and Welfare Act, indicates that considerable areas of the country are almost completely unknown. 1945 was a good average year as regards rainfall and grazing, and in the geological exploration of the Onkhar area an oil seepage was found, of which 800 square miles were mapped. This area is well watered and there are valuable belts of Damas trees in the coastal lowlands. A potential motor track from Dur Elan to Onkhar was discovered. The original purpose of the survey was the collection, co-ordination and distribution of data from existing knowledge, and also the continued collection of further data, especially as regards topography, meteorology, geology, botany, zoology and tribes and their stock, so as to fill in the gaps in the structure of a composite research scheme and eventually to compile a full account of the general geography of British Somaliland on which wise development could be based. Detail is included in this report as an example of the sort of information which general survey officers are expected to collect, and some notes on the methods of work are also included for the use of colleagues in Somaliland, including native assistant surveyors.

A Gazetteer of British Somali Place Names (Burao: General Survey. 1*s*.), covering British Somaliland and Grazing Areas, September 1943–February 1945–December 1945, has been prepared by the Survey Department of the Protectorate Government and published separately, to facilitate the location of place-names which may or may not be recorded on existing maps, and to provide an authoritative foundation for fixing as closely as possible the spelling of these names according to the recommendations of the Royal Geographical Society.

Scientific Expedition to Arnhem Land

The National Geographic Society, Smithsonian Institution and the Commonwealth of Australia jointly are sending a scientific expedition to Arnhem Land at the close of the rainy season in March. The expedition will study the aborigines and the plant and animal life, including marine life, throughout the dry season, which normally ends late in October. Arnhem Land, which is an aboriginal reserve, has no charted trails suitable for motor transport; the expedition's approach will be by small schooner to coastal stations on Van Diemen Gulf, the Arafura Sea, and the Gulf of Carpentaria. Natives will be enlisted as porters for journeys inland. Of five bases selected for the expedition's use, one especially suited for study of marine life is on Groote Eylandt just off the east coast in the Gulf of Carpentaria. Other bases are at the heads of navigation of mainland streams, where Christian missions established early in the century have been allowed to remain. The leader of the expedition will be Charles Pearcy Mountford, ethnologist of the South Australia Museum, Adelaide. Mr. Mountford, who has taken part in various anthropological and ethnological expeditions in Australia, is an authority on aboriginal art, customs and culture. Other members of the party are Frank M. Setzler, head curator, Department of Anthropology; Dr. David H. Johnson, associate curator, Division of Mammals; Herbert G. Deignan, associate curator, Division of Birds; and Dr. Robert R. Miller, associate curator, Division of Fishes, all of the Smithsonian Institution; and Harrison Howell Walker, National Geographic staff writer-photographer with several years of Australian experience. A similar group of Australian scientific workers will take part in the expedition.

Fuel Systems for the Aero-Gas Turbine

Dr. E. A. Watson and his colleagues were associated with Air Commodore Whittle in the early development of the aero-gas turbine. A paper presented before the Institution of Mechanical Engineers on December 5 gives an account of the results of their researches into fuel systems for such turbines. In the first part of the paper, Dr. Watson deals with the methods used for ensuring that the correct quantity of fuel is supplied to the engine under all conditions of thrust and altitude. The desirable characteristics of fuel systems from this point of view are deduced in a logical way, commencing with a typical heat input–engine speed curve at given inlet pressure and temperature, which is then modified to take into account variation of inlet conditions. It is then shown that neither an approximately isochronous governor nor a constant-stroke fuel pump driven directly by the engine possesses the required characteristics. The remaining alternative is to define the fuel flow directly by the pilot's control, with a compensating device for attitude variation. The remainder of this part of the paper is devoted to a discussion of the methods employed to achieve this, illustrated by descriptions of the various devices which have been used.

In the second part of the paper, the author turns his attention to the atomization of the fuel in the burners, and gives an account of some very ingenious methods which have been developed by various investigators to determine particle size and distribution. Illustrations are given of some atomizers which have been used. The paper should be of general interest to all who have followed the development of the gas turbine from its early stages, and the second part of particular interest to those concerned with the combustion of liquid fuels.

The Electronic Organ

So far as can be ascertained, there is only one type of electronic organ, that is one operating from purely electric means (see *Nature*, **145**, 170 (1940)) and so obviating pipes, being developed and manufactured in Great Britain, namely, the Electrone of the John Compton Organ Co., Ltd. The fact that it is produced by a long-established pipe-organ company means that it is properly 'voiced' by experienced craftsmen, without which it might be feared that traditional organ-tone might be lost. The model now available has two manuals and pedals, and a good array of stops and couplers. It was described by its inventor and designer, Mr. L. E. A. Bourne, and fully demonstrated by Mr. J. I. Taylor at a meeting of the Institution of Electronics held at the Royal Society of Arts on January 26. The post-war model is a great improvement over that produced in small quantities before the War, and can now easily take a place with regular pipe-organs of three times the price and greatly diminished maintenance. The improvement is largely due to a re-design of the electrostatic runners, using formants in many of the tracks instead of the previous all-sine-wave tracks, and more carefully selected loudspeakers. There are twelve unit-generators, all equal but driven by one belt, coupling pulleys of diameters inversely proportional to the equal-tempered ratios. Harmonics up to the thirtieth are used at present, but experiments are being made to go much higher when larger instruments are constructed, that is, larger in the sense of diversity of registration and effects, not volume, since this merely means using more amplifiers and suitably disposed loudspeakers.

Intensive Vegetable Cultivation

The increased demand for fresh vegetables has stimulated the grower's interest in new or improved methods of intensive cultivation. There remains, however, the difficulty of providing him with the latest information in an accessible form, and three illustrated bulletins issued by the Ministry of Agriculture (London: H.M. Stationery Office) on different aspects of the subject will do much to meet this need. "Irrigation" (Bull. No. 138. 1*s*. 6*d*. net) is entirely new. In it natural water supplies of all types are discussed, and the various methods of augmenting them by means of spray or soil irrigation described. Such artificial systems inevitably entail heavy expenditure, but it is considered that in some circumstances the results may fully justify it. "Crop Production in Frames and Cloches" (Bull. No. 65. 2*s*. 6*d*. net) has been completely rewritten. It provides a wealth of practical information, though stressing the fact that a thorough understanding of soils, varieties, ventilation, etc., is needed before success in this specialized line can be expected. "Practical Soil Sterilization" (Bull. No. 22. 1*s*. 3*d*. net) appears in a revised form. Large-scale methods employing both steam and chemicals are described for use in glasshouses, but instructions for dealing with small quantities of soil needed for propagation purposes or growing plants in pots are also included.

Annular Eclipse of the Sun on May 8-9

The National Research Council of Japan has arranged a programme of observations of the ionosphere during the annular eclipse of May 9 next, the central line of which passes across a small island north-west of Hokkaido. One of the objects of the programme is to obtain further evidence on the speed of particles proceeding from the sun to the earth. The exact times of contacts are to be recorded in connexion with a large-scale programme of geophysical observations.

National Foundation for Scientific Research, Brussels

The nineteenth annual report of the National Foundation for Scientific Research, Brussels, covering the year 1945–46, includes the reports of the ten scientific commissions together with details of grants made, of distinctions obtained during the academic year, and particulars of researches in progress during 1946–47. A list of publications during the year is appended under authors, together with a classified list of authors according to the scientific commission with which their work is associated. The Commission for Mathematics and Astronomy reports on a study of irregular algebraic surfaces and on correspondences between two algebraic surfaces. Prof. M. A. Picard reports on behalf of the Commission for Physical Chemistry, Electro-chemistry and Radioactivity on research on new radioactive substances, while on behalf of the Commission for Morphological Medical Sciences, Prof. M. G. Leplat refers to a study of senescence. The Scientific Commission for Pathology of Transmissible Diseases, Colonial Pathology and Hygiene has studied the extension of bilharziasis and its control, rickettsiosis and filariasis, while the Commission for Clinical Sciences has been investigating the problems of antibiotics and the mode of action of sulphonamides. The Commission for Applied Chemistry has investigated the constitution and chemical properties of mineral oils, and a new Scientific Commission has been set up for the study of problems of nuclear energy.

National Institute of Sciences of India: Elections

At the annual general meeting of the National Institute of Sciences of India, held at Patna on January 1, the following new fellows were elected: Dr. B. S. Bhimachar, fisheries officer with the Government of Mysore, Bangalore; Pratap Chandra Bose, chief engineer, Corporation of Calcutta; Dr. Satya Charan Chatterjee, head of the Department of Geography, Patna College, Bankipur, Patna; Jehangir Fardunji Dastur, head of the Division of Mycology, Indian Agricultural Research Institute, New Delhi; Dr. Arun Kumar Dutta, reader in physics, Dacca University; Dr. Rukmini Kishore Dutta Roy, Geological Survey of India, Calcutta; Dr. Robert E. Heilig, chief physician, Jaipur; Dr. Kolar Ramakrishna Krishnawami, director of industries, Bihar, Patna; R. A. MacGregor, formerly chief metallurgist to the Government of India, Calcutta; Ganesh Chandra Mitter, chief assayer, His Majesty's Mint, Bombay, and honorary professor of industrial chemistry, Royal Institute of Science, Bombay; Dr. Mahadeo Atmaram Moghe, professor of zoology, College of Science, Nagpur, and head of the Department of Zoology and dean of the Faculty of Science, Nagpur University; Dr. S. P. Raju, director of the Engineering Research Department, H.E.H. Nizam's Government, Hyderabad, Deccan; Dr. Srinivasa Ramanujam, Central Potato Research Institute, New Delhi; Dr. Subbarao Ramachandra Rao, professor of physics, Central College, Bangalore; Dr. Jyotis Chandra Ray, director, Indian Institute for Medical Research, Calcutta.

Physiology and Pathology of Animal Reproduction

The First International Congress on the Physiology and Pathology of Animal Reproduction and on Artificial Insemination will be held during June 23–30 at Milan. On June 21 a preliminary conference will take place, under the auspices of the United Nations Educational, Scientific and Cultural Organisation, at which a limited number of Italian and foreign specialists will discuss "Interacting Substances of Ova and Sperm, and Parthenogenesis". The Scientific Commission of the Congress will arrange the papers sent to the Congress in sections according to subject; full sessions will discuss certain themes of general interest. The subjects the Congress is to deal with are: (*a*) biological problems of animal reproduction; (*b*) breeding problems of animal reproduction; (*c*) pathological problems of animal reproduction; (*d*) methodological and practical problems of artificial insemination of animals; (*e*) legislative and organisational problems of artificial insemination and of animal reproduction. An exhibition of related material and books, and also visits to breeding stations and scientific institutions, are being arranged. Papers for the Congress must be received by March 31. Detailed information can be obtained from Prof. T. Bonadonna, secretary-general of the Congress (via Bronzetti 17, Milan). The subscriptions are: for members actually taking part in the Congress, 8 dollars or £2; for others, 4 dollars or £1.

International Symposium on Noise

An international symposium on noise is to be held by the Acoustics Group of the Physical Society in association with the Royal Institute of British Architects during July 14–16, in the hall of the Institute at Portland Place, London, W.1. The draft programme provides for four sections: (1) noise measurement; (2) field and laboratory studies; (3) reduction of noise, air-borne and structure-borne; (4) building practice, as applied in houses and flats, factories, theatres, concert halls, etc. Contributions to the symposium are invited, and those who intend to read papers or submit written contributions are asked to inform the recorder, Dr. A. J. King, not later than March 31. Anyone wishing to have accommodation reserved should apply as soon as possible to the Accommodation Officer. The address for him and the Recorder of the Symposium is: Acoustics Group, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Royal Meteorological Society

The following have been elected officers of the Royal Meteorological Society: *President*, Dr. G. M. B. Dobson; *Vice-Presidents*, Capt. L. G. Garbett, E. Gold, G. Manley, J. F. Shipley, A. Thomson (for Canada) and J. Paton (for Scotland); *Treasurer*, W. N. Witchell; *Secretaries*, E. L. Hawke and Wing-Comdr. R. M. Poulter; *Scottish Secretary*, A. J. Drummond; *Foreign Secretary*, L. C. W. Bonacina; *Councillors*, A. C. Best, A. W. Brewer, J. S. Forrest, Major H. C. Gunton, W. G. Kendrew, I. T. D. Kirkpatrick, Dr. A. R. Meetham, Dr. F. J. Scrase, Prof. P. A. Sheppard, A. E. Slater, Lieut.-Comdr. P. C. Spink and Dr. T. W. Wormell.

Ethics and Science Conference

The Ethics and Science Conference arranged by the British Social Hygiene Council will be held on Friday, March 19, at the Livingstone Hall, London, S.W.1. The main theme of the Conference will be "Society and the Individual", each of the two sessions being devoted to a different aspect of this problem; the speakers at the morning session considering "The Value Society Sets upon the Individual", and at the afternoon session "The Values the Individual Sets before Himself". The chair will be taken by Mr. L. J. F. Brimble and Dr. E. B. Strauss, and the speakers will include Mr. F. Ian G. Rawlins, Canon Marcus Knight, Mr. Kenneth Walker, Dr. E. H. Larkin, Mr. John Mackay-Mure, Mrs. Joan B. Thompson, Father Leycester King, Dr. Mary Smith, and others. Time will be allowed for discussion at both the morning and afternoon sessions and at an open meeting in the evening. It is hoped that, as a result, fresh light will be thrown upon the problems arising from the apparent conflict between the scientific and spiritual interpretations of life. Further information and tickets (members of the Council, 2*s*. 6*d*.; others, 3*s*. 6*d*.) may be obtained from the British Social Hygiene Council, Dept. S.J.1, Tavistock House North, Tavistock Square, London, W.C.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Formation of Siphons in Lamellibranchia

THE mantle edge in the Lamellibranchia consists, as is well known, of three lobes. Of these the one adjacent to the shell (Fig. 1, 1) is concerned with the secretion of this, while the bounding periostracum is secreted as a thread from the base of the groove (*PG*) between this and the next lobe. This middle lobe (2) has sensory functions, bearing tentacles and in certain cases, for example, *Pecten* and *Spondylus*, eyes. The innermost lobe (3) is characteristically muscular. It contains radial muscles attached to the shell along the pallial line and, between upper and lower strands of these, other muscle running longitudinally. Action of these muscles, in conjunction with distension caused by pressure of blood, is responsible for the movements of this lobe, usually known as the velum or, better, the pallial curtain. By this means the entrance of water into the mantle cavity is controlled, for example, in *Ostrea*[1]. In extreme cases, such as *Pecten* and *Lima*, it also controls the direction in which water is expelled during the swimming movements[2].

In other words, the inner, secretory lobe retains the primitive function of the mantle edge in the Mollusca, while the sensory and muscular lobes have come into being with the evolution of the Lamellibranchia. The sensory functions of the head have been taken over by the enclosing mantle, the margins of which alone are now in contact with the environment. The greatly increased water current caused by the lateral cilia on the ctenidia which have been enlarged in connexion with feeding is controlled by the muscular lobe.

While in the more primitive Lamellibranchia the original freedom of the mantle edges is retained, as in the genera mentioned above, in the majority these are fused to a greater or less extent. Openings are retained for the extrusion of the foot and for intake and expulsion of water, with occasionally a fourth aperture. What does not appear to have been recognized is that the degree of fusion involved in the formation of the inhalant and exhalant apertures or siphons may take one of four forms, involving fusion of one, two or, in part or entirely, all three lobes of the mantle edge. These are shown diagrammatically in Fig. 2, *A–D*.

In the first of these, (*A*), only the inner, muscular lobe is involved. The simple exhalant opening (not a true siphon) of *Mytilus* is so formed. The inhalant and exhalant openings, one or other of which may be prolonged into a short siphon, in the Leptonacea[3], best exemplified by *Kellia*, and which are widely separated with the inhalant opening anterior, are similarly formed. The same is true of the Tridacnidæ[4] where, owing to the twisting round of the visceral mass in relation to the shell, the exhalant opening has migrated to the topographically upper surface. There are at least three groups in which posteriorly directed siphons are formed in this manner, namely, in the Nuculanidæ among the Protobranchia and in the Tellinacea (including, as pointed out by Graham[5], the Solecurtidæ) and Anatinacea among the Eulamellibranchia. In all these the middle and outer lobes of the mantle edge are continuous around the posterior margin of the shell; but the muscular lobes of the two sides unite to form the siphons. Those of the Nuculanidæ show an interesting series of stages in the conversion of ciliary into tissue junctions in the formation of the siphonal tubes[6]. In this group also the exhalant and inhalant siphons are united to one another; but not in the other two, where they are free throughout. Those of the Tellinacea are conspicuous for their length and mobility in connexion with the deposit-feeding habits of this group (now being studied); those of the Anatinacea are shorter but, at any rate in *Thracia*[7], are capable of temporary extension during the formation of mucus-lined passages from the posterior end of the animal through the substratum to the surface. In all, the siphonal openings are lobed or bear a single row of short tentacles.

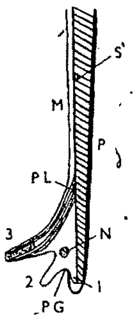

Fig. 1. SECTION THROUGH MANTLE EDGE OF A LAMELLIBRANCH. *M*, MANTLE; *N*, NERVE; *P*, PERIOSTRACUM; *PG*, PERIOSTRACAL GROOVE; *PL*, PALLIAL MUSCLES; *S*, SHELL; 1, 2, 3, OUTER (SECRETORY), MIDDLE (SENSORY), INNER (MUSCULAR) LOBES

The second type of siphon, in which the inner and middle lobes are concerned, (*B*), is the most common. It occurs in such widely distributed genera as *Cardium*, *Venus*, *Venerupis* (*Paphia*) and *Ensis*. The united siphons are usually relatively short and are fringed by a common row (or rows) of tentacles from the middle lobe (2). The inner lobe (3) is represented around the inhalant opening by an inner row of larger, more mobile and usually inwardly arching tentacles which serve as strainers. In the exhalant siphon it forms a membrane which confines and directs the water current.

In the third type, (*C*), the siphons are also invariably fused and similarly fringed with tentacles and with a membrane round the exhalant opening, for example, in *Aloidis*[8]. But here the inner margin of the outer lobe which secretes the periostracum is also involved, so that this protective covering is continued almost

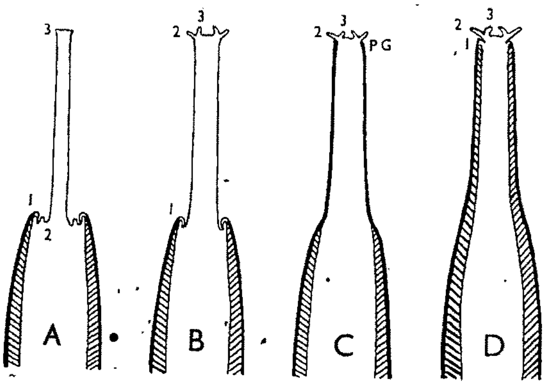

Fig. 2. DIAGRAMMATIC LONGITUDINAL SECTIONS SHOWING FORMATION OF SIPHONS: (*A*) WHERE INNER MANTLE LOBES ALONE FUSED; (*B*) WHERE MIDDLE LOBES ALSO FUSED; (*C*) WHERE SIPHONS COVERED WITH PERIOSTRACUM DUE TO FUSION OF GROOVES SECRETING THIS; (*D*) WHERE ALL LOBES COMPLETELY FUSED

to the tip, just short of the common ring of tentacles. This condition is found in the Mactridæ, the Lutrariidæ (*Lutraria*, as will be shown in a forthcoming paper, is really a *Spisula* or *Mactra* specialized for deep burrowing), the Myidæ (including *Aloidis*) and the Hiatellidæ. By providing protection for the siphons, this condition might be thought to have arisen in direct connexion with deep burrowing, as in *Lutraria, Mya* and *Panomya* (*Panope*). But genera allied to the three of these, namely, *Spisula, Aloidis* (*Corbula*) and *Hiatella* (*Saxicava*) respectively, have only short, or relatively short, siphons which are similarly protected. It would, therefore, appear that acquisition of this type of siphon is a necessary preliminary to that of the other modifications associated with deep burrowing. As will be shown in detail later, the general similarity between *Lutraria, Mya* and *Panomya* must be attributed to convergence.

The final stage in siphonal formation, (*D*), is represented in the Cuspidariidæ (Septibranchia)[9], where the siphons lie within a posterior tubular extension of the shell due to the complete fusion of the outer mantle lobes.

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Oct. 14.

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[1] Hopkins, A. E., *J. Exp. Zoöl.*, 64, 469 (1933).

[2] Yonge, C. M., *Mém. Mus. Roy. Hist. Nat. Belg.*, (2), 3, 77 (1936).

[3] Leyborne Popham, M., *J. Mar. Biol. Assoc.*, 24, 549 (1940).

[4] Yonge, C. M., *Sci. Rep. Gt. Barrier Reef Exped.*, 1, 283 (1936).

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[9] Yonge, C. M., *Phil. Trans.*, B, 216, 221 (1928).

Aspects of the Locomotion of Whales

IN an article in *Nature* of January 10, p. 44, Mr. R. W. L. Gawn, superintendent of the Admiralty Experimental Works, Haslar, has directed attention to the possibility that an investigation of the propulsive mechanism of large whales might result in the design of faster submarines. In this connexion the results of work carried out in this Department may be of interest.

(1) In order to drive a large whale at its maximum observed speed against a resistance equal to that of a rigid model when towed at the same speed, the output of power from each pound of muscle need not —as pointed out by Mr. Gawn—be greater than that characteristic of other types of mammalian muscle. On the other hand, a dolphin travelling at well-authenticated speeds would, if its resistance is equal to that of a rigid model, require an output of power at least six or seven times that attributed to the muscles of a well-trained athlete or dog[1]. The difference between the whale and the dolphin is largely, if not solely, due to the fact that the amount of available muscle increases with the cube of the body-length, whereas the surface resistance increases only with the square. If the maximum output of useful work per pound of muscle of a 60-ft. whale and a 6-ft. dolphin is the same, and if the whale's maximum speed is 20 m.p.h., then the dolphin's speed should not exceed 9 m.p.h.—a figure far below that actually observed. As a submarine, the dolphin, rather than the whale, forms a more obvious and perhaps easier subject for investigation.

(2) There seems no reason to believe that the form or surface of an inert whale, dolphin or fish endows the body with a resistance substantially different from that of a well-streamlined object of comparable size and speed; the observations of Kempf and New[2] and of Richardson[3] establish this fact for dead specimens of pike, herring and mackerel, and quite recently I have found that a similar drag coefficient applies to a living fish by observing the rate of decrease of its speed during the passive glide which frequently follows a burst of active swimming. By following the course of the glide and knowing the speed at which it starts, it is possible to calculate the initial output of energy. For a 20-cm. trout, this was found to be approximately 0·4 gm./metres/sec./gm. of body-weight. The significance of this figure lies in the fact that it is almost identical with that obtained by Houssay[4] for considerably larger trout the maximum output of power of which was assessed by their ability to raise relatively large weights at low speeds. There is, therefore, no difficulty in accounting for the performance of small fish, at least so far as their behaviour in the laboratory is concerned.

(3) When we compare the performance of a 20-cm. trout with that of a salmon, we are in the same dilemma as when we compare the behaviour of a large whale with that of a dolphin. If we endow each gram of the muscles of the salmon with the same output of power as that of the trout, and assume that its resistance—like that of the trout—is equal to that of a rigid model of comparable size and speed, the maximum speed of the salmon should not exceed 7 or 8 m.p.h. If, as many anglers believe, salmon can travel at 15–20 m.p.h., they must, like the dolphin, either have remarkably powerful muscles, or have a very low surface resistance.

The data at present available can only be harmonized by one of three assumptions: (*a*) the speeds often attributed to large fish have been very greatly exaggerated; (*b*) the output of power from the muscles has been greatly under-estimated; (*c*) the resistance of an actively swimming fish is substantially lower than that which operates when the animal is gliding passively through the water. Before it is possible to determine the significance of the first of these factors, we require much more reliable data concerning the maximum speeds of fish of known size. Anglers tend to exaggerate the speed at which a line is running out from a small reel, just as they over-estimate the tension in the line. On the other hand, in the laboratory we may be working with fish which are not in a particularly good state of athletic fitness; we may also be making a mistake in assuming that the output of power from mammalian muscle cannot be substantially greater than 0·01 h.p. per lb.—a point recently stressed by Dr. D. A. Parry.

(4) A detailed study of the propulsive mechanism of any aquatic animal obviously presents very difficult hydrodynamical problems, and it is perhaps impertinent for a biologist to suggest any particular line of approach. Nevertheless, it seems legitimate to stress the fact that the surface of an actively moving fish differs from that of a rigid model in two fundamental respects: (*a*) the tail and caudal fin are oscillating from side to side; (*b*) the aspect which the fin presents to the water is partly determined by mechanical forces. Until the flow past such surfaces has been considered in detail, it seems dangerous to assume that the resistance of a swimming fish is the same as that of a rigid model. Observation of appropriate models indicates that the flow of water

past the surface of an active fish is totally different from that of a rigid surface; the water flows smoothly past the undulating surfaces and is subjected to well-defined acceleration. It would be significant if a flow of this type tended to reduce turbulence. Similarly, it would be of great value to know more about the propulsive effect, considered by Garrick[5], of an actively oscillating surface hinged to the hinder edge of an aerofoil. If the flow past the body of an actively swimming salmon proves to be laminar, we can accept Houssay's estimate of muscle-power without asking anglers to believe that the fish cannot travel at 20 m.p.h.

The object of these comments is not, in any way, to detract from the value of further information concerning the propulsive powers of large whales or the hydrodynamical properties of rigid surfaces, but to emphasize the peculiar importance of studying forms, such as the dolphin, where the ratio of body surface to muscle weight seems to render them much more impressive models of submarine design. At the same time, the situation seems likely to remain obscure until we know a great deal more about the hydrodynamical properties of oscillating surfaces, and have been able to measure the forces operating against the body of a living or model fish in a water channel. The whole problem seems to present an admirable opportunity for co-operative effort. The results of such an inquiry might or might not lead to the construction of faster or more efficient submarines; but in so far as they enabled us to measure the propulsive thrust of a fish's tail, they would have a very direct bearing on the design of efficient fish passes for salmon.

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Zoological Laboratory,
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Jan. 20.

[1] Gray, J., *J. Exp. Biol.*, 13, 192 (1936).

[2] Kempf, G., and New, W., *Z. wiss. Zool.*, 17c, 353 (1932).

[3] Richardson, E. G., *J. Exp. Biol.*, 13, 63 (1936).

[4] Houssay, F., "Forme, Puissance et Stabilité des Poissons" (Paris, 1912).

[5] Garrick, T. E., Nat. Adv. Com. Aero. Report 567 (1936).

MR. GAWN has revived interest in Gray's[1] demonstration that the drag of a fast-moving small whale, treated as a rigid body, seems to demand far more power than its muscles could supply, even if the propulsive efficiency were 100 per cent. Clearly, the assumptions underlying the evaluation of the equation

$$\text{muscle power} = \frac{\text{drag} \times \text{speed}}{\text{propulsive efficiency}}$$

need reconsidering. We have recently published some work[2] which considers two of the factors: muscle power and propulsive efficiency.

(1) *Muscle Power.* Mr. Gawn follows Gray in using 0·01 h.p./lb. as the maximum mechanical power output of muscle—a figure based on the external work done during a 15-min. maximum effort by a rowing crew. But muscle-power cannot be expressed as a simple function of size, without taking into account the conditions under which the muscle is working, and in particular the rate of fatigue and muscular efficiency. Thus a man working a bicycle ergometer at maximum muscle efficiency can develop more than 0·02 h.p./lb. (from data given by Dickinson[3]) until the accumulating oxygen-debt ends the activity; while greater power still can be developed during a single flexion of the arm against a suitabl load. This suggests that an animal capable of higher rate of oxygen intake than man might develo greater power for a given time, or a given power fo a greater time. We have suggested that the respiratory adaptations which enable whales to discharg their oxygen-debt quickly after long dives may als enable them to maintain an unusually high oxyge intake, and therefore power-output, when they ar swimming near the surface and can blow frequently This idea is supported by Scholander's[4] observatio on a porpoise that both the vital capacity (relativ to man) and the absorption constant were greate than in man. As for muscle efficiency, it is quit possible that the efficiencies achieved by man wit the help of well-designed machines may occur i whales during normal locomotion, because the loading of their muscles will be high and the rate of contraction low.

(2) *Propulsive Efficiency.* We have shown that th swimming movement consists of a vertical oscillatio of the tail (that is, region posterior to the dorsal fin and a continuous adjustment of the angle of attac of the flukes to give a forward thrust throughou the tail cycle. The dynamics of such a system hav been worked out assuming the flow around th flukes to be stable; but the efficiency then obtaine is improbably low and indicates the need for furthe work, observational (particularly on the relatio between forward speed and oscillation frequency and experimental. The comments of a marin engineer on this method of under-water propulsio would be of great interest.

We believe that the other problem raised by M Gawn—heat loss—is much less difficult. Blubber i fundamentally similar to a terrestrial mammal's skin and blood vessels run through the thick fat laye (hypodermis) to form a plexus and capillary loop a few millimetres from the surface. Control of th flow of blood through these vessels would provid for a considerable range of heat loss. Indeed, th problem is how to keep warm rather than how t lose excess heat, for we have shown that heat los by conduction through the blubber alone is such tha a 14-cm. layer would be needed to reduce bas metabolism to the level characteristic of mos mammals. Perhaps most whales need to kee swimming in order to keep warm.

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Zoological Laboratory,
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Jan. 20.

[1] Gray, J., *J. Exp. Biol.*, 13, 192 (1936).

[2] Parry, D. A., Thesis for Ph.D. Degree, Cambridge (1947).

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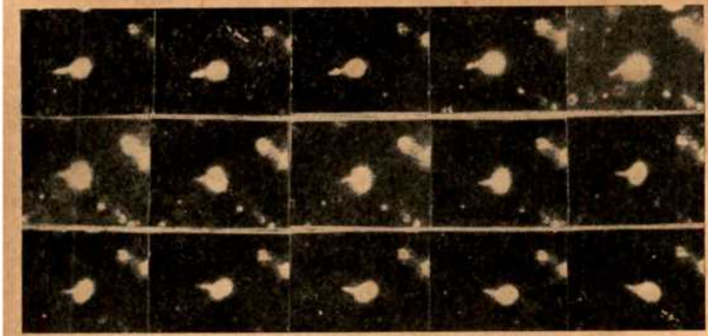
Bacterial Flagella and Motility

IN dark-ground microscopy with the sun a light-source, motile bacteria, when swimming fas show a tail, as in the top left-hand photograp reproduced. This tail is occasionally seen to untwis into a number of wavy threads which appear t remain attached to the periphery of the bacteri body for a while and then float away[1,2,3]. Whe such preparations are dried, the wavy threads ca be stained with so-called flagellar stains, and hithert they have been regarded as 'flagella' or motor-organ Motility of bacteria is thought to be due to activit



of these threads, either by themselves or twisted into a tail. Sunlight dark-ground studies of several kinds of motile bacteria under various conditions have convinced me that motile bacteria are not rods, but that they are spiral-shaped, and that they propel themselves by a gyrating, undulating movement of their bodies. Flagella or motor-organs, therefore, appear superfluous[3,4].

This suggested that the wavy threads, constituting the tail, might not be flagella. The undulating, gyrating movement of the body may spin the outer slime covering of bacteria into a tail, which is dragged along by the body. There always is a good deal of to-and-fro movement as well. Aided by micellar structure of the mucus, this continuous spinning will result in a tail consisting of a number of wavy slime threads. If these conceptions are correct, the tail must behave passively, whatever happens to the bacterial body.

The gyrating, undulating motion of bacteria can suddenly go into reverse. If this is done at high speed, the momentum of the body will drive it on in the direction in which it was going ; but the bacterium may then perform a semi-somersault and the rear end will suddenly become the front end. Such a semi-somersault will leave a *passive* tail more or less where it was, in space, the body performing its semi-somersault independently. This is just what happens.

The accompanying reproduction shows fifteen enlarged consecutive pictures of a 16-mm. film made to illustrate bacterial movement[3]. They show, from upper left to bottom right, a typhoid bacterium performing a semi-somersault. Its body goes through a clockwise half-turn, the front end becoming the rear end. (It could not be kept in perfect focus, the whole movement taking less than a second.) The short body radiated too much light (this was necessary to bring out the faint tail) and so there is no spiral shape visible. It is clear that the bacterial body first moves forward with a straight tail, that the forward movement comes practically to a stop while the semi-somersault is performed, and that the tail remains practically where it is and does not take part in the semi-somersault. As soon as the semi-somersault is ended, forward movement is resumed, and the tail is dragged on again.

My interpretation is that during the semi-somersault the wavy threads, which constitute the mucous covering and the tail, perform a sliding movement past one another, thus giving the bacterial body sufficient freedom to perform its semi-somersault without interfering with the appearance of the tail.

If the tail consisted of flagella or motor-organs, attached all over the body, twisted into an active tail at the end, and yet governing the motion of the body, it becomes difficult, if not impossible, to imagine how such organs could bring about the phenomenon illustrated.

The film mentioned above contains several instances of such semi-somersaults with identical behaviour of the tail. The one reproduced here had the special virtue of going through its stages at a relatively low speed. These observations provide a strong argument in favour of my view that what are traditionally regarded as active bacterial flagella really are passive mucous twirls, and that motile bacteria move by means of gyrating, undulating movements of their bodies.

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Oct. 10.

[1] *J. Path. Bact.*, **47**, 1 (1938).
[2] *J. Biol. Phot. Assoc.*, **8**, 158 (1940).
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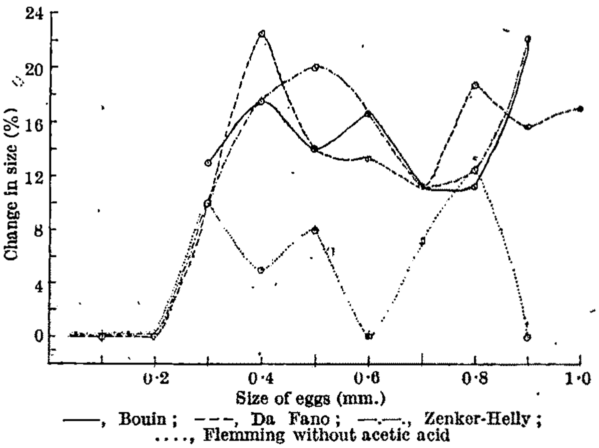
[4] *J. Bact.*, **53**, 256 (1947).

Elminius modestus: Another Imported Pest of East Coast Oyster Beds

THE barnacle *Elminius modestus* Darwin was known only from the southern hemisphere until, less than a year ago, Bishop reported its presence at Chichester and probably at Harwich[1]. Further details of its present known distribution are given by Crisp and Chipperfield[2]. It is now abundant in the estuaries of the Crouch, Roach and Blackwater, and at Whitstable. The multiplication of the American pests, *Crepidula fornicata*[3] and *Urosalpinx cinerea*[4], had already affected these famous oyster-producing grounds, before the greater part of the stocks there were wiped out in the severe winter a year ago. The presence of *Elminius* in very great numbers will tend to retard recovery.

Dense populations of large individuals occur at landing stages, such as the ex-Admiralty pier at Burnham-on-Crouch and the Seasalter Oyster Company's quay at Whitstable. On most shores the equally dense communities consist of small individuals derived from this year's settlement. The present distribution of *Elminius* therefore suggests that it is a comparatively recent introduction from ships' fouling, and shows clearly that it multiplied enormously last summer. In this area it is now more widespread than any British species of barnacle, and it occurs in some places, such as the beach at Maldon, where native barnacles appear to be absent. Between tide-marks on most shores it is the dominant barnacle, and it extends from the sub-littoral zone almost to high-water mark of neap tides. Its upper limit roughly coincides with that of *Balanus balanoides*. In the lower part of the tidal zone and below tide-marks it meets with severe competition from *B. improvisus*. Surfaces which were already thickly populated by *B. improvisus* escaped settlement by *Elminius* last summer, but most bare surfaces did not. Last year *Elminius* settled abundantly on periwinkles and on Whitstable mussels, forming encrustations which will be still heavier this year when the barnacles have grown. It has even settled



The frequency distribution diagrams on log sectional paper show that the samples taken were not abnormal. Diagrams showing the average shrinkage indicate that shrinkage increases with the size of the egg. The smallest eggs showed almost negligible shrinkage, while in the larger ones it was considerable. The eggs of moderate size also showed a fair amount of change in their dimensions. An interesting point was that in Flemming without acetic acid the eggs swelled up and their diameters increased, although the swelling was less than the shrinkage caused by the other fixatives. Curves of percentage change in dimensions show that of all the four fixatives Flemming without acetic acid seems to be the least harmful; for the highest point on its curve is near the lowest point of other curves.

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The Iron Alum Acetocarmine Method for Algæ

THE chromosomes of many Algæ have been found difficult to stain by the ordinary acetocarmine method. Where staining takes place, it is seldom deep enough in colour. The addition of ferric acetate or other ferric salts to the carmine solution, or rubbing together of steel needles in it, brings about only slight improvement, if any, as observed by Baker[1].

However, the use of iron alum as a mordant on previously fixed material, preceding the acetocarmine treatment, brings about a totally different effect. It has been shown[2] that chromosomes strongly absorb iron from an iron alum solution. They absorb more than other parts of the cell. This, it is thought, must be of importance. With many Algæ, a few minutes or less in a weak solution of iron alum, followed by rapid washing in water, is sufficient for the formation, on addition of acetocarmine, of a dense blue-black colour, presumably ferric carmine lake. This is rapidly dissolved on heating the preparation when covered with a coverglass, but remains longest in the chromosomes, nucleoli and 'chromocentres'. Thus differentiation is brought about. The lake gives a beautifully precise dark red to purple-black stain, and if the degree of mordanting is well adjusted other parts of the cell are only faint pink or scarcely stained. Such preparations are readily made into permanent mounts in 'Euparal' or Canada balsam in the usual way. If the coverglass is floated off in 95 per cent alcohol there is no loss of stain. Preparations which have been kept for two years show no fading.

That the ferric carmine lake can be formed in this way is contrary to the statement of Baker (ref. 1, p. 155), "the lake cannot actually be formed in strongly acid solution". The strength of the acetic acid solution in which the lake appears by the method described above is something less than 45 per cent, due to dilution of the carmine by the small amount of water placed on the slide with the washed algal material: nevertheless this dilution cannot be great. Unless the material has received only a rapid dip in dilute alum solution, there is always an excess of lake to be dissolved away, and it may be necessary to add acetic acid to complete the differentiation.

The contrast with ferric hæmatoxylin lake is marked when aceto-hæmatoxylin is used instead of carmine, after mordanting. On heating, a beautifully differentiated hæmatoxylin stain results, but this is quite transitory. When the permanent balsam mount is made, even after repeated blueing, the colour generally fades within 12 hours.

Other metallic salts, including copper, lead and aluminium, have been tried as mordants. Even other ferric and ferrous salts are, however, apparently less satisfactory than iron alum.

The advantages of the method when used with Algæ are several. It is rapid, a permanent mount being possible within 30 min., starting from fresh material. It can be used following any fixative. Obstacles to the view of the nucleus are readily removed; for example, chlorophyll by fixation with 2 parts of glacial acetic acid to 1 part of 95 per cent alcohol, starch by heating. Not least is the absence of shrinkage, another consequence of heating under a coverglass. Collapse of the cells in xylol is a familiar nuisance when mounting filamentous forms. It is suitable for class-work, when a permanent mount is often unnecessary, for example, for demonstrating the number of nuclei in algal cells. It is equally good for archegonia and antheridia of fern prothalli and has been successfully used on fungi. A disadvantage from the research worker's point of view is its frequent failure after wax embedding.

A detailed schedule of treatment will be included in a forthcoming paper on the nucleolus and nucleolar organisers in *Spirogyra*.

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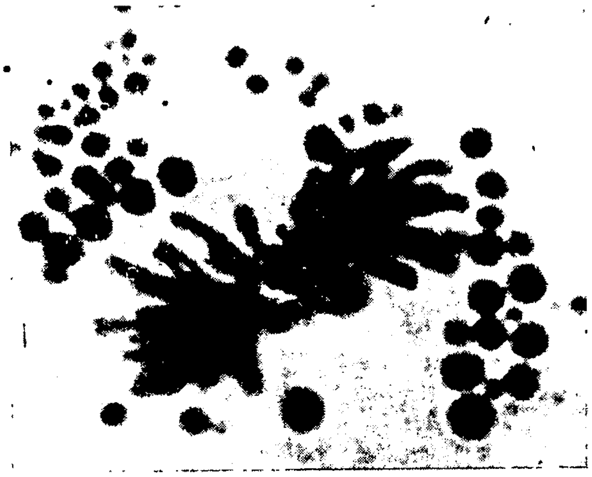
Amphibian Tissue Cultures for Biophysical Research

CULTURES of embryonic chick tissue have been successfully used for many types of cytological research and have proved admirable material for biophysical [illegible]tions into the mechanism of mitotic cell [illegible] fortunately, however, chick fibroblasts [illegible]t very suitable for detailed observatio[illegible]omosomes owing to the small size [illegible]rge number of chromosomes in t[illegible]

Previou[illegible]icated that amphibian cells mig[illegible]uitable material for such stu[illegible]ary experiments, a



METAPHASE GROUP IN NEWT FIBROBLAST. THE LONGITUDINAL SPLIT IN CHROMOSOMES IS CLEAR AT THIS STAGE. × 640

convenient method has been developed for cultivating various tissues and organs of adult frog (*Rana temporaria*), newt (*Triturus vulgaris*) and tadpoles of *Xenopus lævis* in hanging-drop preparations. Explants of *Rana* testis produce a broad outgrowth of fibroblasts which divide readily and survive without subcultivation for a period of two weeks, and longer if the tissue is transferred to a fresh medium. The cells are 40–50 μ in length and the chromosomes about 20 μ ($2n = 26$).

The limb and kidney of *Xenopus lævis* tadpoles give a good growth of fibroblasts after subcultivation. These cells have remarkable powers of flattening on the coverslip, and the cytoplasm is free of granules. This condition makes them very suitable for optical studies. The cells are of the same size as those of *Rana temporaria* and $2n = 36$. Fibroblasts from liver cultures of adult newt *Triturus vulgaris* are 80 μ in length and the chromosomes 20–30 μ in length ($2n = 26$).

In collaboration with Dr. A. F. W. Hughes, a cinematographic analysis of the mitotic process is being made in cultures of *Rana temporaria* by means of phase-contrast illumination. In the films the chromosomes are very clear from early prophase to late telophase. The separation of daughter chromosomes is also visible at magnifications greater than 500, and reconstitution of the nuclear membrane shows some new features. A full account of the results will be published elsewhere. It is also proposed to use this material for studies with the ultra-violet and electron microscopes.

I wish to express my appreciation of the help and advice given to me by Dr. H. B. Fell, director of the Strangeways Laboratory, where with the generous provision of facilities the work has been carried out. I am also indebted to Prof. J. T. Randall, who suggested this investigation, and to the Department of Scientific and Industrial Research for a maintenance grant.

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Submicroscopic Structure of the Red Cell

IN a recent paper, Dervichian, Fournet and Guinier describe experiments on the low-angle scattering of X-rays from red blood cells[1]. They show that the scattering curve can be explained as being due to the superposition of two intensity distribution curves: one showing a regular decrease from the centre outwards and the other a distinct maximum at $2\theta = 0{\cdot}025$ radians, corresponding to a Bragg spacing of 62 A. The authors conclude from the latter that the hæmoglobin molecules in the red cell are not distributed at random, but that a certain mean distance between neighbouring molecules is frequently realized. These results are the more interesting, since the scattering effects observed can be predicted from the molecular dimensions of hæmoglobin and its concentration in the red cell, as will be shown below.

The normal red cell is not birefringent. Individual hæmoglobin molecules, on the other hand, are strongly anisotropic, and it seems probable, therefore, that the hæmoglobin molecules in the red cell have complete freedom of rotation. We know from single-crystal X-ray analysis that hæmoglobin molecules (of horse) can be regarded as circular cylinders of 57 A. diameter and 34 A. height[2]. The cylinders are known to be enclosed in a monomolecular envelope of 'bound water' 3 A. thick, which brings the corresponding dimensions of the hydrated cylinders to 63 A. and 40 A. respectively. If the hæmoglobin molecules have complete freedom of rotation, their effective shape will correspond to that of the smallest sphere into which the hydrated cylinders can be inscribed. The diameter of this sphere is $\sqrt{63^2 + 40^2} = 74{\cdot}5$ A.

Considering the large size of the molecule, the concentration of hæmoglobin in the red cell is astonishingly high (34 per cent), which suggests that the molecules may be arranged in some form of close-packing. A 34 per cent solution contains $3{\cdot}35 \times 10^{18}$ molecules per ml., giving a volume per molecule $V_m = 298{,}000$ A.^{3}. Assuming close-packing, the average distance between the molecules will be $\sqrt[3]{4V_m/\sqrt{2}} = 75$ A. Alternatively, the inter-particle distance found from the position of the diffraction maximum observed by Dervichian, Fournet and Guinier by using the expression for a close-packed liquid[5] is $d' = \dfrac{\lambda\sqrt{3/2}}{2\sin\theta} = 75$ A.; this value agrees closely with both the calculated inter-molecular distance and the effective molecular diameter derived above. Thus, provided we assume the hæmoglobin molecules in the red cell to be close-packed, the inter-molecular distance calculated purely from the molecular weight of hæmoglobin and its concentration in the red cell agrees with the distance calculated from the observed diffraction ring; and, moreover, this distance is the same as the effective diameter of the freely rotating molecules, derived from X-ray analysis of crystalline hæmoglobin.

This close agreement lends strong support to the picture of freely rotating molecules arranged in a close-packed lattice. On the other hand, the apparently diffuse nature of the first diffraction ring, together with the absence of higher orders, indicate that three-dimensional regularity within the corpuscles cannot extend over more than a very small number of unit cells at the most; and Dervichian, Fournet and Guinier's description of the arrangement as intermediate between the order in a solid crystal and complete disorder in dilute solution therefore seems very appropriate.

The degree of regularity may perhaps be compared to that in a liquid metal, where each metal ion is surrounded on the average by twelve nearest neighbours arranged in close packing, but where the probability of finding any metal ion at the 'close-packed' distance from any other is high only in the case of nearest neighbours and becomes negligibly small when third or fourth nearest neighbours are considered. Thus we may conclude that despite the existence of short-range order, the hæmoglobin molecules in the red cell are suspended in true solution. This view is supported by the recent finding that the kinetics of the reaction $CO + O_2Hb \rightleftharpoons COHb + O_2$ are the same in the red cell and in cell-free solution[3].

The arguments presented above have some interesting biological implications. Clearly, from the point of view of its functional efficiency as an oxygen carrier, the red cell should combine maximum oxygen capacity with high speed of reaction and diffusion of oxygen through the cell. The greatest possible oxygen capacity would be provided by hæmoglobin crystals, which are known to have a hæmoglobin concentration of 55 per cent[4] and through which oxygen can actually diffuse. On the other hand, the speed of reaction would probably be low in an arrangement where both the position and the orientation of the molecules are fixed, and the rate of diffusion might be hampered by the narrowness of the channels between the molecules in the crystal lattice. It seems likely, therefore, that freedom of rotation of the hæmoglobin molecules and the absence of a three-dimensionally continuous lattice are needed to ensure high rates of reaction and diffusion. In that case 34 per cent is the highest concentration which is compatible with these conditions, since it leads to an average distance of approach between freely rotating molecules which is equal to their effective diameter. Any further increase in concentration would lead to mutual hindrance in the rotation of the molecules, and would be likely to affect the reaction rates.

Our calculations show that close-packing of the molecules is, in fact, an inevitable consequence of the high hæmoglobin concentration. If the molecules were arranged at random, their mean distances would have to be greater than 75 A., with the result that a hæmoglobin concentration of 34 per cent could not be achieved.

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Weight of the Rat Thymus

RECENT work involved accurate weighing of the thymus glands of young (6–12 weeks old) hooded Lister rats of both sexes. It became evident that great care was essential in dissecting out the thymus because of the risk of including one or more lymph nodes in the tissue taken for weighing. In rats of this age, mediastinal lymph nodes are occasionally difficult to distinguish from part of the thymus. One or more of these nodes is usually found on each side of the thymus and is visible from the front on opening the thorax. Identification is simple when the nodes lie apart from the thymus; but when they are welded by connective tissue to the thymus, and the symmetry of the sides of this organ is not altered, confusion may arise.

Close inspection by naked eye or hand lens may be required to distinguish a node from the thymus. Typically, the surface of the node is slightly granular, being marked by the tiny bulges of many follicles. This is in contrast to the smooth, homogeneous surface of the thymus. A line of cleavage can usually be made between a node and the thymus by blunt dissection. Further, a node pressed between the blades of a pair of forceps feels harder and more 'rubbery' than the thymus. The presence of follicles, however, invariably indicates a node, and the pressure test, which would distort the tissues and interfere with subsequent microscopical examination, is not required in practice. Histological examination reveals the interloper, but only after it is too late to assess the true weight of the thymus.

The nodes can be strikingly demarcated from the thymus by vital staining. Intraperitoneal injection of 1 ml. of 0·5 per cent trypan blue (Gurr's) in distilled water every alternate day for eight days (that is, total of four injections) causes an intense staining of the nodes, whereas the thymus takes up the dye poorly. Macroscopically, the submaxillary lymph nodes are not stained so intensely as these mediastinal nodes, and the follicles of Peyer's patches of the small intestine do not appear to concentrate the dye at all. Further work is in progress on these points and on the detailed histology of the lymph nodes. In earlier work from this Institute[1] the procedure followed for stripping the thymus removed the relatively small mediastinal nodes from the weanling rats used for these experiments. But in my older rats examination of specimens of vitally stained lymph nodes adherent to the thymus indicates that the nodes could account for an error up to 30 per cent of the thymus weight if not removed.

The thymus weight of rats is often recorded in experiments besides those concerned with nutrition, and this note is published to direct attention to the possibility that such observations may be seriously complicated if great care is not taken to free the thymus from the closely related mediastinal lymph nodes.

The above work was done during the tenure of a full-time Agricultural Research Council scholarship.

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Brain Lactate in Emotion

THERE are many indications that emotional excitement is associated with increased functional activity of the central nervous system. This is shown by the increased autonomic and motor activity in emotion, as also by the shock and exhaustion which may follow intense emotion. Histologists have described changes in the staining properties of the nerv[illegible]ells in emotional fatigue; but there is littl[illegible]ion as to the nature of the underlying [illegible] changes.

Lactic ac[illegible]ions were carried out on the brains of y[illegible]he animals were killed by dropping them into liquid air, which, in addition to killing them instantaneously, produced a rapid fixation of the biochemical changes in the brain. It was found that the brain lactate in rats which had been frightened for four minutes by repeatedly removing their support gave consistently higher values (mean for six rats, 40 mgm./100 gm. tissue) than in normal resting litter-mate controls (mean, 18·7 mgm./100 gm. tissue). Stone[1] has previously reported that the brain lactate in mice may be raised after muscular exercise. In the present investigation the rise in brain lactate in emotional excitement was still observed in rats in which muscular activity had been almost abolished by giving tubocurarine: it was therefore unlikely that the effect was due to concomitant muscular exercise. The blood content of the brain is too small to account for the lactate found in the tissue, and in any event blood lactate estimations in the experiments with tubocurarine gave comparatively low blood lactate values. It would appear that the observed rise in brain lactate is due to the increased functional activity of the brain in emotional excitement.

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Starches of the Wrinkled and the Smooth Pea

We wish to report some observations concerning the chemical constitution of pea starch which may influence current views on the part played by this polysaccharide in plant metabolism. The form of the starch grain is often characteristic of the plant or plant organ in which the starch is found, but in most of the common starch-bearing plants this difference in grain-form is not reflected in the chemical composition of the starch. By composition is meant, in this context, the relative proportions of the amylose (unbranched chain) and amylopectin (branched chain) components of the starch. Most of the cereal and root starches are composed of 20–30 per cent amylose and 70–80 per cent amylopectin. Until recently, the only exceptional starches which had been examined were those of the waxy (or glutinous) variety of cereals. Thus, waxy maize starch, which has a low gelatinization temperature and is stained reddish-purple with iodine (B.V. 0·10), owes these properties to the fact that it contains little, if any, amylose, being composed almost entirely of the branched-chain component.

Attention was directed to the unusual properties of the starch of the wrinkled pea by Hilbert and MacMasters[1], who showed that it contained a higher percentage of amylose (60–70) than did any starch hitherto examined. We have confirmed this finding and have shown, moreover, that the starch of at least one variety of wrinkled pea (Steadfast) contains less than 2 per cent of amylopectin.

The starch prepared from the defatted flour of Steadfast wrinkled pea by separation with cold water contains much protein which a[illegible]rs to be an integral part of the grain. The pro[illegible]starch, which stains blue with iodine (B.[illegible]ontains only 54 per cent of acid-hyd[illegible]ysaccharide. Although practically ins[illegible]g water, it can be dispersed in hot caustic soda solution, and by a graded acidification of the alkaline solution it is possible to obtain the starch free from protein. A more generally applicable method, however, consists in the exhaustive extraction of the protein-starch complex with hot 30 per cent chloral hydrate solution (pH 3), the extraction being continued until the insoluble residue no longer contains acid-hydrolysable polysaccharide.

The main protein-free fraction obtained by chloral hydrate extraction was a typical amylose, inasmuch as it did not gelatinize appreciably in boiling water, was hydrolysed to an equal degree (98 per cent) by $1 \cdot 5\,N$ sulphuric acid and by β-amylase, and its complex with iodine showed a blue value and a visible light absorption curve substantially the same as those of the amylose separated from potato starch by the thymol method[2]. A quantitative analysis of all the fractions obtained by extraction with chloral hydrate revealed the presence of not more than 2 per cent of the branched-chain component. The estimation was based upon the relative extent of hydrolysis effected by mineral acid on one hand and by β-amylase on the other.

Although the wrinkled pea is now regarded by botanists as the type (*Pisum sativa*) and the smooth pea as the variation (*P. arvense* L.), it is probable that the reverse is true and that the wrinkled pea is the product of artificial breeding[3]. It is of interest to find, therefore, that the starches of the two varieties are chemically different. We have shown that the protein-free starches derived from two types of smooth pea, Early Bird and Pilot, contain 66 per cent of amylopectin and only 30 per cent of amylose. The salient differences between the starches of *P. sativa* and *P. arvense* L. are shown in the accompanying table.

STARCHES FROM THE WRINKLED AND THE SMOOTH PEA

Variety of pea	Protein-free starch				
	B.V.	Amylose		Amylopectin	
		%	B.V.	%	B.V.
Wrinkled (Steadfast)	1·10 (av.)	98	1·10	2	—
Smooth (Early Bird)	0·535	29·4	1·25	65·8	0·200
Smooth (Pilot)	0·560	30·2	1·30	66·1	0·265

Blue Value (B.V.) is defined in ref. 4.

The starch of the smooth variety of pea appears not to exist in combination with protein in the grain, for it is possible to obtain protein-free starch from the pea flour by the usual treatment with cold water, that is, without disruption of the grain.

Wrinkled pea starch, being an amylose, is precipitated almost quantitatively by thymol from an aqueous dispersion, and it shows, in a more marked degree, the properties associated with the unbranched component of cereal starches. It may be dispersed by treatment with warm alkali, but subsequent neutralization is followed by rapid and spontaneous precipitation of the starch from solution (retrogradation). It does not swell in pyridine and can be acetylated by acetic anhydride and pyridine only if it is freshly precipitated by the addition of acetone to a chloral hydrate solution. The acetate so obtained is fibrous in form. In these respects the protein-free starch of *Pisum sativa* more nearly resembles cellulose in physical characteristics than does any of the seed or root starches hitherto investigated.

It may well be that the composition of pea starch is conditioned by the degree of maturity of the seed, and a determination of the amylose-amylopectin ratio at different stages of growth should give some insight into the biogenesis and biological function of starch in this plant.

We wish to thank Sir Norman Haworth for his interest in this work, and the Colonial Products Research Council for financial assistance. We wish also to acknowledge our indebtedness to Dr. T. J. Schoch for a sample of starch isolated from Laxton's Progress variety of wrinkled peas.

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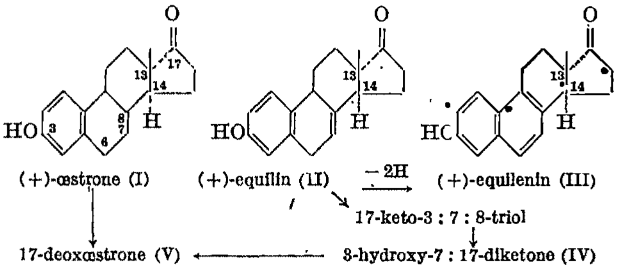
Nature of the C/D-ring Union in the Œstrogenic Hormones

In a recent discussion[1] of the nature of the *C*/*D*-ring union in the natural œstrogenic hormones (+)-œstrone and (+)-equilenin, I suggested that the stereochemical correspondence of these compounds was not beyond all doubt. It has since come to my notice that satisfactory evidence of such correspondence does, in fact, already exist in the literature. Because this evidence appears generally to have escaped recognition, it seems desirable to direct attention to it, and it is briefly summarized hereunder.

(*A*) When (+)-equilin (II) is shaken with palladium black in ethanol at 80° in an atmosphere of nitrogen, dehydrogenation occurs to give (+)-equilenin (III)[2,3]; in view of the very mild conditions employed, it seems certain that (+)-equilin and (+)-equilenin correspond stereochemically at C_{13} and C_{14}. (+)-Equilin is hydroxylated by treatment with osmium tetroxide to yield a 17-keto-3 : 7 : 8-triol[4], which by distillation in a high vacuum loses 1 mol. of water to afford a 3-hydroxy-7 : 17-diketone (IV)[5], which by Wolff–Kishner reduction of its disemicarbazone gives 17-deoxœstrone (V)[5], obtained previously by the same method from the semicarbazone of (+)-œstrone (I)[6]. Although carried out at 205–210°, it seems improbable that pinacolic dehydration of the 3 : 7 : 8-triol, involving migration of a hydrogen atom from C_7 to C_8, could lead to inversion of configuration at C_{14}; similarly, Wolff–Kishner reduction of many steroid ketones has been carried out, but in no case has inversion at C_{14} been observed; for example, androstane-3 : 17-dione gives androstane[7] and ætiocholane-3 : 17-dione furnishes a high yield of ætiocholane[8]. These reactions therefore link (+)-œstrone (I) with (+)-equilenin (III) and indicate that these hormones, as also (+)-equilin (II), correspond stereochemically at C_{13} and C_{14}.



(*B*) When the 3-hydroxy-7 : 17-diketone (IV) is acetylated, there is obtained an enol-diacetate, in which the position of the new double-bond between C_6 and C_7 is established by the absorption spectrum[5]; this by hydrogenation with palladium black in acetic acid and subsequent alkaline hydrolysis gives a 17-keto-3 : 7-diol[5], converted by treatment as the 3-monobenzoate with phosphorus pentachloride (1 mol.) in the presence of calcium carbonate into a 7-chloride[9]. Elimination of hydrogen chloride from this by use of sodium iodide in pyridine furnishes, after removal of the benzoyl group by alkaline hydrolysis, Δ^6-œstrone, since the position of the new double-bond is established by the absorption spectrum and hydrogenation with palladium black in ethanol at 20° gives (+)-œstrone as the sole product[9]. This sequence of reactions avoids the high-temperature Wolff–Kishner reduction, and again links (+)-œstrone (I) with (+)-equilenin (III) in respect of configuration at C_{13} and C_{14}.

$$\begin{tikzcd}
\text{(+)-œstrone (I)} & \text{(+)-equilin (II)} \arrow[r] \arrow[dr] & \text{(+)-equilenin (III)} \\
\Delta^6\text{-œstrone} \arrow[u] & & \text{3-hydroxy-7 : 17-diketone (IV)} \arrow[d] \\
\text{17-keto-3-benzoyloxy-7-chloride} \arrow[u] & \text{17-keto-3 : 7-diol} \arrow[l] & \Delta^6\text{-17-keto-3 : 7-diacetate} \arrow[l]
\end{tikzcd}$$

(*C*) Quite recently[10], transformations analogous to the foregoing have been carried out on "α"-dihydroequilin, which as the 3 : 17 "α"-diacetate is hydroxylated by treatment with osmium tetroxide to a 3 : 7 : 8 : 17 "α"-tetrol, also obtained by reduction with sodium and ethanol of the 17-keto-3 : 7 : 8-triol mentioned in section (*A*); this tetrol, either by distillation at 200° in a high vacuum or by treatment with hot 8 per cent sulphuric acid, undergoes pinacolic dehydration to give a good yield of a 7-keto-3 : 17 "α"-diol, which by Wolff–Kishner reduction or by removal of the 7-carbonyl group by the procedure described in section (*B*) furnishes "α"-œstradiol, a reduction product[11] of (+)-œstrone.

Once again these reactions link (+)-œstrone (I) with (+)-equilenin (III), and appear to prove that these hormones possess the same type of *C*/*D*-ring union, at present assumed by convention to be a *trans*-fusion.

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p-Hydroxybenzil

By oxidizing *p*-hydroxydeoxybenzoin with chromic anhydride in acetic acid, Weisl[1] obtained a substance, m.p. 175°, which he claimed to be *p*-hydroxybenzil. He described it as an amorphous powder, crystallizable with difficulty from aqueous ethanol in the form of orange needles; in alcoholic solution, it gave a deep red colour with potassium hydroxide.

Recent work in these Laboratories has shown that *p*-methoxybenzil[2], when demethylated with hydrobromic acid, gives a *p*-hydroxybenzil, m.p. 129–130° (found: C, 74·1; H, 4·7. $C_{14}H_{10}O_3$ requires C, 74·3; H, 4·5 per cent) (acetyl derivative, m.p. 67°), which crystallizes readily from benzene or aqueous ethanol in pale yellow needles; with potassium hydroxide its alcoholic solution assumes a deep golden-yellow colour, evidently due to heightened resonance effects in the anionic form of the molecule. The same compound has been obtained almost quantitatively by the oxidation of *p*-hydroxydeoxybenzoin with selenium dioxide and in a small yield by the application of Weisl's method to *p*-acetoxydeoxybenzoin with subsequent deacetylation of the product. It seems very probable, therefore, that Weisl, through omitting to protect the hydroxyl group during his oxidation, obtained some product of more complex nature which he wrongly assumed to be *p*-hydroxybenzil.

The reaction of *p*-hydroxybenzil, m.p. 129–130°, towards urea and sodium ethoxide in ethanol proceeds in the normal manner to give a mixture of the hydantoin and the glycoluril. 5-Phenyl-5(*p*-hydroxyphenyl) hydantoin, recently mentioned but not characterized by Melton and Henze[3], has m.p. 311° (decomp.) (found: C, 66·7; H, 4·9. $C_{15}H_{12}O_3N_2$ requires C, 67·2; H, 4·5 per cent); this compound is also produced by the demethylation of 5-phenyl-5(*p*-methoxyphenyl) hydantoin, m.p. 224–225°, obtained from *p*-methoxybenzil and urea by the standard method. All melting points are corrected.

Further details of this work will be incorporated in a later publication.

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Auroral Activity in Southern Norway from the Middle of August to the Middle of October, 1947

Corresponding to the very high solar activity last autumn, an unusual number of auroras have occurred in southern Norway; I have never before seen so many auroras in so short a time. Thanks to fine weather conditions, all my aurora stations have been in action and a great number of pictures have been obtained for the determination of height and position of the auroras.

Auroras were observed between the following dates and the next one: August 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 28; September 3, 7, 11, 13, 14, 15, 17, 18, 24, 25; Octo[illegible] 2, 3, 5, 7, 8, 10, 11, 12, 13, 14, 17, 18. On Au[illegible] September 3, 7 and 24, auroras forme[illegible] On several occasions red rays and re[illegible]re seen.

Photographs were taken from my stations on August *13*, *15*, 16, *18*, 19, 21, *22*, 25, 28, September *3*, 7, 11, *15*, *17*, *18*, *24*, *25* and October *2*, *7*, *13*, 17, 18. On the dates printed in italic type, pictures were taken from two, three, four or five stations simultaneously. In all, 1,920 photographs could be used, among which 398 sets were suitable for height determination.

Of special interest were the photographs taken on August 15–16. During that night Lovell, Clegg and Ellyett obtained for the first time radar echoes from the aurora[1], a fact which, if verified, may have the greatest importance for future auroral research. 125 successful pictures were taken that night from my stations, Oslo, Dombås, Holmestrand, Askim and Kongsberg, which gave twenty-eight sets of simultaneous pictures. Of these, eight sets have been measured, giving, among other things, heights of summits of sunlit auroral rays equal to 539, 774, 520, 541, 452, 425, 573, 590, 730 and 657 km., which is of the same order as the heights found by radar.

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Lorentz-like Transformations

The analogy between Dingle's relativistic theory of temperature radiation[1] and the special theory of relativity may be given precise mathematical form by the introduction of a transformation of which those due to Lorentz and Dingle are special cases. This may assist in the further development of the thermal theory.

Consider quantities a and t which transform according to

$$\left.\begin{aligned} da' &= g(b_1)\ (da - b_1 dt), \\ dt' &= g(b_1)\ h(b_1\,, b)\ dt, \\ b' &= (b - b_1)/h\ (b_1\,, b), \end{aligned}\right\} \qquad (1)$$

g and h being continuous functions of their arguments. The quantity b is defined as da/dt and b_1 is a particular value of b which acts as a parameter of the transformation. With

$$g(0) = 1 \equiv h(0,b) \qquad (2)$$

the transformation goes over into the identity as $b_1 \to 0$.

As invariant metrics of the transformation (1) the special forms (i) $da^2 - dt^3$, (ii) $dt(dt - da/k)^3$ are of interest, k being a constant. In case (i) the two-dimensional Lorentz transformation is obtained from (1) in the form

$$\left.\begin{aligned} da' &= \frac{da - b_1 dt}{(1 - b_1{}^2)^{1/2}}, \\ dt' &= \frac{dt - b_1 da}{(1 - b_1{}^3)^{1/2}}, \end{aligned}\right\} \qquad (3)$$

whereas case (ii) yields Dingle's transformation:

$$\left.\begin{aligned} da' &= \frac{da - b_1 dt}{(1 - b_1/k)^{1/4}}, \\ dt' &= (1 - b_1/k)^{3/4}\, dt. \end{aligned}\right\} \qquad (4)$$

The physical interpretation of the symbols and a comparison with Dingle's notation are given in the accompanying table.

TABLE OF SYMBOLS USED

Symbols used		Interpretation	
Present notation for cases (i) and (ii)	Dingle's notation for case (ii)	Case (i)	Case (ii)
a	η	Distance covered	Measure of entropy radiated
t	t	Vel. of light × time	,, ,, time
b	τ	Vel. ÷ vel. of light	,, ,, temperature
w_1	Not used	$+1$	Measure of an infinitely high temperature
w_2	$-\zeta$	-1	Constant depending on an experimental arrangement and corresponding to the absolute zero of temperature
$g(b_1)$		$(1 - b_1^2)^{-1/2}$	$(1 - b_1/w_2)^{-1/4}$
$h(b_1, b)$		$1 - b_1 b$	$1 - b_1/w_2$

These properties suggest a study of the general transformations (1). They form a group provided

$$\left.\begin{aligned} g(b'_2) &= \frac{g(b_2)\,h(b_1\,,\,b_2)}{g(b_1)\,h(b_1\,,\,b_1)}, \\ h(b'_2\,,\,b') &= \frac{h(b_2\,,\,b)\,h(b_1\,,\,b_1)}{h(b_1\,,\,b)\,h(b_1\,,\,b_2)}. \end{aligned}\right\} \qquad (5)$$

Furthermore, particular values, w_n ($n = 1, 2, \ldots$) of b such that $w'_n = w_n$ (values of b which are invariant under (1)), must satisfy

$$h(b_1\,,\,w_n) = 1 - b_1/w_n \qquad (6)$$

by (1). Hence

$$b_1 \neq w_n \quad (n = 1, 2, \ldots), \qquad (7)$$

since, with $b_1 = w_n$, (6) shows that $h(w_n, w_n) = 0$, so that the transformations (1) would become meaningless in this case. If these transformations form a continuous group, it follows from (7) that there can be no value w_n of b within the range which the parameter b_1 can cover. Such values of b can thus occur only at the end-point(s) of the range of values of b_1 within which the transformations (1) are effective. In fact, with the convention $w_1 > w_2$,

in case (i) $w_1 = 1$, $w_2 = -1$, $1 > b_1 > -1$,
in case (ii) $w_1 = \infty$, $w_2 = k$, $\infty > b_1 > k$.

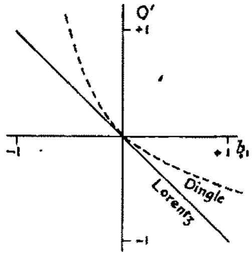
It is interesting to note that these conclusions are already inherent in the transformation (1). They represent a generalization of the property of Einstein's special relativity that, if v be an arbitrary velocity, c the velocity of light, the relations

$$v = -c, \quad -c < v < +c, \quad v = +c,$$

are each invariant under a Lorentz transformation. In Dingle's case they enable us to interpret the constant k (which occurred in the second metric) as an invariant temperature which, with the usual measures, corresponds to the absolute zero of temperature. k must be negative, since the group property of the transformation requires that the value $b_1 = 0$ be possible.

In the relativity case, b_1 is the velocity of a system of reference S' relative to another system S. Expressing this relationship symbolically, we write

$$b_1 : S \rightarrow S', \text{ and introduce } b_2' : S' \rightarrow S''. \qquad (8)$$



RELATIONS BETWEEN o' AND b_1, TAKING $w_2 = -1$ IN BOTH CASES

Hence $b_2 : S \rightarrow S''$ and, in particular,

$$\text{if } S'' \equiv S, \text{ then } b_2 = 0, \text{ and } b_2' = o' = -\frac{b_1}{h(b_1,o)} \qquad (9)$$

by (1). Hence for case (9) the relations (8) yield the reciprocal transformations

$$b_1 : S \rightarrow S', \quad -b_1/h(b_1,o) \;:\; S' \rightarrow S.$$

The relation between these two transformations for the two special cases is illustrated in the figure. Thus, on transforming from S' to S the last equation (1) is replaced by

$$b = \frac{b' - o'}{h(o',b')} = \frac{(b - b_1)h(b_1,o) + b_1 h(b_1,b)}{h(b_1,b_1)} \qquad (10)$$

by (1), (2), (5) and (9). Using (10) to eliminate $h(b_1,b)$ from (1), our transformation is seen to be a linear transformation with matrix

$$g(b_1)\begin{pmatrix} 1 & -b_1 \\ \dfrac{h(b_1,b_1) - h(b_1,o)}{b_1} & h(b_1,o) \end{pmatrix}. \qquad (11)$$

Though we are not here concerned with the physics of the theories leading either to case (i) or to case (ii), their unification in the above way may be of interest.

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[1] Dingle, H., *Phil. Mag.*, 35, 499 (1944); 37, 47 (1946); *Nature*, 157, 515, 556, 737 (1946).

MR. LANDSBERG'S letter, in that it derives a general transformation of which the Lorentz transformation is a special case, is doubtless of importance mathematically. It seems to me to have considerable physical interest for two reasons. First, it should help to elucidate the difference between the 'one-way' character of the laws of radiation and the 'two-way' character of the laws of motion, since it shows that both sets of laws, expressed in relativistic form, are special cases of a more general relation. Secondly, the detailed correspondence obtained between the Lorentz transformation and the transformation operative in thermal relativity should help by analogy in the further development of the latter. It might help, for example, in deriving a rigorous relation between specific heat and temperature (expressed, of course, not in those terms but in terms of the thermal relativity measurements) by analogy with the mechanical relation between mass and velocity.

HERBERT DINGLE

DOSAGE/RESPONSE RELATIONSHIPS IN MOULD INHIBITION

By J. N. PHILLIPS and J. M. VINCENT
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WHILE in the inhibition of several moulds by alkyl *p*-hydroxybenzoates, the expression :

$$y = a\,x^b, \qquad (1)$$

where y is proportionate reduction in rate of increase in colony diameter (inhibition), x is concentration of inhibitor, a and b are constants ($b < 1$), provides a fair statement of results and permits a reasonable comparison of substances[1], considerations raised by Hinshelwood in connexion with antibacterial action[2] have suggested the desirability of re-examining data for agreement with the form of the Langmuir adsorption isotherm.

The experimental points for the inhibition of *Aspergillus niger* by the alkyl *p*-hydroxy- and *p*-aminobenzoates is fitted rather better by the logarithmic (equation 1) than by the simple adsorption relationship. For these cases the former remains the better statement of results, although it throws no light on possible mechanism of inhibitor action. There is, however, little to choose between the two curves over a fair part of the inhibitory range, and even with this organism the adsorption form might serve as a first approximation. The alkyl *p*-aminobenzoate inhibition of two other organisms (*Penicillium roqueforti* and *Byssochlamys fulva*) fits the adsorption equation as well as, or rather better than, the logarithmic form. The detail of these investigations will be reported elsewhere, but certain implications of the equation based on the adsorption phenomenon seem to merit attention.

From the adsorption isotherm :

$$k_1x(1-A\theta) = k_2A\theta, \qquad (2)$$

where k_1 and k_2 are constants of adsorption and desorption respectively, θ is number of molecules adsorbed per unit area, A is effective area occupied by each molecule adsorbed at the surface, x is molar concentration of substance being adsorbed, it follows that :

$$A\theta = B.x/(1 + Bx), \qquad (3)$$

where $B = k_1/k_2$.

We can now look at two ways in which inhibition may be related to adsorption per unit area :

(i) as proportional to the *area* occupied by the adsorbed molecules, when

$$y = K_1A\theta, \qquad (4)$$

where y is inhibition, K_1 is a constant expressing the relative effectiveness per unit area occupied by adsorbed molecules ;

(ii) as proportional to the *number* of molecules adsorbed, when

$$y = K_2\theta, \qquad (5)$$

where K_2 is a constant expressing the relative inhibitory effectiveness per molecule adsorbed.

Regarding the first possibility and combining (3) and (4),

$$y = K_1B.x/(1 + Bx). \qquad (6)$$

The corresponding equation for the second postulate would be :

$$y = K_2B.x/A(1 + Bx). \qquad (7)$$

Equations (6) and (7) can then be written in the linear forms :

$$x/y = 1/K_1B + x/K_1. \qquad (6a)$$

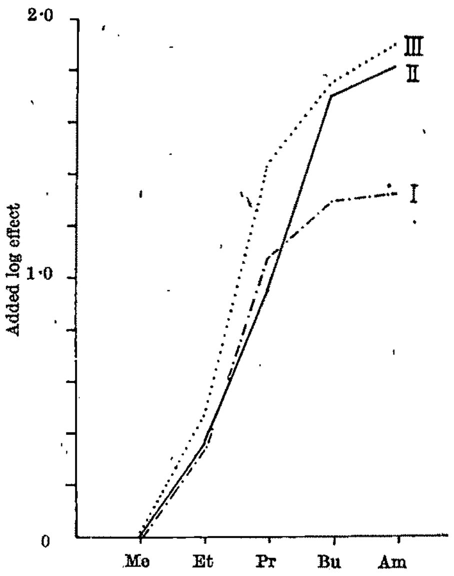
$$x/y = A/K_2B + Ax/K_2. \qquad (7a)$$

If then the experimental data be plotted as x/y against x, the slope of the line (generalized as $1/K$) represents $1/K_1$ or A/K_2 according to the supposition being examined.

Whatever the detailed factors represented by the slope, B can be determined by substitution in equations (6*a*) and (7*a*). This constant would then, by definition, provide a measure of relative adsorbability at a biological surface.

It is possible by these means to examine dosage/response data in order to analyse inhibitory action in terms of: 'biological' adsorbability (B) and relative effectiveness per unit area occupied by adsorbed molecules (K_1 or K_2/A). The technique seems likely to have a use in the more critical study of toxic substances and has obvious similarities to the Lineweaver and Burk manipulation of the Michaelis–Menten equation[3].

The application of the method is illustrated in the case of the relative inhibitory action of successive alkyl *p*-aminobenzoates on *B. fulva* (see graph).



INCREASED EFFECT WITH INCREASING CHAIN-LENGTH OF ALKYL *p*-AMINOBENZOATES

Curve I : Logarithm of concentration causing 50 per cent inhibition of *B. fulva*. Methyl = −0·43.

Curve II : Logarithm of lowering of surface tension (data of Adams, Rideal *et al.*[4]). Methyl = 0·28.

Curve III : Logarithm of 'biological adsorption' (B) as defined in text. Methyl = −1·0.

Curve I shows the increase with chain-length of overall inhibitory effectiveness as gauged by − log (concentration giving 50 per cent inhibition). This should be compared with surface activity data (Curve II)[4] from Adams, Rideal *et al.* Up to propyl, there is good agreement between this biological effect and the simple physical property of lowering surface tension at an air–water interface. Beyond propyl, the biological effect falls markedly below the surface tension data. If, however, K and B are dissected out from the biological data, there are two interesting consequences. The slope of the line increases, that is, K decreases, with chain-length :

Ester	K
Methyl	20·4
Ethyl	18·5
Propyl	12·4
Butyl	11·4
Amyl	9·8

At the same time, the logarithmic increase in 'biological' adsorption (B), plotted against chain-length (Curve III), agrees very much better with the simple physical determination (Curve II).

Since inhibition seems likely to be more closely related to the number of molecules adsorbed than to the area they occupy, it would seem profitable to examine the slope values regarded as A/K_2 (equation 7a). Without losing sight of the possibility of decreased K_2/A being due to a decrease in effectiveness per molecule (K_2), a more reasonable proposition for such a homologous series would be that it results from increasing A due to extra molecular bulk or a different disposition relative to the adsorbed surface.

It needs to be observed at this point, however, that other inhibitor/organism relationships need not be so straightforward as that quoted above. At least two reasons can contribute to this: (i) the accurate determination of the constants is often difficult; (ii) the dosage/response relationship is, to a varying degree, only approximated by the simple adsorption form, and it might be necessary to restrict the determination of constants to a relatively small portion of the curve such that permits valid comparison between substances. With these reasonable provisos, data for *P. roqueforti* and *A. niger* seem to show at least the same trends as those seen clearly in *B. fulva*. Their detailed examination will be dealt with elsewhere in collaboration with Mr. G. W. K. Cavill.

In conclusion, we should like to express our indebtedness to Prof. C. N. Hinshelwood for his critical comment on an earlier draft of the ideas set out in the present communication. Needless to say, although the present form has been influenced by such comments, Prof. Hinshelwood cannot be held responsible for any of its residual imperfections.

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NITROGENOUS CONSTITUENTS OF THE POTATO

By Dr. E. B. SLACK

Biochemical Laboratory, Cambridge

OSBORNE and Campbell[1] isolated a globulin from the expressed sap of minced potatoes. By extracting the crushed potato residue with 10 per cent sodium chloride, they were able to obtain an additional amount of protein which they considered was identical with the globulin contained in the press juice. When a solution of this protein in 10 per cent sodium chloride was gradually heated, a flocculent coagulum was formed at about 60° C., and further precipitates were obtained at higher temperatures up to 80° C. At this temperature coagulation of all the protein was complete, although a minute amount of proteose material appeared to remain in solution. The authors concluded that the only true protein present in potato was a globulin, with rather indeterminate heat-coagulation properties, for which they proposed the name of 'tuberin'. Neuberger and Sanger[2] extended this work and found that the potato residue, after removal of the press juice, contained a small amount of nitrogen (about 8 per cent of the total potato-nitrogen) which was insoluble in all the usual protein solvents. In more recent studies on tuberin, Groot, Janssen, Kentie, Oosterhius and Trap[3] have shown that it can be separated electrophoretically into two components.

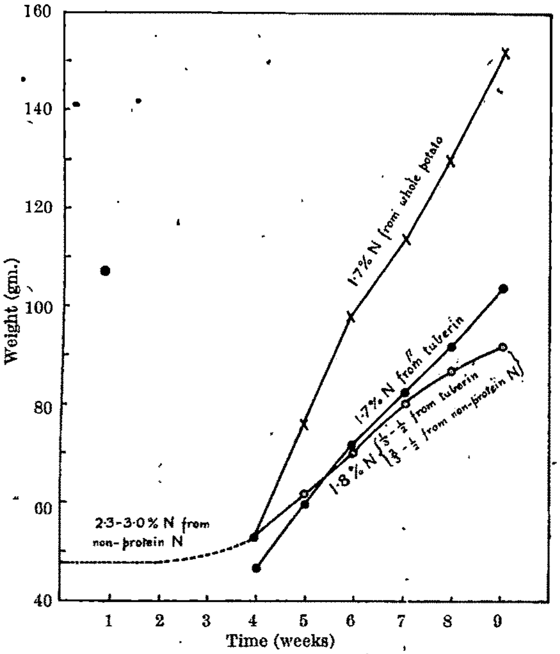
Determinations of the amino-acid content of tuberin were carried out by Sjollema and Rinkes[4] and by Groot[5]. The results of the earlier workers are probably not very reliable owing to the inadequacy of methods at that time. It is noteworthy, however, that Groot's recent figure for the lysine content of tuberin is of the same low order, 3·6 per cent, as that obtained by the earlier workers.

Using Gale's decarboxylase method[6], I have found that a sample of tuberin, prepared from King Edward potatoes by heat coagulation of the press juice at 80° and pH 4·5, had a lysine content of 7·7 per cent, a value that is more consistent with the high nutritive value of tuberin reported by Kon[7] and by Chick and Cutting[8]. Estimations of the other essential amino-acids of tuberin were made by the methods of Tristram[9] for valine, leucines, tyrosine and phenylalanine, of Macpherson[10] for arginine and histidine, of Lugg[11] for cystine and methionine, of Hess and Sullivan[12] for tryptophan, and of Rees[13] for threonine. The results show that the only amino-acid present in inadequate amount is methionine (see accompanying table). In addition to tuberin, the potato contains a variety of other nitrogenous substances present in considerable amount, the actual ratio of protein to non-protein nitrogen varying appreciably with different samples. In the case of the King Edward potatoes used in the present work, about half to two-thirds of the total nitrogen was non-protein.

AMINO-ACID COMPOSITION OF TUBERIN AND OF WHOLE POTATO

Amino-acid	Amino-acids (gm.) per 16 gm. nitrogen in Whole potato	Tuberin
Phenylalanine	5·4	6·6
Leucines	11·3	17·5
Valine	4·8	6·1
Tryptophan	0·8	1·6
Threonine	3·7	5·9
Arginine	4·4	6·0
Histidine	1·7	2·2
Lysine	5·0	7·7
Cystine	1·7	2·1
Methionine	1·6	2·3

Neuberger and Sanger[2] and Chick and Cutting[8] examined the non-protein fraction and found that about 50 per cent of the nitrogen was present in the form of amides (glutamine and asparagine), and about 30 per cent in the form of nitrogenous bases precipitable by phosphotungstic acid. Only about 10–20 per cent of the non-protein nitrogen was found to be present in the form of α-amino-acids. In the present work, this α-amino fraction has been separated by the procedure of Vickery[14] and analysed for the essential amino-acids by the methods specified for tuberin above. By combining the values obtained for the amino-acid content of the non-protein fraction with those found for tuberin, and assuming that all the protein present in potato has the same composition as tuberin, it is possible to calculate the amino-acid composition of the 'crude-protein' (N × 6) of the whole potato. The result is given in the table, and shows that the latter is poorer in its content of all the essential amino-acids than tuberin, from which it might be predicted that its nutritive value would also be inferior to that of tuberin.



THE AVERAGE GROWTH-RATES OF YOUNG LITTER-MATE RATS RECEIVING DIETS COMPLETE WITH RESPECT TO ALL ESSENTIAL NUTRIENTS EXCEPT PROTEIN, SHOWING THE RELATIVE NUTRITIVE VALUE OF VARIOUS NITROGENOUS CONSTITUENTS OF THE POTATO[15]

Chick and Cutting[8] and Chick and Slack[15] have shown, however, that although the non-protein fraction is alone incapable of supporting growth, yet the mixture of protein and non-protein nitrogen in the whole tuber possesses a nutritive value, as measured by its growth-supporting capacity for young rats, at least equal to that of the isolated tuberin. The obvious explanation of this result is not possible, since no supplementation between tuberin and the non-protein nitrogen could be demonstrated when the two fractions were isolated and fed in various proportions. In the accompanying growth charts, obtained in one such experiment, the broken line represents the average weight-change of a group of six litter-mate weanling rats receiving a diet complete with respect to all essential nutrients except nitrogen. The latter was derived entirely from protein-free potato juice and fed at a level of 2·3 per cent nitrogen on the dry weight for three weeks and at a level of 3·0 per cent nitrogen for a further week. There was little change in weight on these diets. At the end of a month, three of the six rats were given a diet containing 1·7 per cent nitrogen derived from whole potato, and the other three a diet containing 1·8 per cent nitrogen derived from a mixture of tuberin and non-protein nitrogen in the proportions in which they occur in the whole potato. The average growth-curve of a group of three rats receiving a diet in which all the nitrogen is supplied at a level of 1·7 per cent nitrogen derived entirely from tuberin is included from another experiment.

It is difficult to account in terms of amino-acid content for the superiority of the whole potato over tuberin as a source of dietary nitrogen. The small amount of unidentified nitrogen which cannot be extracted from potato residue (about 8 per cent of the total potato nitrogen and almost certainly protein) may be exerting an effect, or the potato may contain minute amounts of material similar to streptogenin, which Woolley[16] has shown to be a peptide-like factor stimulating the growth of *L. Casei* and obtained b tryptic digest of certain proteins of which it is a integral part. Otherwise it would appear that th potato contains further substances which, thoug neither proteins nor amino-acids, are capable replacing or supplementing these in the diet.

I wish to thank Dr. Harriette Chick for permittin me to include the results of the experiments shown i the graph, and should also like to record my appre ciation of the helpful advice and encouragement have received from Sir Charles Martin and Pro A. C. Chibnall.

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NEW CHEMICAL AND PHYSICAL LABORATORY AT THE ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH, HANTS

CHEMICAL research in the Royal Aircraft Estab lishment commenced under Dr. J. E. Ramsbottor in the early years of the First World War, but unt very recently the accommodation for chemical an physical research was by no means adequate fo present-day needs. However, a new laboratory ha recently been completed and was formally opene on October 29 by Mr. G. R. Strauss, Minister c Supply. In his introductory address, the director c the Royal Aircraft Establishment, Mr. W. G. A Perring, outlined the growth of chemistry at th Establishment and summarized the outstandin contributions of the Chemistry Department to aerc nautical research. A specification for a new labora tory was originally drawn up by Dr. Ramsbottor and his staff before the Second World War, and i his capacity of war-time head of the Chemistr Department, Prof. W. F. K. Wynne-Jones was re sponsible for the detailed layout of the laboratory an for pressing forward the extended scheme. Muc valuable advice was received from Sir Ian Heilbron c the Imperial College of Science and Technolog London, and throughout the planning and cor structional period Mr. R. B. Twiss, a member of th Chemistry Department staff, has been the genere adviser on all research requirements to the architec Mr. Oliver Law, the consulting engineers, Messr A. H. Barker and Partners, and the contractor Messrs. Trollope and Colls.

The new laboratory was designed in 1944 and cor structed during the period 1945–47. Its genere layout represents an attempt to provide up-to-dat facilities for both basic research in the chemical an

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NEW CHEMICAL AND PHYSICAL LABORATORY AT THE ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH

physical fields and more applied studies of aviation problems of a chemical and physical nature. Well-sited, easily accessible by new roads in front and rear, the laboratory comprises a single block, in plan dumb-bell-shaped and almost symmetrical, the long centre section terminating in two transverse wings. The overall length is about 220 ft., the width of the centre part 44 ft., and of the wings 65 ft., the total floor area being of the order of 40,000 sq. ft. Excavation of the whole centre section provides considerable basement area for spectrographic laboratories, service control rooms, air-conditioning equipment, refrigerators, a liquid-air plant and bulk store. The wings are not excavated and their solid floors permit heavier plant installation than suspended floors.

The main building rises three floors above the basement, and has a flat roof surmounted by a small central laboratory, lift room, and the fume-extraction plant, the latter comprising four large fan chambers and their associated acid-resisting ductwork. Most of the floor area is available for experimental work, all services being carried up into the central laboratory.

The building construction is robust; the reinforced concrete framing (columns, beams and floors) was cast *in situ*. The external walls are filled with 13½-in. solid brickwork above ground-floor level; basement retaining walls are of reinforced concrete, brick-faced. The foundations are adequate for structural weight plus a uniform loading of 200 lb. per sq. ft. for all suspended floors.

Along the centre section of the building, columns are regularly spaced at 10 ft. 7 in. centres, with spacing in wings appropriate to the greater spans. The central corridors on each floor, including the basement, extend from wing to wing and are 7 ft. wide, so that along the length of the block subdivision by transverse brickwork partitioning provides rooms which are multiples of the unit bay size (internally 10 ft. 3 in. by 16 ft. 9 in.). The wings, 62 ft. by 20 ft. internally, can be used as single rooms or subdivided, the extra width providing for large centre benches as in the analytical laboratory, or for bulky equipment as in the X-ray section.

Ceilings are generally 10 ft. 9 in. high (basement 8 ft. 9 in.), but in the centrally disposed 8-bay pilot-plant laboratory the first floor has been omitted to give headroom of 22 ft. for tall apparatus such as stills, there being a gallery around three sides at first-floor level, accessible via two iron stairways within the room, with an emergency exit steel door to the first-floor corridor. This double-height room is of fire-resisting construction, isolated from the building by two more steel doors giving access from the ground-floor corridor. There are two more entrances from outside the building directly opposite these isolating doors.

Individual laboratories in the whole block are designed to make changes of function easy to accomplish; specialized layout has therefore given place to flexibility, with the exception of a few special rooms, for example, the X-ray and electron microscopy and the textile sections.

Special attention has been given to stores, all three of which are near the lift, those on the first and second floors having separate lift access gates. Laboratories making greatest demands on the stores are as near as possible to them; offices and other rooms lie farther along the corridors, towards the south end of this building. In general, the ground floor is allotted to the more physical operations; the first, except for the analytical laboratory, is largely administrative; and the second devoted chiefly to chemical work requiring efficient fume disposal above roof-level.

The electrical and mechanical services follow the general flexibility requirement, considerable subdivision with ease of accessibility simplifying maintenance and facilitating modifications with minimum disturbance. Adequate service outlets and floor drain points, either blanked off as future provision or continued to required positions, are provided in nearly every room. Conversion of function, for example, offices into laboratories, is thus straightforward. Some standardization of fittings also has improved adaptability to varying requirements.

In more detail, the distributed services are cold and hot water, medium pressure steam, compressed air, gas, three- and single-phase 400/230-V. A.C. and 210-V. D.C.; low-voltage supplies are provided from any A.C. point by variable transformers and rectifiers, with local batteries where necessary.

Distribution of non-electric services to rooms is via horizontal sub-mains suspended along corridor ceilings on each side, separately controlled branches feeding outwards from the centrally disposed main risers. Branches off the sub-mains enter rooms at high level and are there valved; each room is thus independent of others.

The electrical services are similarly distributed, vertical feeders supplying separate A.C. and D.C. multiple plug-in busbar systems on ground and second floors, and distribution boards elsewhere. By this means, separately fused branch connexions may be made at 2-ft. intervals even with busbars alive without disturbance to more than the single laboratory concerned; leads run in flexible conduit to separate distribution boards in rooms; the whole system is thus extremely adaptable. Each laboratory is fitted with specially designed combination plug and terminal box outlets, the circuits being well subdivided. Additional supplies may be obtained from a fresh tapping of the appropriate busbar system. Lighting points are fed from the same source, but are separately fused. Colour differentiation is employed for all services.

Heating and ventilating of the building are effected by low-pressure steam radiators and the central plenum installation, the latter forcing filtered and tempered air through ducting following the route of the general services. Vitiated air is thus displaced, each room having inlet and exit grilles at high level. The ducts pass centrally along corridors, the whole being enclosed by false ceilings, with removable access panels along the whole length, the voids on each floor communicating with the exit air shaft discharging at roof-level.

A brief summary of the field of chemical and physical research covered by the Chemistry Department was given at the opening ceremony by Dr. T. P. Hughes, the present head of the Department. As a specialist department of the R.A.E., the Chemistry Department must be prepared to offer chemical advice and services to all departments of the Royal Aircraft Establishment and to certain departments of the Ministry of Supply; both these functions have been discharged with some notable successes in the past. Much of the work is necessarily of a short-term and *ad hoc* nature; but roughly speaking about half the effort of the Department is directed along fairly long-term lines and includes a healthy proportion of basic chemical and physical research.

The Chemistry Department is responsible for much of the development and application of non-metallic materials to aircraft, and under Mr. H. W. Hall is a section specializing in the chemistry and physics of such solids as plastics, rubber, wood and adhesives. Recent developments in high-speed flight have emphasized the value of maintaining smooth surfaces on thin highly stressed wings, and it has been considered that reinforced plastic structures might possess many production and operational advantages over the conventional metal wing. To develop this specific application, and also to examine the possibilities of plastic structures for all airframe requirements, a section under Mr. J. E. Gordon is attempting to make a few large-scale structures in reinforced plastics. A related field is that of textiles, where a section under Mr. J. W. W. Dyer is covering certain aspects of the development and performance of textiles and proofed fabrics.

The physics and chemistry of the many special fluids used in civil and military aircraft, such as paints, fuels, hydraulic fluids, lubricating oils and greases, are being studied in a section under Dr. E. W. J. Mardles. Much of the work is concerned at present with the rheological behaviour of these fluids. The assessment and reduction of fire risks in aircraft is the major function of a section directed by Mr. W. G. Glendinning. A section under Dr. J. D. Main-Smith covers miscellaneous chemical problems, chiefly of an inorganic nature. Among many other successes, this group developed the simple chemical carbon monoxide indicator which is widely used for aircraft cabin-contamination tests.

The chemistry of the reactions liberating energy in various forms of aircraft power plant is being investigated in a section under Dr. W. G. Parker. In the same manner as the development of piston engines and their fuels has been materially assisted by the understanding of the combustion process gained by some twenty years of physico-chemical research, it is hoped to obtain some insight into the combustion processes in later power plants, such as gas turbines, ram jets and rockets, for here the greater simplicity of the mechanical design has considerably increased the scope of the chemist.

In his address, Mr. G. R. Strauss emphasized the importance of scientific research in the aircraft field, and declared that the Government would continue to give every support to aeronautical research and development. In the new laboratory he hoped that the chemists and physicists would find congenial working conditions for the important part they have to play in aeronautical research of the future.

GOVERNMENT RESEARCH IN BRITAIN

WHILE the veil of secrecy drawn for the most part over the activities of the Department of Scientific and Industrial Research since the spring of 1939 remains unlifted, and we still await the resumption of publication of the annual reports of the Department and even the appearance of the long-promised review of its war-time activities, pronouncements regarding administrative developments are made in diverse ways and sometimes to strange audiences. The address of the Lord President of the Council to the North Herts Labour Party at Letchworth on January 14, containing the important announcement regarding the development of a scientific centre at the new town of Stevenage, is a recent example. Mr. Morrison prefaced his announcement by stating that the Government is eager to see science supporting enterprise in the national effort for economic recovery and independence. It proposes to bring to public enterprise new ideas and progressive development by making full use of the unrivalled scientific brains of Britain, sweeping away the old isolation of science and the tendency to look at scientific workers as people not needed in industry or only needed in the 'back room', or as long-haired old gentlemen cut off from worldly affairs. The Government is taking steps, he said, to bring science into the forefront of British industry, and does not believe that industry can give the nation what it wants in increasing abundance at decreasing costs unless science becomes more of a partner.

Mr. Morrison referred to the recent increase in the number and the effectiveness of the research associations in industry, and to the way in which the National Coal Board has brought science into the coal-mining industry at the top level and in every area. He looked to the time when every British worker will be conscious that he has a scientific man close at hand to make his work easier and less unpleasant, and to help him to get a better result. Although it would be some time before British industry could be re-equipped, even existing plant could be made much more productive by the assistance of science.

Mr. Morrison emphasized that time would also be required before fundamental research now being carried out could show results in industry; in the meantime, he said, we must rely chiefly on the more effective use of the vast amount of scientific knowledge which already exists, but which has not yet been fully applied in British industry, and on harnessing the social sciences to help managements and workers in their daily problems. Here the Lord President instanced the contribution of housing research under the Department of Scientific and Industrial Research in raising standards of comfort in housing, and to the investigations of the Shirley Institute into the productivity of different cotton mills. The latter investigations had suggested that by bringing the practices of all mills up to those of the best, the output of the present labour force and machinery might be increased by not less than ten, and possibly as much as forty, per cent. Mr. Morrison also referred to the work of the Industrial Health Research Board on lighting and fatigue, and in particular to the value of choosing the right colours for machines and working equipment in reducing fatigue and increasing output.

The organisation of science is also important, and the Lord President, after paying a tribute to the work of the Advisory Council on Scientific Policy, referred to the programme of the recently established Committee on Industrial Productivity and its various panels. If science, however, is to be at the heart of industrial effort in Britain, it is also necessary for the nation to understand, use and continually demand the fruits of science. He said that the new developments mentioned represent a start towards making Britain a truly scientifically minded nation, with all the advantages which flow from that. We must in future be accustomed to setting aside for science larger resources and more man-power if we are to get the maximum results. Much of our scientific research had been carried on under very bad conditions, and the Government is taking steps to improve those conditions as fast as possible. Recently, he said, he had arranged for the largest of our new scientific stations—that for mechanical engineering research—to be located in Scotland. It is important that scientific research and the inspiration it brings should be well distributed over the country, although many of our research establishments must of necessity be in the London region.

The Government has decided, Mr. Morrison said, that the new town at Stevenage should be given preference in considering the sites of new scientific establishments in the London region. A number of research stations would have to move from their present sites, which they have outgrown. He was unable to say what actual research will be located at Stevenage; but the town will become one of the important scientific centres of the future. Letchworth, since its earliest days, has been the home of industries characterized by a progressive attitude to research, and he hopes that those industries would benefit from the new development, and that Letchworth would share the Government's vision of science in the service of the people.

AMERICAN AWARDS TO BRITISH MEN OF SCIENCE

AWARDS have recently been made by the Government of the United States to the following British scientific workers, for their services during the War:

Medal of Freedom with Silver Palm: Sir Henry Dale, president during 1940–45 of the Royal Society and a member of many important Government scientific committees; Sir Jack Drummond, director of research, Boots Pure Drug Co., Ltd., scientific adviser to the British Ministry of Food during 1944–46; Sir Alfred Egerton, professor of chemical technology, Imperial College of Science and Technology, London, for his work as a secretary of the Royal Society and member of the Scientific Advisory Committee to the War Cabinet; Sir Melvill Jones, Francis Mond professor of aeronautical engineering in the University of Cambridge, for scientific research and development, as an outstanding authority on the problems of aerial gunnery; Dr. Alexander King, of the Ministry of Supply from early 1940, and head of the British Commonwealth Scientific Office in Washington from March 1944; Sir Edward Mellanby, secretary of the Medical Research Council, a principal figure in the organisation and conduct of British research in military medicine; Dr. Hugh M. Sinclair, lecturer in biochemistry, University of Oxford, sometime honorary nutritional consultant and co-ordinator of research in the British Zone, Control Commission (British Element); Mr. Cyril G. Trotman, for work as head of the Planning and Reporting Section of the Chemical Defence Experimental Station at Porton, and later as British representative on the international Project Co-ordination Staff in the United States; Dr. Hector F. Willis, of the Admiralty Research Laboratory, Teddington, for scientific research and development in theoretical physics and particularly the transmission of sound.

Medal of Freedom with Bronze Palm: Sir Charles Darwin, director of the National Physical Laboratory, Teddington, and first head of the British Commonwealth Scientific Office in Washington, for service to scientific research and development; Mr. J. N. D. Heenan, for his work in the development of turbo-jet and turbine engines for use in U.S. Army Air Force aircraft; Sir Ian Heilbron, professor of organic chemistry in the Imperial College of Science and Technology, London, for scientific research and development in connexion with chemical warfare munitions; Mr. Charles Lea, who was in charge of the development of incendiaries for the Ministry of Aircraft Production; Mr. Andrew Stratton, of the Royal Aircraft Establishment, South Farnborough, for research work in connexion with proximity fuses; Mr. T. W. J. Taylor, for work in connexion with scientific research and development.

Medal of Freedom: Dr. James Craigie, of the Imperial Cancer Research Fund, associate professor of immunology and bacteriology at the University of Toronto, and member of the Joint United States–Canadian Commission during June 1942–Feb. 1946; Mr. Amherst F. H. Thomson, representative of the Ministry of Supply, and later of the British Admiralty, for work in connexion with the development of proximity fuses.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 9

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 4.30 p.m.—Sir Jack Drummond, F.R.S.: "Fats in the Life of the Nation" (Cantor Lecture).

University of London (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. J. A. Lauwerys: "International Co-operation in Education".*

Institution of the Rubber Industry, Midland Section (at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 7.15 p.m.—Symposium on "Colour in the Rubber Industry" (Miss M. D. Gauntlett: "Physics and Measurement of Colour"; Mr. J. Haworth: "Technology of Colour"; Mr. T. E. H. Gray: "Use and Abuse of Colour").

Textile Institute, Macclesfield, Leek and District Section (at Nicholson Institute, Leek), at 8 p.m.—Mr. E. B. Higgins: "Plastics, Fabrics and Finishes".

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the Alembic Club, in the Physical Chemistry Laboratory, The University, Oxford), at 8.15 p.m.—Dr. F. A. Freeth, F.R.S.: "Relationship between Academic and Industrial Research". (To be repeated on Friday, February 20, at 8.15 p.m., in the University Chemical Laboratory, Pembroke Street, Cambridge.)

Tuesday, February 10

University College London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. W. H. Pearsall, F.R.S.: "Modern Botany". (Further lecture on February 12.)*

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Maintenance of Television Receivers in the Home" (to be opened by Mr. G. H. Watson).

Conway Discussion Circle (at Conway Hall, Red Lion Square, London, W.C.1), at 7 p.m.—Miss Barbara Low: "The Influence on Mind of Unconscious Factors".*

Wednesday, February 11

Physical Society, Colour Group (in the Small Physics Lecture Theatre, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 3.30 p.m.—Dr. D. R. Duncan: "The Classification of Colour-Mixture Phenomena".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. N. J. M. Taverne: "Aerial Photography and Exploration for Oil".

Institution of Electrical Engineers, Transmission Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. T. W. Ross and Mr. R. M. A. Smith: "Centralized Ripple Control on High-Voltage Networks".

Society of Chemical Industry, Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. A. B. P. Page and Dr. O. F. Lubatti: "Some Effects of Fumigants upon Foods".

Society of Dyers and Colourists, Northern Ireland Section (at the Queen's Hotel, Belfast), at 7.30 p.m.—Dr. P. W. Cunliffe: "Fastness Standards".

Thursday, February 12

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. H. J. Axon and Dr. W. Hume-Rothery, F.R.S.: "Lattice Spacings of Solid Solutions of Different Elements in Aluminium"; Mr. B. Chalmers, Mr. R. King and Mr. R. Shuttleworth: "The Thermal Etching of Silver".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. W. V. Mayneord: "Some Applications of Nuclear Physics in Biology and Medicine".

Physical Society, Acoustics Group (in the Lecture Theatre, Science Museum, South Kensington, London, S.W.7), at 5 p.m.—Discussion on "The Borderline of Psychology, Physics and Music" (to be opened by Dr. R. W. Pickford, Prof. van der Pol and Mr. J. Steuart Wilson).

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. E. K. Rideal, F.R.S.: "Adsorption and Heterogeneous Catalysis". (Further Lectures on February 19 and 26.)

Chemical Society (joint meeting with the University Chemical Society, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. M. G. Evans: "The Factors Influencing Radical Reactions in Solution".

Institution of Electrical Engineers, Installations Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. A. Cameron Brown and Mr. E. W. Golding: "The Application of Electricity to Horticulture".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. A. R. Howell: "The Aerodynamics of the Gas Turbine".

British Institution of Radio Engineers, North-Western Section (in the Reynolds Hall, College of Technology, Sackville Street, Manchester), at 6.45 p.m.—Mr. J. A. Sargrove: "A New All-Stage Valve".

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Mr. R. McV. Weston: "The Importance of Illumination in Photomicrography".

Chemical Society, Society of Chemical Industry, and Royal Institute of Chemistry, Edinburgh and East of Scotland Sections (at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. James Stewart: "The Chemistry of Rumination".

Chemical Society (in the Chemical Department, The University, Woodland Road, Bristol).—Prof. H. W. Melville, F.R.S.: "The Formation of Ethylenic Polymers".

Friday, February 13

Physical Society, Low-Temperature Group (joint meeting with the Institution of Chemical Engineers, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 10 a.m.—Conference on "Developments in the Industrial Production and Use of Gaseous Oxygen".

Textile Institute, Lancashire Section (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. J. E. Fielden: "Electronics in the Textile Industry".

Biochemical Society (at Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1), at 2 p.m.—Scientific Papers and Demonstrations.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting, followed by Annual General Meeting.

Institute of Physics, Manchester and District Branch (in the new Physics Theatre, The University, Manchester), at 7 p.m.—Mr. R. J. Bracey: "The Design of Optical Instruments".

Sheffield Metallurgical Association, Methods of Analysis Group (at 198 West Street, Sheffield), at 7 p.m.—Mr. E. J. Vaughan: "The Spekker—What it is and How it Works", Part 2.

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. A. O. Rankine, F.R.S.: "Physical Problems in Oil Production".

Saturday, February 14

British Psychological Society (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Mr. G. C. Grindley: "The Effect of Knowledge of Results on some Very Simple Skills".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Statisticians (approximately 12) in the Home Civil Service—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2105 (February 12).

Assistant Lecturer in Chemistry—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (February 14).

Research Biologist (Scientific Officer Grade), and a Research Assistant (Assistant Experimental Officer Grade) for routine analysis, etc., as member of a team studying plankton ecology in relation to the fisheries—The Head of the Department of Oceanography, University College, Hull (February 14).

Laboratory Steward (Grade II) in the Department of Physics—The Clerk, Birkbeck College, Bream's Buildings, London, E.C.4 (February 14).

Chemist to take charge of the Plant Protective Chemistry Section—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (February 21).

Lecturer in the Department of Physiology—The Secretary, The University, Aberdeen (February 21).

Chemists (men and women) in the Scientific Officer Class and Experimental Officer Class of the Chemical Inspection Department, Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F78/48A (February 28).

Superintending Analyst—The City Analyst, City Laboratories, Mount Pleasant, Liverpool 3 (February 28).

Microbiologist and an Organic Chemist in the Colonial Microbiological Research Institute, Port-of-Spain, Trinidad—The Under-Secretary of State, Colonial Office (Research Department), Palace Chambers, Bridge Street, London, S.W.1 (March 1).

Assistant Lecturer or Lecturer in Organic Chemistry—The Registrar, The University, Leeds 2 (March 1).

Senior Lecturer in Mechanical Engineering, Senior Lecturer in Aeronautical Engineering, Senior Lecturer in Civil Engineering, a Lecturer in Electrical Engineering, and a Lecturer in Mechanical Engineering, at Auckland University College, Auckland, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (March 1).

Readership in Public Health at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 3).

Junior Physicist in the Radiotherapeutic Department—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1 (March 6).

Readership in Physics at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 9).

Readership in Entomology at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 3).

Laboratory Assistant—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9.

Entomologist for research into problems concerned with insects and other animals in the soil in connexion with agricultural problems, and an Entomologist or Zoologist (temporary) to study soil insects and other animals in relation to problems of forestry—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Lecturer in Physics, and Assistant Lecturers in Geography, Chemistry and Physics—The Registrar, University College, Leicester.

Assistant Biochemist at the Courtauld Institute—The Secretary, Middlesex Hospital Medical School, London, W.1.

Director of Research for the Whiting (Calcium Carbonate) Industry—The Secretary, British Whiting Federation, 26 Claremont Road, Surbiton, Surrey

Research Assistant to investigate insect pests of pea crop—The Secretary, School of Agriculture, Cambridge.

Scientific Officers (2) for the Soil Survey of Scotland—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

Histological Laboratory Technician, and a Bacteriological Technician—The House Governor, Canadian Red Cross Memorial Hospital, Taplow, Maidenhead, Berks.

Research Engineer for experimental stress analysis of the structures, wheels, etc., of vehicles both under static and operating conditions, a Research Physicist for investigation of general noise problems associated with the operation of I.C. engines and motor vehicles, an Information Officer, a Chemical Laboratory Assistant for general inorganic chemical analysis, and a Metallurgical Laboratory Assistant for general metallurgical examination of automobile engineering components—The Director, Motor Industry Research Association, Great West Road, Brentford, Middx.

NATURE

No. 4085 SATURDAY, FEBRUARY 14, 1948 Vol. 161

CONTENTS

Page
Higher Technological Education in Britain 217
German War Research 219
Model Research in Hydraulics. By Prof. J. Th. Thijsse . . . 219
Cereal Rusts. By P. H. Gregory 220
Control of the Germinal Epithelium. By Prof. S. Zuckerman, C.B., F.R.S. 221
Research on the Trematoda. By Dr. G. Lapage 222
A Collector's Trail. By Miss Frances Pitt 222
Genetics and Algal Life-Histories. By Dr. Kathleen M. Drew . . 223
Biochemical Reactions of Chemical Warfare Agents. By Dr. E. Boyland 225
Reproduction of Photographically Recorded Oscillograph Signals. By R. L. F. Boyd 227
Obituaries :
Prof. Theodore D. A. Cockerell. By Robert B. Benson . . 229
Prof. R. E. Liesegang. By Prof. Eric K. Rideal, F.R.S. . . 230
News and Views 230
Letters to the Editors :
A Short-Focus Modification of the Lamm Scale Method for Measuring Refractive Index Gradients.—Harry Svensson . 234
Sensitivity of a South American Frog to Curare.—Dr. G. L. Brown, F.R.S., and M. Vianna Dias 234
Sodium Citrate Concentration in Ether-extracted Plasma.—Margaret E. Mackay and W. d'A. Maycock 235
Effect of Antihistamines on *Daphnia*.—Dr. Otakar Poupa . . 235
Histaminolytic Activity of a Copper Protein in Serum.—Dr. C. G. Holmberg and C.-B. Laurell 236
Specific and Non-specific Competition in Tubular Excretion.—I. Sperber 236
Improved Method of Getting Rats' Eggs from the Fallopian Tubes.—S. A. Simpson and P. C. Williams 237
Oxidation of Anthracene by Osmium Tetroxide.—Prof. J. W. Cook, F.R.S., and Dr. R. Schoental 237
Relative Reactivity of Aromatic Double Bonds.—Dr. G. M. Badger and Dr. R. I. Reed 238
Synthesis of Ovalene.—Dr. E. Clar 238
Colour Reagents for the Paper Chromatography of Sugars.—Dr. W. G. C. Forsyth 239
*p*H of Trisodium Citrate Solutions Stored under Customary Laboratory Conditions.—J. Jordan and Dr. M. Bobtelsky . 240
Preparation of Rare-Earth Chlorides.—F. R. Hartley and A. W. Wylie 241
Mechanism of Conductance by Hydrogen and Hydroxyl Ions in Aqueous Solutions.—Dr. S. I. Weissman 241
Volumetric Estimation of Thallium.—B. C. Mehrotra . . 242
Band Spectrum of ClO in Flames.—Dr. G. Pannetier and Dr. A. G. Gaydon 242
Interaction Terms in Molecular Vibrations.—D. F. Heath and Dr. J. W. Linnett 243
Spectral Response of Lead Selenide.—T. S. Moss and R. P. Chasmar 244
Pinhole Radiography of Magnetrons.—Dr. R. Dunsmuir, Dr. C. J. Milner and A. J. Spayne 244
Latent Infection in *Coffea arabica* L.—R. W. Rayner . . . 245
Persistence of *D.D.T.* and Benzene Hexachloride in Soil.—Dr. M. S. Smith 246
Newly Discovered Submarine Canyons of New Guinea and South Australia.—Reg. C. Sprigg 246
Units and Useful Range in Photo-electric Colorimetry.—Dr. Walter Koch and Dr. Deborah Kaplan ; Dr. J. R. Edisbury, R. J. Taylor and N. T. Gridgeman 247
High-Altitude Measurements on Cosmic Rays :
Penetrating Cosmic Ray Showers. By Dr. E. P. George and A. C. Jason 248
Penetrating Bursts. By Dr. E. P. George and P. T. Trent . . 248
Structure of Turnip Yellow Mosaic Virus Crystals in the Electron Microscope. By Dr. V. E. Cosslett and Dr. Roy Markham . . 250
Discharge Tube for Nuclear Reactions with Improved Yield. By Jaroslav Pachner 252
War-time Rheological Investigations for the British Armed Services . 252
Social Studies of the Elderly. By Eleanor French 253
Fuel Economy in Switzerland 253
New Italian Cosmic Ray Laboratory 254
Veterinary Educational Trust 254
Vegetable Tanning Materials of India 255

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HIGHER TECHNOLOGICAL EDUCATION IN BRITAIN

AMONG the unanimous recommendations of the report of the Percy Committee on Higher Technological Education, that for the establishment of a national council of technology received widespread support, and after announcing his intention to implement this recommendation, the Minister of Education in September 1947 appointed a 'working party' under the chairmanship of Mr. D. R. Hardman to advise on the establishment of a national council and on the principal steps to that end. All ten regional councils and academic boards recommended by the Percy Committee have already been constituted. National colleges have been established in several branches of technology and others are contemplated in the near future. Local education authorities were directed in Circular 133 issued by the Ministry of Education on March 19, 1947, to prepare their schemes of further education and plans for county colleges, as the basis for national action along the lines of the Education Act of 1944 ; and although here, as in the expansion of the universities, restrictions on building may hinder development, that delay affords a further opportunity for considering the long-term plans for the expansion of higher education as a whole.

The first meeting of the 'working party' revealed a large measure of agreement both on the general issue and on major questions of detail among its members. The 'party', which included Dr. J. E. Myers, Dr. A. E. Trueman, and Mr. F. W. Lawe, was satisfied that the case for setting up a national council had been established and recommended that steps be taken to that end with as little delay as possible, so that developments in training technologists as well as craftsmen, technicians and others may proceed along sound lines.

It is proposed that the general function of the national council should be to advise the Minister of Education on the national aspects of regional policy ; and although it will be an advisory and deliberative body, the possibility of executive functions, for example, such as might be involved in the certification of technological courses of graduate standard, is visualized. The 'working party' does not, however, altogether agree with the proposal in the Percy Report that the national council should be advisory to the University Grants Committee as well as to the Minister of Education. It is pointed out, quite correctly, that the University Grants Committee is itself the appropriate committee to advise the Government and to carry out certain defined functions in its own field. It is also true that the University Grants Committee has a province of its own separate from that of the proposed council; but it is by no means clear from this report where confusion will arise if the University Grants Committee is formally dependent for advice on technological education on the new council. The 'working party' recognizes that the closest consultation should exist between the University Grants Committee and the proposed new council in all matters of common concern, but it believes that this can be best achieved by the establishment of a joint committee of the Council and the University Grants Committee. No clue is given, however, to the responsibilities or terms of reference of such a joint committee, other than that it will deal with "matters relating to education of University standard". Since two specific functions of the council in respect of which it should advise the Minister of Education, namely, the planning of new developments, including national colleges, and the development of appropriate research in colleges, are listed separately, it would seem that the 'working party' has missed the point of this vital recommendation of the Percy Committee.

Even if Great Britain's resources of trained teachers of science and technology were not severely limited, and there were no severely competitive demands for trained man-power, the expansion of higher technological education and of the universities could not proceed independently without some close overall review, if not, indeed, a system of priorities. The expansion of technical colleges involves demands for equipment as well as buildings at precisely the point where university expansion is at present most handicapped. A link ensuring that the University Grants Committee is fully informed on proposals for higher technical education would seem almost essential.

Similar considerations apply to the question, which has been widely canvassed in recent years, of the development in Great Britain of institutions of the type of the Massachusetts Institute of Technology. Such developments must be evaluated from the point of view of university education as a whole, and also from that of technical education and the research organisation of the country. It should be remembered, moreover, that many industries look to the universities and not to the technical colleges for their leaders; and while the raising of the status of the technical colleges may tend to alter the balance, it is still true that as the scientific character of an industry becomes more pronounced, its demand for technologists tends to decrease and that for trained men of science to increase.

While the universities and the technical colleges, from the point of view of the expansion required for teaching and research, are in sharp competition with one another and with the demands of industry and of Government research establishments, the existing organisation which leaves the universities entirely outside the responsibilities of the Minister of Education, however logical and justifiable from one point of view, provides no obvious means for the overall review of resources. Such a review is imperative in order that duplication and waste of effort may be avoided and the output of technologists and of scientific workers related to real demand. The Percy Committee, as its report implicitly shows, was aware of this need; but admittedly it will not be easy to devise appropriate organisation to serve the need. Even in respect of teaching, account must be taken, as the Percy Committee also recognized, of the research associations and like institutions. Indeed, it seems that the Committee, in stressing the importance of bringing the research associations themselves into the closest possible relations both with the regional academic boards and with the national council, was aware of their value to industry as sources of trained technologists and scientific workers as much as from the research work actually carried out in their laboratories. From the point of view of technical education and the supply of technologists to industry, the position of the research associations requires appraisal, for it is as important as their contribution to the research structure of Great Britain.

The urgent need for closing this gap in the evaluation of universities, technical colleges and other institutions as suppliers of technologists and scientific men for industry, even if by some temporary expedient only, seems to have escaped the 'working party', in spite of its recognition that a national body is required which can advise on all questions bearing on education for industry and commerce, including training for the professions of management and for design in relation to industry and commerce. Even there, however, it would limit the responsibility of the national council to such aspects of those wider functions as fall within the jurisdiction of the Minister of Education. Nevertheless, it is recognized that technical and commercial education is a whole, from craftsmanship to management, and that problems in different parts of the field are interdependent; it is considered impracticable to extend the scope of the council to cover the whole field of further education. Accordingly it is recommended that the council should be entitled "The National Advisory Council on Education and Commerce". Indeed, the general impression left by the report is that departmentalism has considerably restricted the 'working party's' vision. The imagination and perspicacity which characterized the paragraphs dealing with the technical colleges in the Nuffield College Statement on "Industry and Education" five years ago are sadly lacking.

Detailed recommendations for the constitution of the proposed council are appended to the report. Besides the representatives of the regional councils and regional academic boards constituting the majority of the council, it is proposed that the Minister of Education should have the right to select the chairman and to appoint directly up to twenty members to ensure that important branches of technical and commercial education are adequately represented, and also, at his discretion, assessors from Government departments. The council would work through a competent standing committee of up to twenty-four members, with such advisory sub-committees as may be required, and provided with secretarial and other staff and office accommodation by the Ministry of Education.

There can be no doubt that even within the limited field visualized by the 'working party', the proposed council should do much to support and co-ordinate the efforts of regional councils to improve the status, the resources and the work of the old technical colleges, and to ensure that regional and local needs are adequately served both in respect of teaching and of research. It remains to be seen whether the national council itself will prove able to resolve the main difficulty of the qualifications to be awarded by colleges of technology, on which the Percy Committee itself was sharply divided. On this one point also the Percy Report contains ample evidence of the importance of establishing, at a high level, some interdepartmental means of obtaining an overall review of university needs and requirements and of those of the technical colleges, in relation to the country's needs and resources, even if only as temporary expedient until the broad lines of policy in university expansion have been determined and conditions permit that policy to be implemented without recourse to a system of priorities. There are questions here which concern not merely the Minister of Education but also the Minister of Labour and National Service and the Lord President of the Council, quite apart from the Chancellor of the Exchequer and the Minister of Works. Whether or not they can be resolved in part by the Advisory Committee on Scientific Policy or some other means without the establishment of a temporary special body remains to be seen. The departmental swathing in which the 'working party' would bind the new National Advisory Council on Education for Industry and Commerce would seem to preclude a resolute attempt to deal constructively with the problems of technical education in Great Britain.

GERMAN WAR RESEARCH

German Research in World War II

An Analysis of the Conduct of Research. By Colonel Leslie E. Simon. Pp. xi + 218. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 24*s*. net.

THERE are many lessons to be learnt in all fields of military art from a study of the conduct of the Second World War, but many of these will be out of date and misleading in ten years time. The important lessons are those which will remain true because they depend upon human nature and not on the particular stage of scientific and technical development at the time. Under this heading comes the question as to why Germany, whose men of science and engineers are among the best in the world, failed to mobilize fully her scientific and technical resources until it was too late for them to be effective. Colonel Simon's book sets out to give a review of their major achievements during the War, and to give also the principal reasons for their successes and failures, particularly from the point of view of the organisation of research and development.

Such a book must inevitably be handicapped by considerations of security, but the author gives an account of the more important weapons developed by the Germans on the air and army sides—naval weapons are not mentioned. This will be of considerable interest to the non-military scientific worker. To the man of science interested in British war developments, however, the most important chapters are those giving an account of the German organisations for research, development and testing, and their relation with the army and the production ministries.

Few will quarrel with Colonel Simon's main thesis that it was lack of liaison between the scientific and military staffs which led to the wastage of scientific and technical effort in developing unpromising projects, and in the frittering away of energy on a number of spectacular but strategically inferior weapons. Where the ultimate blame for this lay is not made clear by the author. One cannot help feeling that a deeper analysis would trace this lack of contact and understanding to two main causes: first, to the over-confidence of the military leaders after the initial success, which led them to neglect the development of weapons which would be necessary for the successful prosecution of the later stages of the War; secondly, to the "Führer Prinzip", which does not encourage the objective discussion and analysis of military requirements, bringing together the scientific man, production engineer and military staffs at the highest level. It may very well be that the German magnetic mine was a blessing in disguise to Great Britain, because its early defeat established the reputation of the scientific investigator with the public and the military, whereas in Germany it was the army, supported by the air force, which had all the initial success.

Colonel Simon points out another important circumstance which led to the development of weapons which were unsatisfactory either from the performance or the strategic point of view. This was the existence of a powerful armament industry with its own research and development establishments, which was able to put over its own ideas and projects without their being tested by an effective and impartial group at a central proving ground.

This book will be of great interest to all scientific men who work in, or have worked in, experimental establishments; it will be of even greater interest to those who have also worked at the headquarters of the services or supply ministries. It contains an admirable account of the conditions under which the German men of science worked, which were excellent from the point of view of equipment and amenities, but deplorable in the lack of real co-operation from the military leaders.

MODEL RESEARCH IN HYDRAULICS

Scale Models in Hydraulic Engineering

By Prof. J. Allen. Pp. 407 + 35 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 30*s*. net.

THIS is the book of the Manchester School for hydraulic model research, closely connected with the names of Reynolds, Gibson and Allen. The hydraulic model experiments begun here by Osborne Reynolds in 1885 were most probably the first systematic attempt in this line. It was not until the very last few years of the nineteenth century that Engels introduced this work on the Continent, and nearly thirty more years elapsed before John R. Freeman convinced the American hydraulic engineers and others that hydraulic model research on a great scale is a powerful means of solving problems connected with many hydraulic constructions.

Nowadays there are more than a hundred hydraulic laboratories engaged upon this work. These laboratories can be divided into two groups, very unequal in numbers: the overwhelming majority in the United States and on the Continent of Europe, using big models, and the British laboratories, which seem to have the monopoly of the really small-scale models.

It is well known that the chance of discrepancies between the model and the prototype increases as the scale-ratio is higher. Prof. Allen devotes a large part of his book to proving that models with very high scale-ratios can be used with success, provided they are well-designed and operated judiciously. These models always have to be strongly distorted: the reduction of the horizontal dimensions (x) is much more pronounced than that in the vertical direction (y). In extreme cases the vertical exaggeration ($x : y$) has been a hundred and more: in the first Severn model, $x = 40{,}000$ and $y = 366$; the Seine model of Vernon Harcourt was characterized by $x = 40{,}000$ and $y = 400$. At present these very high ratios seem to be confined to preliminary experiments which may help in designing another larger model. In the latter, x may vary between 2,500 and more than 10,000; y from 60 to 400; $x : y$ from slightly more than 10 to 85.

A typical example of a successful model of this type is the Rangoon tidal model ($x = 8{,}060, y = 192$). As in many others, the bottom consists of carefully selected sand which imitates the transport observed in the Rangoon estuaries and on the adjacent bars. Starting from the soundings of 1875, the model has succeeded in reproducing the conditions of 1897, 1910 and 1932. The tests have been carried up to and beyond 1982. The model indicates that the deterioration of the Rangoon approaches is unlikely to continue much longer, and Prof. Allen convinces us there is a fair chance that this prediction may come true.

'Continental' practice is gradually developing in the direction of small-scale models: the well-known Mississippi models in Vicksburg have $x = 2{,}000$ and $y = 100$. The Delft laboratory is actually constructing a model of the estuaries and tidal rivers in Holland in which $x = 2{,}400$ and $y = 64$, a vertical exaggeration of 37·5. It is true that these models have fixed bottoms, so that they are not subject to the complication of sand movement, but their scales overlap the recent British ones. Prof. Allen mentions the Great Ouse and Wash model, in which $x = 2{,}500$ and $y = 60$, and in the James Forrest Lecture before the Institution of Civil Engineers which Prof. Allen delivered in May 1947, attention is given to the newly designed model of the Firth of Tay with $x = 1{,}760$ and $y = 144$. In this lecture Prof. Allen explained why British small-scale models with movable bottoms give good results and Continental ones do not. The vertical scale ratio y is limited by the speed V of the current in the channels: from an empirical relation it may be deduced that the upper limit of y is proportional to $V^{3\cdot7}$. I would like to direct attention to the fact that all the British models have to do with parts of the world where high tides and strong tidal currents occur: they would fail if the method were used to reproduce the conditions on the coasts of Denmark or New Jersey or Holland.

The theoretical considerations which underlie the experiments are expounded in the first chapters of the book. Similarity in friction losses is extensively discussed. It is curious that the Bazin formula (which dates from 1897) is taken as a starting point; only little attention is given to the later work of Prandtl, Kármán and their successors, and the interesting investigations at the Imperial College of Science and Technology, London, by Prof. C. M. White and his collaborators are not mentioned at all.

It is to be regretted that in hydraulics so much use is still made of formulæ (like that of Bazin) which describe the results of a number of experiments, but which are not based on adequate theoretical considerations.

For Continental students of hydraulics, the chapters dealing with tidal models are the most interesting ones of the book. They give a survey of how the work in the United Kingdom is done, why it is possible and what its limitations are. Prof. Allen's work will help to create a better mutual understanding between the workers on both sides of the North Sea (and of the Atlantic Ocean).

Other investigations than the tidal ones are not forgotten. The author mentions the paradox that models of small objects such as spillways, sluices and weirs sometimes have to be larger than those of estuaries; the reason for this is explained.

The chapter on waves shows that in several parts of the world much has been done and is being done in order to solve the many problems connected with waves of several kinds. Mutual information is necessary if we want to know more of the impact of breaking waves. The bore or eagre is dealt with, and two beautiful plates give a picture of this phenomenon in the Severn. It is not clear why the hydraulic jump is treated together with the waves: it is no real wave at all, because conditions in it are permanent.

Valuable details of the construction and operation of the models complete this book. We may consider it as a welcome addition to the literature of hydraulics.

J. TH. THIJSSE

CEREAL RUSTS

The Nature and Prevention of Cereal Rusts as Exemplified in the Leaf Rust of Wheat

By Dr. K. Starr Chester. (Annales Cryptogamici et Phytopathologici, Vol. 4.) Pp. xvi + 270. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1946.) 5 dollars.

"THE most destructive disease of the world's greatest food crop", is Dr. K. Starr Chester's valuation of *Puccinia triticina*, the orange leaf rust or brown rust of wheat. The reader who, misled by the short title "The Cereal Rusts", turns to this book for a comparative or systematic account of the cereal rusts will be disappointed. He will find instead a valuable monograph on the brown leaf rust of wheat, in which the author summarizes his own researches and gives a comprehensive review of the literature with a bibliography of nearly five hundred titles. In preparing the book the author has translated a number of the major Russian contributions and made them available to other workers by depositing copies in several North American libraries.

Unlike the more familiar black stem rust (*Puccinia graminis*), the brown leaf rust overwinters in most of its geographical range in the mycelial stage on autumn-sown wheat or on volunteer wheat plants. Only in exclusively spring wheat areas, like the Canadian prairies, does the long-distance transport of spores from massive sources on autumn-sown wheat assume a dominant role. Reverse migration from cooler regions has been shown by Chester in the United States and by Mehta in India to recolonize areas where summer temperatures are too high for survival on wheat. Only in the Lake Baikal region of eastern Siberia does an alternate host regularly play a part in the annual cycle of the rust. *Isopyrum fumarioides*, a common biennial ranunculaceous weed of wheat fields in this area, regularly bears the æcidial stage and is the only means by which the rust survives the winter in this isolated area of wheat cultivation. European species of *Thalictrum* have been infected from wheat artificially, and new physiological races of the rust have been produced on this host by hybridization; but under natural conditions *Thalictrum* is apparently never affected by *P. triticina*. What are the chances of new races developing on *Isopyrum* in eastern Siberia and being borne by uredospore inocula to far distant areas where the brown leaf rust has dispensed with sexual reproduction on its alternate host? Dr. Chester thinks the possibility remote, as the Lake Baikal area is isolated by immense barriers of desert and mountain from other wheat-growing areas. In his account of dissemination the author gives reasons for considering that while dissemination of uredospores may occur over hundreds of miles as in North America and India, nevertheless the Lake Baikal area, Australia and South America are effectively isolated from the rest of the world's wheat-growing areas. Despite this comforting conclusion, *P. triticina* now exists in many physiological races which must have arisen by hybridization on *Isopyrum* or by mutation in the uredinial stage on wheat.

In trying to reduce many of these races to synonymy by introducing the notion of *race-groups*, the author will no doubt provoke criticism. However, this innovation allows him to explain the known reactions of wheat varieties to races of leaf rust in terms of the inheritance of a dozen or fewer hypothetical 'resistance-susceptibility' factors. Physiological races of the rust differ, it is suggested, in their ability to develop in the presence of some combinations of these factors. This leads to an interesting hypothesis as to the nature of the factors involved. "Resistance is commonplace, susceptibility is the rare exception. . . . It is not so much a question of what defences all other plants have that these susceptible varieties lack, as of what positive qualities these varieties have that all other plants lack." The author considers that this role may be filled by certain specific plant proteins, required by the fungus for its metabolism. Of the various kinds of evidence brought forward in support of this hypothesis those based on serological arguments are the least convincing. However, the idea should stimulate experimentation even where it fails to command assent. It falls into line with the concepts of Lwoff developed in his "Évolution physiologique", and with recent work in America and Europe on X-ray induced mutants in moulds and other fungi.

The economic importance of *Puccinia triticina*, according to Dr. Chester, has been unwarrantably under-estimated in face of the greater practical and academic attention focused on the black stem rust, *P. graminis*, with its alternate host on barberry. Extensive data are brought forward to show that, from being looked upon as harmless in Australia and the United States in the early years of this century, and relatively unimportant in the 1930's, brown leaf rust is now regarded as a severely destructive disease on half the wheat acreage of the United States, the U.S.S.R. and China. Attacking the crop earlier than stem rust, *P. triticina* represents a constant drain on the plant, less spectacular than the end-of-season epidemics of stem rust, but every few years reaching disastrous proportions over a large area of North America, as in 1938 when Thatcher wheat, bred for resistance to stem rust but susceptible to brown leaf rust, was destroyed over millions of acres. The importance of *P. triticina* has been confirmed by recent experiments in Canada by Peturson, Newton and Whiteside. In Britain this disease, like the powdery mildew, is common but is usually regarded as of little economic importance. This view appears to be supported by reiteration rather than by experiment, and it may be questioned whether any obviously destructive leaf disease can be dismissed as unimportant without carefully designed experiments in which yields of infected and healthy plots can be compared side by side. The evidence now brought forward should make us think again about *P. triticina*.

In a work of this magnitude, dealing with so many aspects of plant disease, every reader will find details to criticize and points with which he will disagree. The format of this book is larger than that of the earlier volumes in Dr. Frans Verdoorn's *Annals Cryptogamici et Phytopathologici*, and the work may stand awkwardly among its fellows on the library shelf. It is, however, a valuable addition to the literature of plant pathology.

P. H. Gregory

CONTROL OF THE GERMINAL EPITHELIUM

Contribution to the Knowledge of the Influences of Gonadotrophic and Sex Hormones on the Gonads of Rats

By J. H. Gaarenstroom and S. E. de Jongh. (Monographs on the Progress of Research in Holland during the War.) Pp. viii+164+8 plates. (New York and Amsterdam: Elsevier Publishing Co., Inc., 1946.) 8 fl.

THE idea of publishing a series of monographs on the progress of research in Holland during the recent war is an excellent one. The present volume is the seventh in the series, and consists of two main sections, and an appendix dealing with a number of diverse experimental observations. The first section concerns the hormonal factors on which the maintenance of testicular activity depends. The second deals with the corresponding aspects of ovarian physiology. Both sections are reports of experiments on rats, a fact which has to be borne in mind when generalizing the results. These show that testosterone can maintain the germinal but not the interstitial elements of the testes of rats the pituitaries of which have been removed, and that it therefore has a gonadotrophic function independent of the pituitary. The testicular involution which occurs as a result of œstrogenic stimulation can also be prevented by testosterone, and this Gaarenstroom and de Jongh interpret as being due not to any antagonistic effect of the androgen on the œstrogen, either in the pituitary or the circulation, but to the direct stimulating effect of the androgen on the testis.

This is an interesting conclusion, the more so because it diverges somewhat from previous explanations of the inhibiting influence which androgens have on the results of œstrogenic treatment. From it, and from observations on the differential effects of the two pituitary gonadotrophic hormones, Gaarenstroom and de Jongh build up a general theory of the control of spermatogenesis. Their view is that one pituitary gonadotrophic fraction stimulates the interstitial cells of the testis to produce androgenic hormone, which in turn activates the spermatogenic cycle of the germinal cells, the initial development of which is under the control of the second pituitary fraction. It is a neat theory, and there is no doubt that it helps to interpret a number of diverse observations. But it does not account for all.

The section on the ovary does not lead to such clear-cut conclusions, and is certainly more controversial. But it, too, is most stimulating to thought, and like the section on the testis, will have to be studied by all workers who are concerned in the study of the development and control of the germ cells.

S. ZUCKERMAN

RESEARCH ON THE TREMATODA

The Trematoda of British Fishes

By Dr. Ben Dawes. (Ray Society, Vol. 131 for the Years 1944 and 1945.) Pp. viii + 364. (London: Bernard Quaritch, Ltd., 1947.)

THIS book is a worthy companion to the same author's book, "The Trematoda" (Cambridge University Press, 1946). The author modestly says that he does not claim to have given an exhaustive account of the trematodes of British fishes, and it has naturally been difficult to decide whether some marine fishes caught off the coasts of the British Isles should be classified as British species or not. New records of species parasitic in particular hosts will certainly be made from time to time as fishes are caught and examined, so that no systematic account written now can hope to be complete. But Dawes has collected, in the 286 pages of classification and systematic descriptions of species in this monograph, the information available at present. To this he adds 26 pages of references to the literature and a list of the British fishes in which the trematodes occur. Both these latter features greatly add to the value of the book. Five chapters give concise accounts of the Platyhelminthes, the three orders of Trematoda and the morphology of the Monogenea, the Aspidogastrea and the Digenea. Many zoologists will find these chapters valuable, quite apart from the systematic details which follow them. A concise account of the Monogenea will be especially useful.

The preparation of this book must have entailed a great deal of labour and care, and it is gratifying to find that the publishers have given it worthy production. It is written in the author's clear and concise style, and the quality of the fifty-one drawings maintains the standard reached in the author's other book mentioned above.

No doubt these two books will stimulate others to take up the many problems which their author outlines. Experimental work is especially needed, and it is likely that, before long, work which is now going on will provide us with a sterile trematode in artificial culture, the study of which will greatly add to our knowledge of the physiology of all the Platyhelminthes. It is not impossible that we shall also learn from this work facts which will lead to a better understanding of the physiology of the Nematoda also.

The beneficent effects of such studies upon the control of diseases of man and animals caused by these organisms would be so considerable that it is to be hoped that experimental biologists will no longer neglect this fascinating field of work. So great, indeed, is the damage done to man and to his food supplies and civilization by the helminths that a strong case could be made out for the organisation of a planned attack upon them. If such an attack were planned, there is no doubt that medical men and veterinarians would heartily co-operate in it; but, before it could succeed, the basic work must be done, and that is work for the experimental biologist who understands the fundamental physiological problems involved and has the experience and training necessary for the study of them.

G. LAPAGE

A COLLECTOR'S TRAIL

The End of the Trail

By Willoughby P. Lowe. Pp. iv+178+18 plates. (Exeter: James Townsend and Sons, Ltd., 1947.) 20s. net.

IN this book, Mr. Willoughby P. Lowe gives some account of his work as a collector for the British Museum (Natural History), which has taken him into many far regions of the world. We say "some account", for Mr. Lowe has spent a life-time in quest of rare creatures and in visiting the most out-of-the-way places. In this by no means bulky volume, which is a successor to an earlier work, "The Trail that is Always New", there are chapters devoted to a winter in Tunisia, no less than four visits to Indo-China, a journey across the Sahara to the Hoggar Mountains, a trip to Tanganyika, collecting in the Ashanti Forests of the Gold Coast, and a visit to the northern territories of the Gold Coast. The reader, greedy for more, feels that these chapters are all too brief; for example, each visit to Indo-China, that ornithological paradise, might well be the subject for a volume to itself.

The facts are related in a style so studiously restrained that it might almost be termed bald, but an occasional descriptive passage gains in impressiveness from its setting. When writing of his work in Tonkin, which was mostly done just north of Hanoi, the capital, he tells us that "... we had special permission to do what we liked. Every day we wandered along the winding paths, cut in the precipitous hillsides where grew magnificent trees, flowering shrubs and ferns. Orchids hung in the shadow of the dark green foliage, and begonias and other beautiful vegetation grew in such utter confusion as to be bewildering. On the ground were fallen fruits, nuts and seeds of every description. Large macaque monkeys made their home along the paths winding in gentle gradient up the mountain slopes and dashed through the tree-tops for safety."

In this wonderful countryside a great variety of life of all kinds was encountered, and a large number of interesting specimens were obtained, including many birds and mammals new to science. The rough list of novelties discovered on this and on other trips which is given at the end of the book is impressive indeed. It embraces many newly described forms of mammals and birds and is an eloquent testimony to the author's hard work as a collector for the Museum. It also gives us a hint, though scarcely more than a hint, of a life not only well spent but also of vast and varied experience; in short, a life to be admired and envied. This book should enthral the young naturalist and set him dreaming of strange creatures in strange lands.

F. PITT

GENETICS AND ALGAL LIFE-HISTORIES

By Dr. KATHLEEN M. DREW
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IN a recent brief review, Barber[1] has directed attention to the need for incorporating results obtained from genetical and cytological studies of the algæ into the general body of genetical science. I am grateful to Prof. Barber for stimulating interest in this field of study, because most genetical work up to the present has been concerned with groups of plants having the Hofmeisterian type of life-history. It is quite unknown to what extent the algæ would lend themselves to extensive genetical investigation and whether data obtained from such experiments would conform to the genetical concepts accepted to-day for the higher plants.

In particular, Barber considered the interpretations of my cytological findings[2,3,4] in *Spermothamnion Turneri* and *Plumaria elegans*. He concludes: (1) that the plants of *S. Turneri* with ninety chromosomes are hexaploid and not triploid and that "it is thus possible that in this species two closed diplobiontic cycles exist"; (2) that the plants with thirty chromosomes are allodiploids; and (3) that the triploid–hexaploid cycle is "fast becoming genetically isolated from its progenitors and will pursue, if it can survive, its own evolutionary pattern". He points out that by not keeping the two cycles distinct, the genetical and evolutionary implications are obscured and "the primary significance of the *completed* sexual cycle is in danger of being overlooked". In *Plumaria elegans* Barber considers that the "genetical situation is entirely analogous to that obtaining in apomictic Angiosperms such as Taraxacum, Hieracium etc., and the asexually propagated bananas and oranges", and that this alga "shows both a normal floridean haploid–diploid diplobiontic cycle (to use the current algological terminology) and a genetically isolated triploid haplobiontic cycle".

With the point of view put forward by Prof. Barber in mind, the available evidence regarding the life-histories of these two floridean algæ are here reconsidered together with the fundamental considerations involved.

While a comparison of the observations in the angiosperms and the red algæ suggests that the fundamental mechanism of chromosome behaviour is the same in both groups, yet certain broad concepts applicable to the angiosperms cannot be transferred without modification to the algæ. The following remarks apply particularly to those red algæ with the *Polysiphonia*-type of life-history. In such algæ the separation of the haploid and diploid phases of the sexual cycle into two physiologically separate entities (omitting any consideration of the cystocarp for the time being) contrasts sharply with the angiosperms, where the haploid is considerably reduced, enclosed in and physiologically dependent on the diploid, which, in fact, exhibits sexual characters.

This somatically separate existence of the two phases is one of the facts which necessitate modification of certain concepts accepted for higher plants. In the first place, the 'progeny' of the diploid phase is the haploid phase and vice versa. While the same is strictly true in the angiosperms, the succeeding diploid phase is referred to as the 'progeny' of the previous diploid. The completion of the gametophyte–sporophyte cycle in these algæ is dependent on the successful establishment, maturation and reproduction of two separate individuals, possibly with different sets of conditioning factors.

Secondly, while the sexual organs are usually restricted to the gametophyte and the tetrasporangia to the sporophyte in such algæ, cases are recorded (especially in the Ceramiales) where, with varying degrees of frequency, both sexual organs and sporangia occur on the same individuals. Whether these individuals are haploid or diploid is unknown except in the cases of *Spermothamnion Turneri*, where cytological evidence shows that the diploid bears both functional diploid sex organs as well as sporangia in which meiosis occurs, and *Nitophyllum punctatum*[5], where sporangia occur on the haploid gametophyte but undergo no reduction division. These examples contrast with the diploid gametophytes of the Bryophyta and Pteridophyta, which usually bear sex organs only. In the latter case, the sequence of reproductive phases and the fundamental gametophyte–sporophyte cycle persists and is dependent evidently on factors other than the chromosome number; but in the algæ cited above the gametophyte–sporophyte cycle is either in the process of being established or is upset. If it is upset, it can be considered either an abnormality or an example of the transference of sexuality to the diploid as has happened in the angiosperms. These examples in no way invalidate Sharp's[6] contention that both genetic and non-genetic factors are concerned in the determination of sex as well as of life-histories. The cystocarp of the Florideæ demonstrates that chromosome number is not the predominant factor in determining the sequence of phases, for in some families it has the chromosome number of the gametophyte and in others the chromosome number of the sporophyte.

Thirdly, the formation of triploids and tetraploids becomes possible, and indeed probable, as a result of the occurrence of sex organs on the diploid, as is shown by *S. Turneri*. The fertilization of the carpogonium on a diploid by a haploid spermatium or vice versa and the production of a triploid involves no abnormality in the formation of the gametes. It is comparable to the diploid × tetraploid cross in the higher plants and not with the forms which originate as the result of some abnormality, as in cases where meiosis is nullified or suppressed or syndiploidy occurs. The genetical consequences are different in the two types.

With these general remarks as a background, the evidence available for *S. Turneri* is now summarized. Along the British coast, plants with 30, 60, 90 and 45–50 chromosomes occur. The same is true for the Atlantic coast of North America in the vicinity of Woods Hole, with the exception that there is only indirect evidence of the occurrence of plants with thirty chromosomes. In the earlier work, I regarded thirty chromosomes as the typical haploid chromosome number. Arguing from the genetical point of view Barber suggests that fifteen is the haploid number. The only other species of this genus for which the chromosome number is known is the Pacific species *S. Snyderæ* (*loc. cit.*, ref. 7), and this has thirty-one. At present, therefore, no definite conclusion about the haploid number can be reached.

The British plants of *S. Turneri* with thirty chromosomes bear sex organs and cystocarps and occasionally undivided sporangium mother cells, sometimes healthy, sometimes degenerated. Plants with sixty chromosomes, particularly those in

American waters, are characterized by the occurrence of both functional sex organs and normal tetrasporangia. A normal reduction division precedes the formation of the tetraspores, but no reduction division precedes the formation of the carpogonium. These American plants are known to produce cystocarps, the chromosomes of the divided carpogonium nucleus and the nuclei of the gonimoblast numbering approximately 120. (There are great technical difficulties in obtaining accurate counts of these high numbers; but details of the degree of accuracy reached have been given (*loc. cit.*, ref. 10). Two gonimoblasts (one American, one British) with approximately ninety chromosomes have also been seen and presumably originated from the fusion of sexual cells one with thirty and the other with sixty chromosomes. With the exception of one bearing a degenerated procarpic branch, no reproductive organs had been found on plants known to have ninety chromosomes. The existence of plants with approximately half this chromosome number, that is, 45–50, suggests the occurrence of an irregular meiosis in tetrasporangia on the plants with ninety chromosomes.

In *S. Turneri* certain facts suggest that the production of triploid plants is not necessarily a rare phenomenon; on the contrary, it may be occasional or even common. The facts (1) that triploid plants (with ninety chromosomes) were found on both sides of the Atlantic among the comparatively few plants of known chromosome number, and (2) that, among the still fewer nuclei available in gonimoblasts in a suitable condition for counting, two were triploid support this view. While the evidence suggests the existence of a 45–50 ⇄ 90 cycle, it appears to me from a consensus of evidence that it is not improbable that these plants reproduce most frequently by vegetative means. If there is a tendency for such a cycle to become genetically isolated, the repeated formation of plants with ninety chromosomes must ultimately result in the production of several genetical strains. It is possible that the formation of the triploid is easier to accomplish in the algæ than in the flowering plants, where the tetraploid × diploid cross is difficult to effect, since environmental conditioning factors such as size relations, endosperm, etc., may be fewer. On this there must be, however, a suspension of judgment until investigations have been extended. It should be noted that if it is accepted that plants with ninety chromosomes are triploid, a difficulty arises in finding a suitable designation for plants with 45–50 chromosomes.

In *Plumaria elegans* sexual plants with thirty-one chromosomes, tetraspore plants with sixty-two and parasporangia-bearing plants with ninety-three occur. The method of origin of the triploid is unknown; but it is possible that it originated in a manner similar to that of *S. Turneri*, that is, by the fusion of a haploid with a diploid gamete. Alternative possibilities that suggest themselves are the fusion of the diploid fusion nucleus with the haploid nucleus of the auxiliary cell or the fusion of the nuclei of two spermatia with the carpogonium nucleus. Unlike the triploid of *S. Turneri* and, in fact, all triploids, that of *P. elegans* has a special type of spore, the paraspore, which reproduces the triploid. Since parasporangia develop only on triploid individuals, it seems permissible to assume they represent a morphogenetic expression of the triploid condition. A comparison of the vegetative propagation of triploid angiosperms with the paraspores of *P. elegans* is no more than a broad biological analogy.

The triploid of *P. elegans* resembles those of angiosperms, however, in having a considerably wider distribution than the haploid and diploid. In this connexion it should be pointed out that the reproduction of the triploid is dependent only on the successful production and germination of the paraspores, whereas the survival of the haploid and diploid is interdependent and depends on the completion of highly specialized reproductive processes. There is nothing to suggest that this triploid is being formed repeatedly, and this being so, it is isolated genetically from the sexual cycle. Tetraspores develop occasionally on this triploid but were too rare for the details of the nuclear divisions to be followed.

Polyploidy, involving specific differences like that occurring in the genera *Chrysanthemum* and *Solanum*, may also occur in the red algæ, and a study of genera such as *Polysiphonia* and *Ceramium* might yield interesting results.

In the algæ, as in the higher plants, it seems possible that autopolyploids may arise by the doubling of the chromosome number in the vegetative nuclei. *Spermothamnion Turneri* has multinucleate cells, and in one of these a nucleus with at least fifty-four chromosomes occurred, all the other nuclei having approximately thirty. Likewise in the polysporangia of *Spermothamnion Snyderæ*[7], nuclei with two or even three multiples of n occurred in the same sporangium. As some nuclei were observed coalescing, this probably provides the explanation of the varied chromosome numbers. Coalescence did not appear to stop meiosis entirely, but the majority of the sporangia on such plants degenerated before maturity.

These observations have all been based on plants growing in Nature, and show the need for more extensive experimental genetical work on the algæ under conditions of culture. A satisfactory culture technique is a preliminary requisite, however, and while some of the simpler forms have been cultured successfully[8] little has been achieved with the more complex marine forms. A preliminary attempt of mine has had some success, and Hassinger is reported by Hartmann[9] to have succeeded in culturing *Callithamnion collymbosum* and to have analysed genetically interesting deviations. A full account of this work is not yet available.

In his article Barber also raised questions of terminology, and I agree that triplo- and polybiontic are unsuitable terms. I[10] have discarded these together with haplo- and diplobiontic and suggested that it would seem more exact to state that the life-history is morphologically mono-, di, tri- or polyphasic and cytologically mono-, di-, tri- or polyphasic. I still adhere to this, these terms being intended to convey a summary of the morphological and cytological facts of each case and nothing more. Such a summary is needed in the algæ where there may be more than one haploid or diploid phases, as in some Ectocarpales and the Florideæ, for example, and where forms such as *S. Turneri* and *P. elegans* occur. The terms haplont, diplont and diplohaplont express the relative length of the n and $2n$ phases.

I have defined life-history[10] as "the observed sequence or sequences of somatic and nuclear phases known for the species under consideration". Life-history, therefore, is not synonymous with completed sexual cycle, which is always a cyclic sequence of two nuclear phases requiring no cytological qualifying term, since it is independent, to a certain extent at any rate, of chromosome number. In *S. Turneri*, for example, it is conceivable, but not proved, that the life-history includes two or even three completed sexual cycles, the 30 $\rightleftarrows$ 60, 60 $\rightleftarrows$ 120 and 45–50 $\rightleftarrows$ 90. Whether or not they are closed independent cycles cannot be decided on the evidence at present available. Should they be independent, the evolutionary implications would be all the greater. In *P. elegans*, on the other hand, the life-history includes only one completed sexual cycle and the triploid appears to be a 'dead-end' from the evolutionary point of view.

Thus, while agreeing with Prof. Barber up to a point, I have endeavoured to show that life-histories in the algæ are conditioned by non-genetic as well as genetic factors, and that, until more data are available, some restraint in applying genetical concepts based on the higher plants should be exercised.

I am also making a plea for wider and more extensive studies of the life-histories in the various classes of algæ. It is now recognized that while the Hofmeisterian cycle provides an adequate account of the life-history of Bryophyta, Pteridophyta and Spermatophyta, it does not suffice to describe the many types of life-history to be found in the algæ. A knowledge of morphology, physiology and cytology as well as of genetics is necessary for an analysis of the factors conditioning the life-histories in this group of plants and for an understanding of how the gametophyte–sporophyte cycles of the higher plants arose.

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BIOCHEMICAL REACTIONS OF CHEMICAL WARFARE AGENTS

THE true nature of Greek Fire is still wrapped in mystery and it is difficult to decide whether its use constituted chemical warfare. Chemical warfare, as we know it, was employed only in the First World War (1914–18), when mustard gas and phosgene were used and the study of their pathology was commenced. Work on the nature of these agents proceeded slowly from 1920 until 1939, when there was increased interest in poison gas. Since the Second World War ended, some of the work which was carried out for the British and American Governments has been released, or 'declassified' as the Americans say, and been published. The Biochemical Society arranged a symposium held at the London School of Hygiene and Tropical Medicine on some aspects of the biochemistry of these substances on December 13.

In introducing the symposium, Dr. Malcolm Dixon described how much of the biochemical research work was carried out by three extra-mural teams under Prof. R. A. Peters at Oxford, Prof. A. Wormall of St. Bartholomew's Hospital, London, and himself at Cambridge. Similar teams had worked on the problems in the United States. Much of the matter has interest apart from the original purpose of the investigations. In fact, many of the substances developed for use in the event of chemical warfare have found direct peace-time applications. Examples of this include the British anti-lewisite (*B.A.L.*), a general remedy for arsenical poisoning; di*iso*propylfluorophosphonate (*D.F.P.*), which is being used as a parasympathomimetic drug in treatment of myasthenia gravis; and methyl *bis*(β-chloroethyl)-amine or nitrogen mustard, used in palliation of Hodgkin's disease.

Chemical Reactions of Mustard Gas

Dr. A. G. Ogston gave the first paper of the symposium, dealing with "The Reactions of Mustard Gas in Aqueous Solution". Earlier work, starting with that of R. A. Peters and E. Walker (*Biochem. J.*, **17**, 260; 1923), on the kinetics of the hydrolysis of mustard gas in water had shown that the reactions of hydrolysis and substitution are of the 'SN_1' type described by Ingold. The initial reaction appears to be an activation process of the first order. The activated form can then undergo a number of different second-order reactions with different substances. The secondary reactions compete with each other, so that the final products depend upon the concentrations and velocity constants of reactions of the substituting reagents present. Mustard gas can combine with almost all chemically reactive groups of biological systems. The differences in velocity constants of the activated molecules for reaction with different substances or groups can be expressed by means of competition factors. Thus thiophosphonates which react readily with mustard gas have high competition factors. Substances with high competition factors were tried as therapeutic agents for mustard gas poisoning, but were not very effective. The reaction of mustard gas, ββ-dichloroethyl sulphide, with water leads first to the half-hydrolysis product, β-hydroxyethyl β-chloroethyl sulphide, and then to thiodiglycol. The half-hydrolysis product has only one tenth of the toxicity of mustard gas.

Dr. J. C. Boursnell discussed the reaction of mustard gas with proteins. Early work had shown that mustard gas reacts with horse serum to give a new antigen, that it inactivates enzymes and combines with kerateine to give a product with increased chlorine and sulphur content (R. A. Peters). The free amino-groups of proteins react in alkaline solution; but other groups must also react, as the phenyl*iso*cyanate derivatives of proteins in which the amino-groups are blocked still combine with vesicants. The protein carboxyl groups also react to give alkali labile derivatives, and nutritional studies with proteins treated with mustard gas have indicated that histidine, lysine, methionine and threonine residues have reacted. Nucleoproteins react to give insoluble derivatives with high sulphur and phosphorus content (I. Berenblum and R. Schoental, *Nature*, **159**, 727; 1947). Studies with mustard gas containing radioactive sulphur (S^{35}) have shown that when the material is injected intravenously into rabbits most of the sulphur is fixed in the lungs and kidney, but pathological studies show that these organs are not seriously damaged by the vesicant.

Effects of Mustard Gas on Enzymes and Tissues

Dr. D. M. Needham described some of the work on the effect of mustard gas on enzymes and tissues. A brief account of this aspect of the subject has already appeared in *Nature* (M. Dixon and D. M. Needham, *Nature*, **158**, 432; 1946). Of a large number of enzymes subjected to the action of mustard gas in low concentrations, only the phosphokinases and some proteinases are markedly inhibited. Of the phosphokinases, hexokinase was the first to be examined, and it is probably due to inhibition of this enzyme and deuterohexokinase that the glycolysis of tissues is inhibited by vesicants. Hexokinase is a sulphydryl enzyme, but the inactivation by mustard gas appears to be due to reaction with other groups than the sulphydryl group. When hexokinase is inactivated, five or six molecules of mustard gas react with each molecule of the enzyme. Hexokinase is inhibited in the skin of animals treated with mustard gas, and this effect may be the fundamental cause of the pathological changes. Creatine phosphokinase is even more sensitive to mustard gas when tested *in vitro* but is not inhibited in tissues of animals treated with the vesicant.

British Anti-Lewisite

The development of British anti-lewisite (*B.A.L.*), which is a product of the Biochemical Laboratory at Oxford, was outlined by Dr. R. H. S. Thompson (cf. R. A. Peters, L. A. Stocken and R. H. S. Thompson, *Nature*, 156, 616; 1945). Early work carried out at Oxford (E. Walker, *Biochem. J.*, 22, 292; 1928) and in the United States showed that arsenicals reacted readily with SH groups of glutathione or of proteins. Sodium arsenite and the arsenical vesicant, lewisite, poison the pyruvic acid oxidase system of brain tissue, and the blood of animals poisoned with arsenicals has a high concentration of pyruvate analogous to that occurring in thiamine deficiency.

The pyruvic oxidase system was used as an *in vitro* test for substances which would neutralize the toxicity of arsenicals. Study of the reaction of arsenicals with kerateine showed that each atom of arsenic reacted with two SH groups of the protein. Monothiol compounds had no effect in neutralizing arsenical poisoning, but a number of dithiols were effective. Of the latter, 2 : 3-dimercaptopropanol was the most suitable, and proved to be an efficient antidote both when tested *in vitro* with the pyruvate oxidase system and *in vivo* against the vesicant action of lewisite on human skin and against the toxic action in animals and men. This compound was called 'British Anti-Lewisite' (*B.A.L.*), and it is now used clinically in treatment of arsenical dermatitis. Dr. Thompson suggested that sulphydryl enzymes might be divided into two classes: (*a*) those which are protected by monothiols, as are choline esterase and hexokinase; and (*b*) those which require dithiols, as do pyrophosphatase and pyruvate oxidase. It is possible that members of the second class require two thiol groups in close proximity for their action, whereas those of the first group need only one thiol group.

Lachrymators

Dr. M. Dixon, in describing the reactions of lachrymators with enzymes and proteins, showed how most lachrymators fall into three classes: the active ('positive') halogen compounds, unsaturated compounds and arsenicals. All lachrymators of these classes poison sulphydryl enzymes, and this suggested that the lachrymators react with sulphydryl residues. Many different experiments showed this to be the case, and the lachrymators are specific reagents for identifying sulphydryl enzymes. The active halogen-containing lachrymators can be used for the manometric estimation of sulphydryl groups as they react rapidly, giving acid proportional to the sulphydryl groups present.

Alkyl Fluorophosphonates

The alkyl fluorophosphonates are highly toxic substances, first made by Dr. B. C. Saunders and shown by Prof. E. D. Adrian and Dr. W. Feldberg and by Dr. Mackworth to be inhibitors of choline esterase. Dr. E. C. Webb discussed the nature of this inhibition, which is non-competitive and not reversed by dialysis. Eserine also inhibits choline esterase, but such inhibition is competitive (being reduced by increase in concentration of the substrate, acetylcholine) and reversible on dialysis. These new compounds are very potent. Thus horse serum choline esterase (that is, pseudo-choline esterase) is inhibited to the extent of 50 per cent by $1\cdot3 \times 10^{-9}$ *M* di*iso*propylfluorophosphonate. Such fluorophosphonates poison other esterases, such as liver esterase. In addition to the fluorophosphonates, hexaethyltetraphosphate and tetraethylpyrophosphate, which were introduced as insecticides, have been found to be extremely potent poisons of choline esterase.

'Nitrogen Mustards'

The pharmacology of the chloroethylamines, to which class the 'nitrogen mustards' belong, was described by Dr. E. Boyland. The nitrogenous vesicants, which are poly(β-chloroethyl)amines, have many properties similar to mustard gas. Study of these substances led to the discovery of interesting pharmacological properties in related compounds. Dimethyl-β-chloroethylamine, on injection into animals, causes prolonged partial paralysis, so that treated mice have the appearance of waltzing mice. Dibenzyl-β-chloroethylamine (known as 'dibenamine') antagonizes and reverses the action of adrenaline on the blood pressure. The alkyl *bis* (β-chloroethyl)-amines are very toxic substances and potent vesicants. The best known of these is methyl *bis* (β-chloroethyl)-amine (HN2). These chloroethylamines are very reactive and combine with many tissue constituents and with water to produce a series of products. One of the hydrolysis products, which has been identified as β-hydroxyethyl methyl ethyleneimonium chloride, causes partial paralysis and rapid death of mice, with convulsions. The poly(β-chloroethyl)amines are also of interest because, like mustard gas, they are radiomimetic poisons—many of their effects resemble those produced by ionizing radiations. Such effects include vesication, death following hæmoconcentration due to loss of fluid by diarrhœa and vomiting, particularly severe damage to the intestinal tract, bone marrow and lymphoid tissue, resulting in reductions in the concentrations of circulating leucocytes and platelets. Both kinds of agent have similar effects on cell nuclei, causing stickiness of nuclei and chromosome breaks. They have been shown to induce mutations in *Drosophila*, *Neurospora* and *Escherichia coli*. Both the vesicants and radioactive material cause greying of the hair of coloured mice without preventing the growth of the hair. The poly(β-chloroethyl)amines have been used clinically as alternatives to radiotherapy in the treatment of leukæmia, Hodgkin's disease and bronchogenic carcinoma. One of the drawbacks to the treatment is the nausea and vomiting caused, which are similar to radiation sickness. The similarity in effects of vesicants and radiations suggests that the study of the action of vesicants may lead to increased knowledge of the mechanism of the biological action of radiations.

At the conclusion of the symposium, Prof. R. A. Peters expressed the view that the investigations on war gases which had been started should be carried to their conclusion. He thought that biochemistry owed a debt to the Ministry of Supply, and particularly to Mr. J. Davidson Pratt and Mr. L. T. D. Williams, for their encouragement of biochemical investigations into these particular war-time projects. Much of the research has given us knowledge which is of both academic interest and practical value in peace-time.

E. BOYLAND

REPRODUCTION OF PHOTOGRAPHICALLY RECORDED OSCILLOGRAPH SIGNALS

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THE practice of recording the secular variation of an E.M.F. signal, representing some physical variable, by photographing an oscillograph screen on a moving film, is now common to almost every branch of applied science; in the past decade, many thousands of feet of film have been so used in the study of an ever-increasing variety of problems. Doubtless the versatility of the cathode ray oscilloscope is at the same time the *raison d'être* and the *sine qua non* for this ubiquity, not the least of its good qualities being its robustness and ability to continue operating under conditions which would preclude other methods.

Frequently it is required to analyse the oscillograph film record in some detail: the peak, mean, or root mean square values of the wave may be required, the Fourier components, or the value of certain ordinates and their corresponding abscissæ. Often, too, the analysis is of such a nature that it could most readily be carried out by electronic methods, as when the operation to be performed is a function of a differential operator. In view of these considerations, especially in the study of mechanical vibrations, it became evident that a means of converting the oscillograph record into an E.M.F. signal would be of value, and accordingly experiments were undertaken which resulted in the production of the curve follower described here.

The development of the instrument was both a test of the applicability of the principle employed to the general requirements enumerated above, and an attempt to meet a specialized need for a means of reproducing certain records containing frequencies from zero to about 200 c./s. Before the work was commenced, however, careful consideration was given to the possibility of employing one or other of the conventional means of acoustic reproduction (if necessary, using a frequency modulated system), such as sound-on-film or disk, or magnetic tape, and in this connexion special importance was attached to the following factors: the size and ruggedness of the recording equipment; its ability to operate in the presence of mechanical vibrations of acceleration magnitude several times that of gravity; its frequency response; and the reliability with which the original signal could be systematically and continuously reproduced. Direct reproduction from an oscillograph record offered a number of advantages: the recording apparatus is readily portable and insensitive to mechanical vibrations, consisting only of the standard laboratory type of oscilloscope and camera; and, moreover, visual observation of the signal can be carried out directly both from the record or from the tube screen. The frequency response of the reproducing equipment is constant down to D.C., a reading of the ordinate being obtained on a voltmeter plugged into the output whether the film is or is not in motion. The output-level is high without amplification (of the order of tens of volts) and is insensitive to changes in the characteristics of components or to the contrast or gradation of the film; and, moreover, it was thought that the method would be of value as an automatic curve follower for feeding analysers with any curve from which a photographic copy or other suitable black-and-white transparency could be made.

The film record, consisting of a clear line trace upon a dark ground, is mounted so as to pass between a lens and a photo-electric cell, while before the lens with its screen focused on the film is a cathode ray tube. A linear 'time-base' moves the cathode ray spot across the screen so that its image scans the film along the ordinate until it reaches the trace, at which instant the sudden change in light entering the photocell produces a pulse which is used to trigger the 'time-base', causing it to restart its sweep from the edge of the record. This process is repeated several thousand times a second, so that the mean voltage on the cathode ray tube deflector plates is a measure of the distance the spot moves from the edge of the record, that is, of the ordinate. Thus, by filtering out the time-base frequency from the sweep voltage, a signal proportional to the ordinate is obtained, and providing the frequency of variation of the signal is less than the scanning frequency by a factor greater than about 5, there is a faithful reproduction of the record.

In the initial experiments all the electronic circuits apart from the photocell were provided by a commercial type of laboratory oscilloscope (the 4-inch double-beam instrument made by Messrs. Cossor, Ltd.), the sweep voltage being produced by the oscilloscope's own 'time-base', while the amplification of the synchronizing pulse was performed by the deflexion amplifiers of the same instrument, the film being repassed through the camera that was used to make the record after it had been modified to take a photo-electric cell behind the film.

As a result of the success of these experiments and in view of the mechanical and electrical simplicity of the method, it was decided to build the instrument shown in Fig. 1, capable of reproducing continuously a loop recording carried on an aluminium drum 10 ft. in circumference. This form of construction was chosen because it completely eliminates wear on the film, and also with the view of using the instrument as the scanning part of an analyser of the type developed by Barber and his colleagues at the Admiralty Research Laboratories[1]. This analyser employs a varying width black-and-white record on photographic paper, mounted on a drum which revolves at a slowly decreasing speed. As the speed falls, each harmonic of the record is in turn brought into resonance with a vibrating galvanometer, from which a signal is obtained providing the Fourier amplitude analysis of the record. The possibility of using such an analyser directly on an oscillograph record is a considerable simplification, and at the

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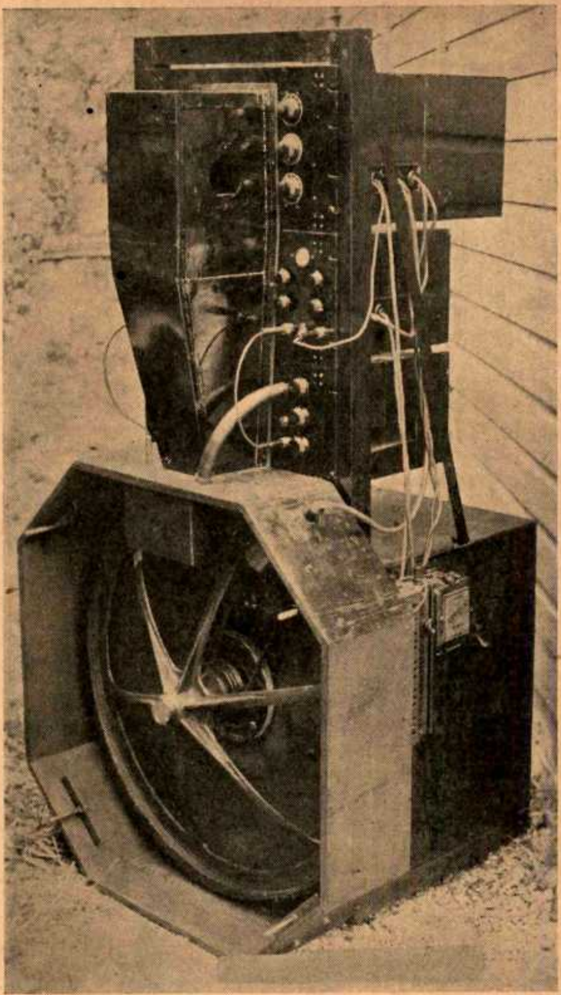


Fig. 1. CURVE FOLLOWER. THE COMPLETE INSTRUMENT IS 5 FT. HIGH

same time makes it possible to deal with record samples containing a harmonic range some ten times wider than was previously possible. The drum of the curve follower is the only part of the instrument which was required to be made with a high degree of precision, as any axial motion of the film would introduce a spurious signal. It would not, however, be difficult to remove the need for precision here by arranging the scan to start from some fixed line on the film, instead of some fixed voltage on the deflector plates.

The basic requirements for faithful reproduction are that there shall be an adequate rate of scan to deal with the highest frequency present in the record; that synchronization of the sweep occur reliably; that the deflexion voltage after filtering be accurately proportional to the peak deflexion voltage before filtering; and that the record be clearly defined and free from blemishes. There are two factors likely to influence the highest frequency which can be satisfactorily reproduced, assuming a record of sufficient contrast and resolution has been obtained. First, the geometry of the trace and scanning spot, as determined by the film velocity, trace thickness and electrical and optical focus of the spot must be taken into consideration; and secondly, the frequency response of the photocell and electrical circuits is important.

It is not difficult, using ordinary laboratory oscilloscopes and cameras, to produce records in which the trace is 0·005 in. wide, and a scanning spot of the same size can readily be obtained, so that it should be possible to reproduce wave-lengths on the film of 0·05 in. with an error in amplitude of about 1 per cent. Using a film speed of 18 in./sec., this would give an upper frequency limit of 360 c./s. (At the same film-speed, twice this frequency could theoretically be attained with an error in magnitude of about 12 per cent, and even this could be reduced at the cost of some slight harmonic distortion by shaping the response of the output filter.) In the present apparatus a variable film-speed up to 18 in./sec. is employed, and since, as has already been mentioned, the frequency band of interest is 0–200 c./s., there is an ample margin of response.

On considering the question of the frequency response of the electronic components, it is clear that the photocell and circuits have to deal with a pulse lasting for a small fraction of the scanning period, which itself is some ten times shorter than the period of the maximum frequency to be reproduced. This gives a pulse of about 10–15 microsec. (Fig. 2), which presents no problem so far as amplification is concerned (a straight two-stage resistance-condenser coupled amplifier is employed) but does make it necessary to give careful consideration to the photocell and cathode ray tube screen.

Let J be the luminous power from the scanning spot reaching the photocell through a clear part of the record, β the opacity of the dark part of the record, c the velocity of the scanning spot at the film, d the trace width, and T the decay constant of the oscilloscope's screen luminescence (assumed exponential). Then the change in luminous power reaching the photocell when the light spot reaches the trace is given approximately by:

$$\Delta J = \pm(1 - 1/\beta)\,\{1 - \exp(-d/cT)\}\,J,$$

the positive sign corresponding to a clear trace on a dark ground, and the negative sign to the reverse.

T is large compared with d/c, so that $\triangle J$ decreases rapidly as the scanning speed increases, and eventually becomes swamped by the shot noise from the photocell. In the early experiments a gas-filled cell was used, but the reproduction of the higher frequencies makes a hard cell more suitable, especially if it is of the electron multiplier type. If such a cell is used (as is the case here) the root mean square shot noise current is proportional to the square root of the mean cell current.

To prevent spurious synchronization of the sweep, the shot noise and hence the mean cell current (while the spot is not on the trace) must be kept at a minimum, and for this reason the transparent trace-on-a-dark-ground type of record is employed. This gives a shot noise $1/\sqrt{\beta}$ times that due to the reverse

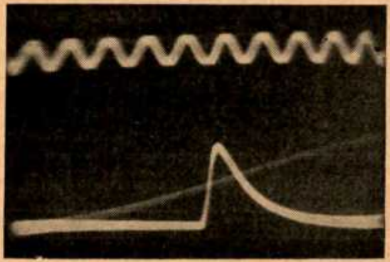


Fig. 2. SYNCHRONIZING PULSE

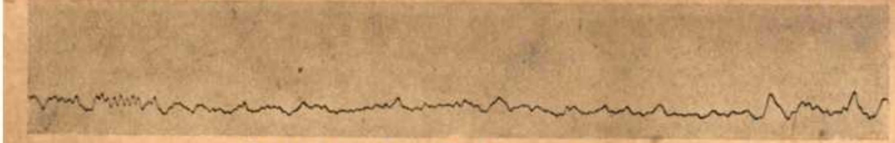


Fig. 3. CONTACT PRINT FROM SPECIMEN RECORD

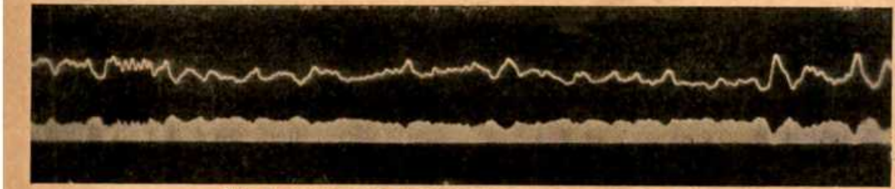


Fig. 4. ELECTRICAL REPRODUCTION OF RECORD IN FIG. 3

type, and at the same time reduces by the square of this factor noise due to modulation of the spot brilliance such as may occur if the oscillograph screen is not of uniform sensitivity. Reliable synchronization has also been assisted by thoroughly smoothing the voltage supplies to those electrodes affecting spot brilliance ; by using the first tube of the amplifier as a short time-constant electrometer and so partially integrating the pulse current ; and by introducing a small diode which rejects signals in the synchronizing circuit below a certain amplitude.

A fairly high-voltage cathode ray tube has been employed, as this gives a longer screen life than would a low-voltage tube operating at the same brilliance. The lens used with this tube is an f 1·0 coated anastigmat giving an optical reduction to 1/10.

The final output signal of the curve follower is obtained by feeding the 4 kc./s. scanning voltage through a low-pass filter preceded and terminated by cathode follower circuits, and having a cut-off at about 1 kc./s. In order that the voltage so obtained may be a faithful reproduction of the amplitude envelope of the scanning voltage, it is necessary for the latter to be linear (with respect to time) and for flyback and restart to be relatively instantaneous. For this reason O. S. Puckle's hard-valve time-base circuit[2] has been employed, the only modification being the addition of a diode to limit the flyback and so to ensure that the scan always restarts at the same voltage irrespective of the previous ordinate scanned. This was found useful in practice, though a careful setting of the time-constants of the circuits might make it unnecessary.

A microammeter reading the photocell current and a small monitoring oscilloscope have been provided to assist in setting the controls.

It will be appreciated that the absence of any requirement for a high-gain linear amplifier and the fact that the only voltage to which the output-level is sensitive is the accelerating voltage on the cathode ray tube are valuable factors, as they simplify greatly the problem of stabilization. Further, the photographic technique presents no difficulties and requires no specialized equipment, since it is only necessary to provide sufficient contrast and adequate transparency of the trace ; gradation and the actual value of the contrast being of no importance. A reversal process must, of course, be employed. At the present time Ilford 5*G*91 film is used, developed in *ID*.33 to which a small quantity of formaldehyde has been added as hardener, potassium dichromate and sulphuric acid being used for bleaching prior to redevelopment in the same developer. Initial development is carried out until there is considerable fogging, as this ensures a maximum transparency of the trace while only slightly decreasing the density of the blacks.

When the instrument is correctly adjusted, the background noise voltage, as determined by measuring the signal when the instrument was scanning a straight line trace, is about 0·5 per cent of the maximum voltage output. An idea of the performance can be gained from Figs. 3 and 4. The upper trace of Fig. 4 is an oscillograph record of the output of the curve follower when scanning the record of which Fig. 3 is a contact print. The lower trace of Fig. 4 is a record of the unfiltered scanning voltage (the phase reversal being introduced by the oscillograph used to make records).

Thanks are due to the Board of Admiralty for permission to publish this article.

[1] Barber, Ursel, Darbyshire and Tucker, *Nature*, **158**, 329 (1946).

[2] Puckle, O. S., *J. Televis. Soc.*, **2**, No. 5 (1936).

OBITUARIES

Prof. Theodore D. A. Cockerell

PROF. THEODORE D. A. COCKERELL, the distinguished naturalist and moralist, died suddenly at San Diego, California, on January 26 at the age of eighty-one.

He was born on August 22, 1866, the eldest of the six children of Sydney J. Cockerell, of Beckenham, Kent ; a younger brother, now Sir Sydney Cockerell, was for many years director of the Fitzwilliam Museum, Cambridge. Threatened with tuberculosis at the age of twenty-one, he went to live in the mountains of Colorado and thrived there. Later, he held appointments at the Public Museum, Kingston, Jamaica, at the New Mexico Agricultural College, and finally back again at Colorado as professor of zoology at the University of Colorado at Boulder, where he spent the greater part of his life.

Cockerell was a keen naturalist from his earliest days, and started publishing his first observations at the age of twelve. He travelled in all the continents of the world, making collections in Hawaii, Japan, Siberia, Australia, Madeira, Morocco, the Belgian Congo, Honduras and Argentine. So recently as 1946 he flew with his wife to Honduras, intent on exploring the little-known fauna and flora of that country, and he discovered there many previously unknown animals.

He was a prolific and versatile writer on any aspect of natural history, education and ethics that crossed his path. He opened new fields for research on such subjects as snails, scale insects, fossil insects, the genetics of sunflowers, the scales of fishes, the anatomy of rodents and the classification of bees. Working early under the shadow of imminent death, he acquired the habit of hurrying his ideas and observations into print as soon as he could. The habit persisted throughout his long life, so that almost all his work appeared in the form of short papers. On the insects alone he published more than 1,200 of these. He proposed 5,500 new names for species and varieties of animals of all classes, though he worked most at the bees as he loved them the best. His collections he gave away to public museums as fast as they accumulated; 13,700 specimens of insects, many of them unique types, he gave to the British Museum (Natural History).

A final appraisal of this huge amount of work must, of course, await the verdict of future investigators. Cockerell worked easily and incessantly, and he inspired generations of American students with his quiet enthusiasm for natural history, his youthful and modern outlook, and his simple goodness; he was beloved by all who knew him.

He was twice married: first to Anne Fenn, daughter of Manville Fenn, the novelist, and afterwards to Willmatt Porter, an American devoted to the study of natural history, who survives him.

ROBERT B. BENSON

Prof. R. E. Liesegang

BY the death of Raphael Edward Liesegang on November 13, at Homburg vor der Hoehe, in his seventy-eighth year, colloid science loses one of its most cultured members.

The early years of the present century witnessed the gradual transition of interest in colloid science from its qualitative and descriptive to its quantitative and mathematical aspects. A few notable workers, now a rapidly diminishing number, made their contributions over this period of transition. Among these, R. E. Liesegang must be regarded as one of the most important. Temperamentally, he was endowed with a high artistic sense, and both his command of languages and the purity of his prose were attributes which played an important part in his scientific work.

His name will always be associated with that interesting phenomenon of periodic precipitation in gels, resulting in the formation of 'Liesegang rings'. The beautiful structures in banded agates can readily be reproduced in the laboratory by diffusion of electrolytes into gels containing suitable precipitants. Many claims resting, however, on somewhat more slender experimental evidence have also been made to interpret several different types of lamellar structures in biological material in terms of Liesegang precipitation.

Liesegang made notable contributions to our knowledge of the sensitiveness of photographic emulsions to light, and must be regarded as one of the pioneers in the fields of colour photography and television. Investigators interested in the early development of methods owe a great debt to Liesegang for his "Kolloidchemische Technologie". ERIC K. RIDEAL

WE regret to announce the following deaths:

Dr. C. W. Kimmins, for many years chief inspector of the Education Department of the London County Council, on January 12, aged ninety-one.

Prof. Burton E. Livingston, emeritus professor of plant physiology, Johns Hopkins University, aged seventy-two.

NEWS and VIEWS

British Hydromechanics Research Association

THE design and manufacture of hydraulic machinery is one of the oldest and most important branches of mechanical engineering, including, as it does, water turbines for power production, pumps of all kinds for water and other liquids, hydraulic presses for various purposes and a great variety of other machines and equipment associated with nearly all forms of industrial activity. At the present time, British manufacturers of such machinery are making a full and valuable contribution to the export drive. But the industry is a competitive one, and it is welcome news that despite their present preoccupations, the leading manufacturers have realized that it is only by continuous co-operative research and development that these activities can be maintained and extended, and have formed the British Hydromechanics Research Association for this purpose. The president of the Association is Sir John Anderson, and it is a good sign that the Council, in addition to representatives of the leading manufacturers, includes representatives of large users of hydraulic machinery.

The director of the new Association will be Mr. L. E. Prosser, who has had many years experience of research in basic and applied fluid mechanics at the National Physical Laboratory, and of the application of the results of such researches to the solution of important problems encountered in engineering practice. The Association will work in close co-operation with the new Mechanical Engineering Research Organisation of the Department of Scientific and Industrial Research, which is planning to erect a well-equipped hydraulic machinery research laboratory as one of its most important activities in the general development of mechanical engineering science and its application to useful purposes. It has been said with some justification that whereas Great Britain has taken a leading part in the development and application of research in aerodynamics, the sister science of hydromechanics has been neglected. These new activities should go a long way to remedy this discrepancy, with resulting advantages both to manufacturers and to users of hydraulic machinery.

Research in Central Africa: Dr. J. E. Keyston

SUPPORT was forthcoming from all branches of scientific opinion for proposals put forward in 1946 at the Royal Society Empire Scientific Conference that research in Africa, south of the equator, should be planned and organised on a regional basis. Even before the Conference, the three Central African territories of Southern Rhodesia, Northern Rhodesia and Nyasaland were contemplating arrangements for a joint attack upon the research problems of their own sub-region of Africa, and for collaboration with the research organisations in the neighbouring territories of East Africa and the Union of South Africa. The Central African Council, which is a consultative assembly of representatives of the three Central African countries, has given effect to proposals made by a Special Committee on Joint Research set up at the end of 1945, by appointing a 'research secretary' whose first duty will be to survey the research facilities available in the Central African, East African and South African territories, to report on any additional facilities required in Central Africa and on the relations to be established between research work and workers in Central Africa and in other countries. This survey is expected to lead to recommendations regarding the nature, priority and future organisation of research in Central Africa.

Dr. J. E. Keyston, who arrived at Salisbury, Southern Rhodesia, in November 1947 to take up the appointment of research secretary, graduated with first-class honours in physics at University College, Nottingham, and thereafter pursued research on gas discharges and on the hyperfine structure of spectral lines at Nottingham, the Electrical Laboratory, Oxford, and the Einstein Laboratory, Potsdam. During 1933–37 he held a scientific appointment in industry and then joined the staff of the Admiralty Research Laboratory. Since the end of 1938 Dr. Keyston has served in the Admiralty headquarters department of scientific research, where he became assistant director of scientific research in 1943 and later deputy director of research programmes and planning. His wide experience of research administration and, in particular, his record in promoting close and friendly liaison between the Admiralty and other research bodies, including the research organisations of the Dominions and the United States, appear well matched to the duties he is to undertake for Central African research.

Beilby Memorial Awards

AWARDS are made annually from the Sir George Beilby Memorial Fund to British investigators in science as a mark of appreciation of distinguished work, particularly in such fields as fuel economy, chemical engineering and metallurgy, in which Sir George Beilby's special interests lay, and generally as an encouragement to younger men. Owing to the War, no awards were made during 1941–46 inclusive; but at a recent meeting of the administrators it was decided to make awards for 1947 to Dr. G. V. Raynor, for his researches on the constitution of alloy systems; and to Dr. G. R. Rigby, for his researches on refractory materials.

Dr. G. V. Raynor was educated at Nottingham High School and Keble College, Oxford. He obtained a first-class in the Honours School of Natural Science (Chemistry) in 1936 and, after a year of postgraduate research on copper alloys in the Inorganic Chemistry Laboratory of the University of Oxford under Dr. W. Hume-Rothery, became research assistant to the latter for work on factors affecting the formation of magnesium alloys. Following election to a senior research award of the Department of Scientific and Industrial Research, he continued investigations on magnesium alloys and obtained the degree of D.Phil. in 1939. During the war period Dr. Raynor was concerned, in association with Dr. Hume-Rothery and others, with work on the constitution of certain steels and aluminium alloys on behalf of the Service Ministries. Early in 1945 he entered the Metallurgy Department of the University of Birmingham as research fellow and became reader in theoretical metallurgy two years later. His work in Birmingham has been directed towards a better understanding of the theory of alloy formation, with particular reference to the behaviour of the transitional metals, and the factors governing equilibrium relations in ternary alloys.

Dr. G. R. Rigby was born at Stoke-on-Trent and, after receiving his general education at Hanley High School, studied chemistry at the North Staffordshire Technical College. In 1928 he was awarded a Royal Scholarship and proceeded to the Imperial College of Science and Technology, London, where he obtained two years later the A.R.C.Sc. diploma and the B.Sc. degree of the University of London with first-class honours. He spent the next two years in the Physical Chemistry Department of the College engaged in research under the late Prof. J. C. Philip on the measurement of electrical charges at gas–liquid interfaces, and was awarded the Ph.D. degree for a thesis on this subject. His appointment in 1932 to the staff of the British Refractories Research Association brought him into touch again with the Staffordshire pottery industry. Initially under the direction of the late Dr. J. W. Mellor and, since 1937, of Mr. A. T. Green, Dr. Rigby has been engaged continuously on a wide range of research work on refractory materials for the pottery industry, and latterly for the iron and steel industry.

Road Research

FOR three months during 1946, Dr. W. H. Glanville, director of the Road Research Laboratory of the Department of Scientific and Industrial Research, visited North America to study the progress made there in applying the results of research to road construction and safety. A report of the visit has now been published as "Road Research Technical Paper No. 7" (London: H.M. Stationery Office, 1947. 1*s.* 6*d.* net). The Road Research Laboratory was engaged in important work during the War, which necessarily hindered the development of the programme of road research in Britain, particularly as regards road safety and the construction of concrete roads. The main purpose of the American visit was to see the progress made in these directions. Problems relating to the serious matter of road safety are being actively investigated in many parts of the United States. As in Britain, the problem is being tackled under three main headings: education, engineering and enforcement. It is interesting to note that while improvements in vehicles in aspects concerning safety are largely in the hands of the motor industry, concerted action is being taken, and the Automobile Manufacturers Association has formed an Engineering Liaison Committee which, by the pooling of patents and ideas, has produced a standard headlamp now fitted to all new American cars. The Committee is also at work on the problem of dazzle, which with the imposition of a partial black-out in towns in Britain has taken on a new urgency. Successful tests have been carried out by the General Electric Co. on the use of headlights emitting polarized beams; with the use of a 'Polaroid' visor it is possible to pass a car with its headlights full on with no discomfort although the road around appears well illuminated. The technical problem appears to be solved; but the difficulties associated with transition from plain to polarized lights remain. In America, as in Great Britain, the design of the structure of the carriageway is based more on the result of experience than on scientific principles. However, much experimental work is in hand which will enable theories to be tested. As an appendix to the report, extracts are given from the programme of the Highway Safety Conference held in Washington, May 1946.

Survey of Svalbard

The Norwegian Svalbard department (Norges Svalbard-og-Ishavs-undersökelser), as can be judged from the report of its activities 1936–44 (*Skrifter*, Nr. 88. Oslo: Jacob Dybwad, 1945. 6.50 kr.), was busy during the period of enemy occupation, although the last expedition to Svalbard was in 1939 and to East Greenland in 1941. The report contains full accounts of these expeditions and of the useful work done in Oslo in compiling various Svalbard maps, on the bibliography of Norwegian polar literature and the exhaustive report on Svalbard place names. "The Survey of Björnöya" (Bear Island), completed between 1922 and 1931, forms a separate publication with full details of the work and a revised edition of the contoured map of the island on a scale of 1 to 25,000. This is printed in brown, blue and black. Small reproductions of some of the earlier sketch maps of the island are also given. This monograph, together with that of G. Horn and A. K. Orvin on the geology and history of the island (*Skrifter*, Nr. 15. Oslo, 1928) with its geological map, form an exhaustive survey of the island, which is now one of the most carefully surveyed areas in polar regions.

Svalbard includes all the islands over which Norway acquired sovereignty by the treaty of 1920. These islands lie between lat. 74° and 81° N., and long. 10° and 35° E. Included are Spitsbergen, Bjørnøya, Hopen, Kong Karls Land and Kvitøya. The Svalbard Archipelago has been visited by western Europeans since A.D. 1194, and it is generally agreed that the Svalbard mentioned in the Icelandic annals refers to these islands. In 1596 the Dutch arrived while trying to discover the North-East Passage, and from the start of the seventeenth century there was much Dutch and English whaling activity. From about 1720–1852, Russian trappers used to winter there and have left traces of their visits. Since then there have been not a few purely scientific expeditions to the region. A list of place names has now been issued (Skrifter om Svalbard og Ishavet, Nr. 80. Pp. 540. Oslo: Jacob Dybwad, 1942. 50 kr.). The names are arranged alphabetically, and bibliography, indexes and a map are included. The committee responsible is to be congratulated on a notable piece of work. It is written in English.

Carnegie United Kingdom Trust

The thirty-third annual report of the Carnegie United Kingdom Trust, to which are appended the accounts for the year ending December 31, 1946, records the progress made during the first year's execution of the plans for the current quinquennium. The principal allocations for the quinquennium opening on January 1, 1946, are £150,000 for music and drama; £100,000 for village halls; £150,000 for the Bureau of Current Affairs; £30,000 for museum services; £25,000 for Young Farmers' Clubs, and £40,000 for youth hostels. The Trust is constituting a small committee to examine the recommendation in Miss E. Younghusband's report on the training of social workers, for the establishment, in association with an appropriate university, of a Carnegie School of Social Work. A new grant has been promised to the National Federation of Women's Institutes in aid of the foundation of a residential centre, at Marcham Park, near Abingdon, to which countrywomen may resort to study problems affecting rural life and for suitable courses of instruction. A grant up to £750 has been promised to enable the Central Landowners' Association, together with other bodies concerned with the preservation of the countryside, to promote a competition designed to encourage the study of village planning.

Funds are being made immediately available for museum services for three main purposes: the supply of expert reports to museums which may wish to consider possible lines of development; the provision of grants to museums already able to carry out approved schemes of reorganisation; and the training of museum staffs. The Trust has continued to meet the whole cost of maintaining the Irish and Scottish Central Libraries for Students, and, in addition to renewing its grant in aid of the National Central Library, has made exceptional grants of £400 to Rutland and £1,500 to Argyll for the establishment of a county library service. A further grant of £6,000 has been promised to the Council for the Promotion of Field Studies for the adaptation and equipment of Flatford Mill, as a pioneer field centre. Grants of £2,500 to the Highland and Islands Film Guild for the provision of a mobile film service in two of the crofting counties of Scotland, a capital grant of £2,500 for the adaptation and equipment of Bisham Abbey as a national recreation centre by the Central Council of Physical Recreation, and a grant of up to £1,000 a year for five years for an inquiry into certain aspects of juvenile delinquency to be conducted at the Philanthropic Society's School, Redhill, are also recorded.

Earthquake in the Philippines

On January 25, a series of some eleven earthquake shocks shook the central Philippine Islands for about four hours. The sugar-growing island of Panay, approximately 285 miles south-west of Manila, was most affected, and the islands of Negros, Cebu, Leyte and Marinduque, all densely populated, were also shaken. The six-storied campanile of the ancient Jaro cathedral collapsed and some fissures caused by the earthquake were more than 100 yards long. Altogether damage was caused to the extent of about £100,000, and at least twenty-seven deaths and many injuries were occasioned by the shock. The earthquake was recorded at observatories throughout the world as the greatest since the Japanese earthquake of December 21, 1946.

The Philippine Islands are definitely in a seismic zone, small shocks occurring there frequently. Considerable earthquakes are reported from time to time, and an extensive catalogue of these, from the Manila earthquake of 1589 to the Butuan earthquake of December 26, 1899, has been compiled by the Rev. William C. Repetti, *S.J.* Destructive earthquakes occurred at Batangas on December 14, 1901, and in the centre of Mindanas on August 21, 1902. Lehmann and Plett wrote an interesting paper on the Philippine earthquake of November 13, 1925.

International Congress of Applied Mechanics

The Seventh International Congress of Applied Mechanics will be held at the Imperial College of Science and Technology, South Kensington, London, during September 5–11. The technical sessions will be organised under the following sections: (1) Elasticity and Plasticity; (2) Aerodynamics, Hydrodynamics, Meteorology; (3) Thermodynamics, Heat Transfer, etc.; and (4) Vibrations, Lubrication and Experimental Methods. In addition, as many as ten general lectures or surveys are contemplated on subjects likely to be of interest to members. Arrangements have been made for visits to the National Physical Laboratory, the Royal Aircraft Establishment, the National Gas Turbine Establishment, and the Research Laboratories of the General Electric Co., Ltd., during the week following the Congress. Forms of application for membership, and other material concerning the Congress, can be obtained from the Organising Secretary, Seventh International Congress of Applied Mechanics, Imperial College of Science and Technology, London, S.W.7.

Theories of Creep in Metals

A SUMMER school in theoretical physics, with particular application to creep in metals, will be held in the H. H. Wills Physical Laboratory of the University of Bristol during June 2–5. The course is intended mainly for members of the staffs of Government and industrial laboratories who wish to familiarize themselves with the theoretical side of subjects with which they have been concerned on the experimental side. Lectures will be given by Prof. N. F. Mott and other members of the staff of the H. H. Wills Physical Laboratory. In addition to the regular lectures, there will be opportunities for research workers attending the course to discuss their own work and its theoretical implications. Subjects to be treated will include: anelastic effects due to slip at grain boundaries; grain growth, recrystallization and the theory of grain boundary slip; geometry of dislocation and the theory of slip bands; theory of transient creep; slip in solid solutions; diffusion of carbon in iron and elastic after-effect; effects of carbon on the mechanical properties of iron; mechanisms of internal damping; crystal growth and the origin of dislocations. The number attending the course will be limited to about fifty, and the fee for attendance 5 guineas. Further particulars and forms of application, to be returned by April 15, can be obtained either from the Director of the Department of Adult Education, University of Bristol, or from the Secretary of the Institute of Physics, 47 Belgrave Square, London, S.W.1.

The University of Bristol, in co-operation with the Institute of Physics, announces also a second summer school in the physics of solids (experimental and theoretical) to take place in Bristol during September 8–15, the subject being "The Oxides and Ionic Crystals". Further details will be announced in due course.

University of London

DR. LESLIE YOUNG, reader in biochemistry in University College, London, and formerly professor of biochemistry in the University of Toronto, has been appointed to the university chair of biochemistry tenable at St. Thomas's Hospital Medical School as from April 1.

The degree of D.Sc. has been conferred on: Mr. W. S. Rogers (East Malling Research Station); Dr. B. N. Singh (Rothamsted Experimental Station); Mr. F. L. Warren (Royal Cancer Hospital (Free)).

Industrial Research in Wales

A REGIONAL conference on "Industry and Research in Wales", organised jointly by the Industrial Research Committee of the Federation of British Industries and the Industrial Association of Wales and Monmouthshire, will be held at Cardiff on March 10. Sir William Griffiths, managing director of the Mond Nickel Co., Ltd., will preside at the morning session and Sir Gerald Bruce, of the Industrial Association of Wales and Monmouthshire, in the afternoon. Among others taking part will be Sir Frederick Rees, principal of University College, Cardiff, Dr. W. D. Scott, of Monsanto Chemicals, Ltd., Capt. H. Leighton Davies, of the Steel Company of Wales, Ltd., Mr. Harry Davies, of I.C.I., Ltd., Dr. Idris Jones, of the National Coal Board, and Mr. R. K. Sanders, of the Metal Box Co., Ltd. Sir Percy Thomas, of the Welsh Board for Industry and the Industrial Association of Wales and Monmouthshire, will sum up. Further particulars can be obtained from the Industrial Research Secretariat, F.B.I., 21 Tothill Street, London, S.W.1, or from the Industrial Association of Wales and Monmouthshire, Aberdare House, Mountstuart Square, Cardiff.

Convention on Scientific Radio

A CONVENTION on Scientific Radio is to be held during April 7 and 8 by the Institution of Electrical Engineers and the British National Committee for Scientific Radio (set up under the auspices of the Royal Society), and is being organised by the Radio Section of the Institution. This is intended to serve as a preliminary survey of the British contribution in the radio field which is to be presented at the forthcoming meeting of the Union Radio Scientifique Internationale to be held in August 1948 in Stockholm. The Convention is divided into four sessions, corresponding in scope to those of the International Union, covering (1) standards and measurements; (2) propagation; (3) radio noise; and (4) radio physics.

Announcements

GENERAL SMUTS has been elected chancellor of the University of Cambridge in succession to the late Lord Baldwin.

DR. HAROLD SCARBOROUGH has been appointed lecturer with title of reader in the Department of Medicine, University of Birmingham.

THE Langley Memorial Prize, value £21, is open to competition among officers of the Colonial medical service who are serving, or who have served, in West Africa. The prize will be awarded for the best paper submitted on a topic falling within one of the following subjects (special consideration being given to original work): (*a*) tropical medicine or surgery; (*b*) tropical hygiene and sanitation; (*c*) tropical entomology and parasitology. Papers, which may consist of either published or unpublished work, should be delivered to the Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, not later than October 1, 1948.

THE trustees of the Lady Tata Memorial Fund invite applications for grants and scholarships, open to workers of any nationality, for research in diseases of the blood, with special reference to leukæmia, in the academic year beginning on October 1, 1948. Grants are made for research expenses or to provide scientific assistants to senior workers; scholarships (£400 per annum for whole-time research) are awarded as personal remuneration. Forms of application, to be returned before March 31, can be obtained by writing to the secretary of the Scientific Advisory Committee, Lady Tata Memorial Trust, c/o Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Short-Focus Modification of the Lamm Scale Method for Measuring Refractive Index Gradients

THE scale method is still regarded as the most accurate and reliable method for measuring refractive index gradients and is extensively used in diffusion and sedimentation measurements. The considerable laboratory space required by the long cameras is, however, inconvenient. I have studied the problem of the necessary focal length in detail, and come to the conclusion that the long focal length is not essential for the method.

Lamm[1] has given a number of reasons for using an objective with a great focal distance. It seems that several of these arguments are questionable. One requirement is essential, however, namely, the use of parallel or nearly parallel light through the cell. It was pointed out by Lamm himself (*loc. cit.*, p. 9) that it should be possible to attain this condition by placing the diaphragm in the focal plane of the objective, which could then have a much shorter focal length. This proposal has now been taken up for further study.

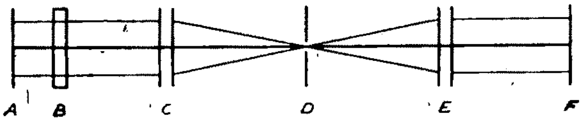
A camera giving an image of natural size with a diaphragm in the focal plane of the objective is not suitable, because a lens cannot be corrected for two purposes so widely different as giving exactly parallel light from the focal point and giving a good image of natural size. The former requirement is fulfilled by an asymmetrical astronomical objective, the latter necessitates a symmetrical lens system; to unite these two requirements, a compromise must be made in the correction of the lens, and a long focal-length may still be necessary.

It is not possible to solve this problem without introducing two lenses. An astronomical objective may be placed near the cell, and the diaphragm in its focal plane. A second lens can give a full-size image of the scale.

There are special advantages in placing the second lens at the focal distance from the diaphragm. In such a case the light is parallel on both sides of the lens system. In this arrangement both lenses should be of the simple astronomical type. From elementary optics it is known that a lens system of two lenses with a common focal plane has its principal planes infinitely far away; thus the magnification depends only on the two focal distances and not on the mutual distances between object, lens system and image. Needless to say, this latter property is of special advantage in the scale method, where the scale position in relation to the camera has to be altered several times during an experiment. If a confocal lens system is used, the magnification remains unaltered.

The magnification is equal to the ratio between the two focal distances. Since there is no reason for magnifying or reducing the scale image, I use two identical astronomical objectives in the camera. Two more advantages are gained by this: the magnification becomes exactly 1, which is very convenient, and the total length from the scale to its image is independent of the scale distance (the optical distance between scale and cell). Thus, if the scale distance is increased by 100 mm., the plate has to be moved 100 mm. in the same direction to restore the focusing, and the magnification of unity is unaltered.

In the original scale method, a correction factor $(l - b)/l$ (l is the distance between scale and lens, b is the scale distance) must be used to calculate the cell co-ordinate from the scale co-ordinate. In the new modification, this factor is also equal to unity, since the light travelling between the scale and the cell must be parallel. Thus the new modification simplifies the calculations considerably.



A, scale; *B*, cell; *C*, astronomical objective $f = 50$ cm.; *D*, diaphragm; *E*, astronomical objective $f = 50$ cm.; *F*, plate

A diagram of the new scale camera is reproduced herewith. It has been tested in diffusion measurements in this Institute for a couple of months and has given results indistinguishable from those obtained with the original method. Experiments will be continued to test the camera in connexion with ultracentrifugal and equilibrium centrifuge measurements.

The distance between scale and plate in our diffusion apparatus was 4 m. with the original scale method. It has now been reduced to 2 m. The corresponding distance in the ultracentrifuges and equilibrium centrifuges is 6 m.; thus 4 m. can be saved, and still more, since the centrifuge cells are considerably smaller than the diffusion cells. The focal length of the lenses can be reduced according to the size of the cell.

I wish to express my gratitude to Prof. Ole Lamm for the kind interest he has devoted to this work and for helpful discussions. I am also indebted to LKB-Produkter Fabriks-AB, Stockholm, for financial support.

HARRY SVENSSON

Institutes of Physical Chemistry
and Biochemistry,
University of Uppsala.

Oct. 1.

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[1] Lamm, O., *Nova Acta Reg. Soc. Sci. Upsal.*, iv, 10, No. 6 (1937).

Sensitivity of a South American Frog to Curare

FROM time to time, reports have appeared of the low sensitivity of South American frogs to curare[1,2].

These early experiments were made with crude curares, the reliability of which is always doubtful and in which apparent differences in potency may be due to differences in, for example, absorption-rate, produced by substances other than the curare alkaloids. We recently have had an opportunity of testing the sensitivity of *Leptodactylus ocellatus* to *d*-tubocurarine chloride supplied to us by Dr. Harold King, of the National Institute for Medical Research, Hampstead, London, N.W.3.

The tests were made at room temperature (21–24° C.) on frogs weighing between 25 and 70 gm., and the technique was the same as that described by King[3].

The *d*-tubocurarine chloride was dissolved in Ringer's solution and injected into the ventral lymph sac of the frogs in a volume of 0·02 c.c. per gm. of frog. The same end-point was used, namely, inability of the frog to recover its normal posture when placed on its back.

Preliminary experiments on six frogs showed that doses up to 10 mgm./kgm. were without any visible effect. Of three frogs which received 15 mgm./kgm., one only became paralysed after 67 min. had elapsed. With doses of 20–30 mgm., paralysis developed in all frogs, but only after 19–50 min. A dose of 40 mgm./kgm. in three frogs produced paralysis in 18, 26 and 28 min.

Since the test described by King required paralysis to occur within 15 min., the dose was increased to 50 mgm./kgm., and this quantity was administered to six frogs. In these, paralysis developed in 13, 14, 14, 14, 15 and 16 min.

King[4] stated that for frogs the paralysing dose of *d*-tubocurarine chloride was 0·5 mgm./kgm. There appears to be no doubt that *Leptodactylus ocellatus* is considerably less sensitive to the alkaloid than is the *Rana temporaria* used for the original tests, a finding which confirms that of Houssay and Hug[2].

The comparison which we have made is, of course, unsatisfactory in many ways; but the experiments were limited by the supply of curarine immediately available. It is hoped in the near future to make comparisons simultaneously on the two amphibians under identical conditions.

This relative insensitivity of *Leptodactylus ocellatus* to substances affecting neuromuscular transmission does not seem to be confined to *d*-tubocurarine chloride, since we have recently found that this frog is less sensitive to acetylcholine than is *Rana esculenta*[5], although the difference is much less striking than in the instance of *d*-tubocurarine chloride. We have also found a similar insensitivity of these frogs to atropine injected arterially into the gastrocnemius muscle. In *Rana esculenta* one injection of 100 μgm. in 0·1 c.c. rapidly produced complete neuromuscular block[6]. In *Leptodactylus ocellatus* three successive injections of 200 μgm. in 0·2 c.c. only reduced the twitch tension to about a third of its original value.

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Sodium Citrate Concentration in Ether-extracted Plasma

A method has been described for the fractionation of human plasma in which fibrinogen is precipitated by ether, and prothrombin by adjusting the *p*H of the supernatant to 5·3 with 0·2 *M* citric acid[1]. The plasma remaining is frozen with excess of ether and the protein concentrated for use as a transfusion fluid[2]. We would like to direct attention to the fact that such solutions of proteins from citrated plasma may contain a dangerously high citrate concentration.

A transfusion reaction reported after the use of material prepared by the above method led us to examine the effects of its injection into rabbits, in which the injection of fluid or reconstituted dried pooled human plasma, where the protein is not concentrated, causes no disturbance of blood pressure or respiration.

When 5 ml. of the plasma used in the transfusion were injected into rabbits anæsthetized with 'Nembutal', there was an immediate fall in blood pressure, slowing of the heart-rate, an immediate acceleration of respiration succeeded by deep convulsive gasps or cessation of respiration and twitching movements of the musculature. Recovery usually occurred in a few minutes.

Dialysis of the plasma against distilled water using a collodion membrane removed the active factor. This, and the effects observed in the rabbit, suggested that the toxicity was due to citrate.

Estimation of citrate by the method of Pucher, Sherman and Vicary[3] showed the citrate concentration in pooled plasma to be about 11 mgm./c.c., in ether-extracted plasma about 15 mgm./c.c., and in plasmas prepared from fractionation residues to vary from 16·7 mgm./c.c. to 23·0 mgm./c.c. The injection of 5 ml. of ether-extracted plasma containing 22·5 mgm. citrate per c.c. produced the same effects in the anæsthetized rabbit as those caused by the injection of the plasma which produced the transfusion reaction. Injection of a similar quantity into unanæsthetized rabbits caused tetanic convulsions and opisthotonus. These effects could be reproduced by a citrate solution of the same strength. Dialysis of the plasma or the previous injection of calcium chloride prevented these effects; and injection of the dialysate, concentrated to the original plasma volume, showed that it contained the active agent, the effects of which were annulled by the previous injection of calcium chloride.

The manifestation of the toxic effects of citrate depends both upon the rate of injection and the concentration of citrate in the injected material. Since transfusions in certain conditions may be given very rapidly, we consider that the possibility that ether-extracted plasma prepared by the method of Kekwick, Mackay and Record[1] may contain a high concentration of citrate, which might under certain conditions prove toxic, should be made known.

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Effect of Antihistamines on *Daphnia*

Daphnia pulex reacts under ultra-violet radiation (wave-lengths less than 4000 A.) with negative phototaxis. In man the influence of the same wave-lengths is connected with release of histamine from damaged cells[1]. Successful therapy with antihistamine in cases of human hypersensitivity to sunlight is therefore not surprising[2]. The working hypothesis which we used was as follows : it is possible that the release of histamine occurs in both cases. If this assumption is correct, antihistamine should modify the motor response of *Daphnia* (phototaxis) in the same way as it prevents the actinic dermal response in man subjected to sunshine.

As light source we used a low-pressure mercury vapour lamp. We tested typical antihistamine substances of well-known activity. They were: α-benzhydrylether-β-piperidinoethane (I)[3], antihistamine activity tested on guinea pig intestine: 6·3 microgm.; 2-phenylbenzylaminoethyl-imidazolin (II) (Antistin-Ciba), 45 microgm.; α-phenylamino-β-aminoethane (III)[4], 29 mgm. It was found that all these substances in small doses suppress the negative phototaxis of *Daphnia*; in larger doses, they invert the phototaxis to positive. This influence is proportional to the concentration of antihistamine used. The minimal effective dose for the substance I is 2·5 microgm. per c.c. of medium (M/133,000).

This reaction seems to be a specific one; it was not possible to provoke it with organic acids (acetic, lactic), lactose, glycocol and sodium choleinicum. Only strychnine among organic substances shows the same influence as antihistamines[1] on *Daphnia*[5]. The mechanism of its action is clearly neurotropic. Further, it was found that the ratio of activity of three antihistamine substances in this *Daphnia* test was the same as in the test on the surviving intestine of the guinea pig. Therefore, it cannot be excluded that the actinic influence of ultra-violet light provokes the release of histamine in invertebrates as in man, although histamine itself, when added to the medium, did not influence *Daphnia* in any way.

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Histaminolytic Activity of a Copper Protein in Serum

WE have recently been studying the blue serum globulin described by Luetscher[1], Pedersen[2], Holmberg[3] and Cohn *et al.*[4].. We have found that it has a copper content of about 0·05 per cent. By denaturing with a mixture of ethyl alcohol and chloroform and fractionating the supernatant solution with ammonium sulphate, we have found a blue copper protein with a copper content of 0·36 per cent. It seems very probable that this substance is identical with the hæmocuprein of Mann and Keilin[5], which thus might be an integral part of the blue globulin.

When a purified preparation of this globulin was added to plasma from a male subject so that the final copper concentration was about 700 γ/100 ml., the result was a 400-fold increase in histaminolytic activity. The blue globulin thus seems to be a component of the histaminolytic enzyme system of plasma.

As is well known, the increase in serum copper during pregnancy runs parallel in time with the increase in histaminolytic activity of plasma. We have also shown that this increase in copper is to be found in the globulin fraction of plasma.

A more detailed report of these investigations will soon appear in the *Acta Chemica Scandinavica*.

Our thanks are due to the Obstetrical Clinic of the Hospital of Malmö for help with the determinations of the histaminolytical activity of our preparations.

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Specific and Non-specific Competition in Tubular Excretion

A CONSIDERABLE number of aromatic acids are known to be excreted by the renal tubules. The chemical structure of these compounds shows much variety, and it does not seem easy to find any property common to them which is not also shared by substances not excreted by the tubules. However, in every case hitherto investigated, the tubular excretion of any anion is reversibly depressed by the presence of considerable amounts of other anions excreted by the tubules. This effect is usually demonstrated by the use of 'Diodrast' or hippuric acid as the depressing agent. The phenomenon is often regarded as an indication that the excretion of these compounds is effected by a common mechanism, or by intimately linked mechanisms.

It has, however, in some cases been shown that the presence of large amounts of 'Diodrast' in the blood may also interfere with reabsorptive processes in the tubules. This circumstance has led to the division of the effects of 'Diodrast' into specific and non-specific competition[1].

It seems clear that the depression of tubular excretion by 'Diodrast' may be non-specific, as well as its effect on tubular reabsorption. Thus the foundation for the view that the excretion of anions by the tubules is determined by specific interaction is considerably weakened by the demonstration of non-specific competition. In order to gain some further information as to the specificity of the depression of tubular excretion, the influence of hippuric acid on the excretion of uric acid has been studied in the chicken.

The intravenous injection of 100–200 mgm. hippuric acid causes the uric acid excretion in a hen to fall by 20–50 per cent for a short period (about ten minutes). Afterwards the uric acid excretion rises slightly above the original level for some time, but soon returns to it. This effect might be interpreted as the result of a diminution of the renal blood flow, possibly caused by the hippuric acid. However, the excretion of piperidine, which is also excreted by the tubules in the chicken, is not influenced in a consistent manner. This is evidence against an influence on the blood flow.

Similarly, the excretion of phenol red is depressed by the intravenous injection of uric acid. In this case the excretion of methylnicotinamide has been used to assess the constancy of the renal blood flow, which seems to be constant or slightly increased.

In man, uric acid is reabsorbed by the tubules; the reabsorption is depressed by 'Diodrast'[2]. It is thus clear that the depression by hippuric acid (or 'Diodrast') cannot be regarded as demonstrating excretion by a common mechanism. Though there is no doubt about the existence of both specific and non-specific competition, it seems that we are at present unable to distinguish between these two phenomena.

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Improved Method of Getting Rats' Eggs from the Fallopian Tubes

Rowlands[1] described the recovery of rats' eggs by unravelling the Fallopian tubes and squeezing out their contents under low-power magnification. Using this method he obtained an average of 4·9 ± 0·5 (standard error of the mean) ova per rat from the tubes of thirteen normal rats two days after mating[2]. Using the same method in forty rats killed 0–2 days after mating, we recovered a similar number of eggs (4·2 ± 0·3 per rat).

A significantly higher average recovery was obtained when the ova were washed out of the Fallopian tubes. A blunted hypodermic needle (26 wire gauge) can easily be inserted into the open ovarian end of the unravelled tube (or into an oblique slit made just below it) and the ova washed out with five to ten drops of physiological saline from a 1-ml. syringe. The washing method is only preferable when the eggs are no longer clumped together surrounded by cumulus cells but are scattered free throughout the length of the tube—that is, more than 24 hr. after mating. Before this time the original method is the better one. By the modified technique the average number of eggs recovered from thirty-six rats 0–2 days after mating was 7·8 ± 0·4 eggs per rat, a number more in keeping with the normal litter size.

This work was initiated when one of us (P. C. W.) was Prophit Research Student of the Royal College of Surgeons, and it was aided by an apparatus grant from the University of London.

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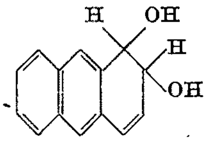
Oxidation of Anthracene by Osmium Tetroxide

We have shown recently[1] that the addition of osmium tetroxide to the 9 : 10-positions of phenanthrene, first observed by Criegee, Marchand and Wannowius[2], is a general property in a series of tetra- and penta-cyclic aromatic hydrocarbons containing a phenanthrene system. If the reaction is carried out in the presence of pyridine a well-crystallized, deep-coloured, pyridine-osmic ester complex is formed, and this on hydrolysis gives a dihydroxy-dihydro derivative of the original hydrocarbon.

The presence of a phenanthrene system is not essential, for anthracene and naphthalene form similar coloured complexes. If, in the case of anthracene, the reaction could be limited to addition of osmium tetroxide to *one* aromatic double bond, then it is probable that hydrolysis would give *dl-cis*-1 : 2-dihydroanthracene-1 : 2-diol (I), which Boyland and Shoppee[3] have shown to be the metabolic oxidation product of anthracene in rabbits. Whether the reaction could, in fact, be so limited seemed very doubtful as addition of osmium tetroxide to anthracene takes place slowly, and the product of addition of one molecule of the tetroxide would contain a true ethylenic linkage which should react rapidly with a second molecule of osmium tetroxide with formation of an osmic ester complex of a tetrol.

This conclusion has been verified experimentally, for hydrolysis of the anthracene-osmium tetroxide-pyridine complex gave a tetrahydroxytetrahydroanthracene. If the above reasoning is sound, this should be the 1 : 2 : 3 : 4-tetrahydro compound. That this is indeed the case was supported by a measurement of the ultra-violet absorption spectrum by Mr. E. J. Y. Scott, who found $\log \varepsilon = 5{\cdot}25$ at 2330 A. for a methanolic solution of the tetrol (2·34 mgm. in 500 ml.). This suggests a naphthalene derivative (II), and final confirmation of this was provided by oxidation of the tetrol by alkaline potassium ferricyanide solution to naphthalene-2 : 3-dicarboxylic acid, m.p. 238–239° alone or mixed with a sample prepared by similar oxidation of 2 : 3-dimethylnaphthalene. It is noteworthy that the very reactive *meso* positions of anthracene are not attacked in this method of oxidation.



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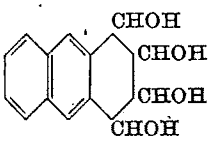

II

To obtain the tetrol a solution of anthracene (0·0025 mol.), osmium tetroxide (0·005 mol.) and pyridine (0·01 mol.) in pure benzene (20 ml.) was kept at room temperature for a fortnight with occasional shaking. The brown osmic ester complex which had separated was collected, washed with benzene, and dried in the air. It (1 gm.) was hydrolysed by heating on the water bath for three-quarters of an hour with a solution of crystalline sodium sulphite (5 gm.) in water (25 ml.) and ethanol (25 ml.). More ethanol was then added to precipitate the salts remaining in solution, and the whole was filtered. The black residue was extracted several times with hot alcohol, the extracts combined with the original filtrate, and the combined liquors concentrated under reduced pressure. The solid which separated after cooling was recrystallized from water, giving almost colourless leaflets (80 mgm.) of 1 : 2 : 3 : 4-*tetrahydroxy*-1 : 2 : 3 : 4 -*tetrahydroanthracene* (II), m.p. 241° (decomp.) (found: C, 68·2; H, 5·8. $C_{14}H_{14}O_4$ requires C, 68·3; H, 5·7 per cent). Its *tetraacetate*, obtained with boiling acetic anhydride-pyridine and purified by chromatography on silica, crystallized from benzene – light petroleum in colourless prisms, m.p. 215–217° (found: C, 64·0; H, 5·2. $C_{22}H_{22}O_8$ requires C, 63·8; H, 5·3 per cent).

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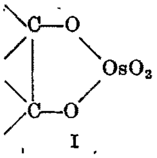
Relative Reactivity of Aromatic Double Bonds

It is well known that osmium tetroxide readily reacts with ethylenic double bonds[1] with the formation of osmic esters (I), which may be converted into *cis*-diols. Criegee *et al.*[2] have found that phenanthrene (II) also reacts with osmium tetroxide. When the reaction was carried out in a non-aqueous solvent containing a little pyridine, a dark brown complex of 9 : 10-dihydrophenanthrene-9 : 10-diol-osmate and two molecules of pyridine was formed. Cook and Schoental[3] have recently extended this reaction to many other polycyclic aromatic hydrocarbons, and in every case addition to adjacent carbon atoms was found to take place, with the formation of a brown complex. With 1 : 2-benzanthracene (III), for example, reaction took place at the 3 : 4 positions. It seemed to us, therefore, that this reaction might be used to compare the relative reactivities of aromatic double bonds.



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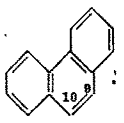
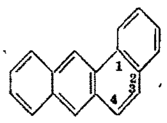


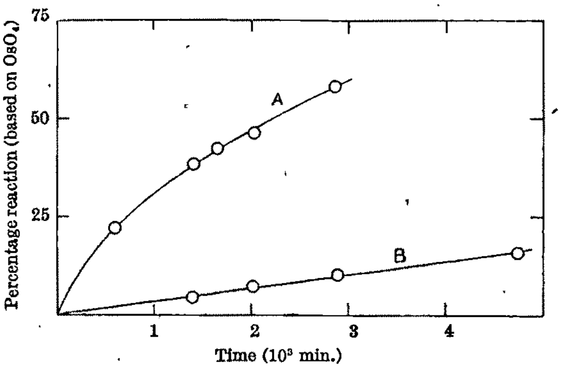
II



III

In a preliminary experiment with anthracene, phenanthrene and 1 : 2-benzanthracene, the hydrocarbon (0·0005 *M*) in pure benzene (15 c.c.) and pyridine (0·15 c.c.) was treated with osmium tetroxide (0·0005 *M*). As judged by the colours of the solutions at suitable intervals, anthracene and 1 : 2-benzanthracene appeared to be approximately equally reactive, and both seemed to react very much faster than phenanthrene. In view of this surprising result, we have carried out a more detailed comparison between phenanthrene and 1 : 2-benzanthracene. (Anthracene is not entirely satisfactory for comparison with phenanthrene, for Cook and Schoental[4] have found that this hydrocarbon reacts with two molecules of osmium tetroxide to form a complex which on hydrolysis yields a tetrol, and we are making a separate investigation of this reaction-rate.)

For the more accurate investigation we have carried out the reaction between the hydrocarbons and osmium tetroxide in chloroform solution, at 30° C.; aliquot portions being taken at suitable intervals and diluted with chloroform and pyridine. The colour intensities of these solutions were then estimated with a Spekker absorptiometer, using green filters. The instrument was calibrated with known concentrations of the appropriate complex; and it was also shown that absorption with an osmium tetroxide – chloroform – pyridine solution, which was yellow in colour, was negligible compared with that of the solution of the complex. The rates of reaction were measured under conditions leading to the production of a second-order rate-constant. The initial concentration of 1 : 2-benzanthracene was 0·04994 *M*, of phenanthrene 0·04996 *M*, and of osmium tetroxide 0·01354 *M*. With 1 : 2-benzanthracene, the reaction was followed until approximately 60 per cent of the osmium tetroxide had been consumed, and the mean rate-constant was found to be $1{\cdot}2 \times 10^{-4}$ (gm. mol. sec./litre)$^{-1}$. With phenanthrene, the rate constant was found to be $1{\cdot}2 \times 10^{-5}$ (gm. mol. sec./litre)$^{-1}$, the reaction being followed until 16 per cent of the osmium tetroxide had been used. 1 : 2-Benzanthracene, therefore, reacts approximately ten times as rapidly as phenanthrene (see graph).



CURVES SHOWING RATE OF REACTION OF OSMIUM TETROXIDE WITH 1 : 2-BENZANTHRACENE (CURVE *A*) AND PHENANTHRENE (CURVE *B*)

It is clear, therefore, that the reaction offers a useful method, not previously available, for the quantitative comparison of the relative reactivity of aromatic double bonds, and it may possibly prove useful in investigations on the Mills–Nixon effect and on bond fixation due to hydrogen bonding. The present investigation was undertaken in an attempt to estimate the validity of the quantum-mechanical calculations of Pullman[5], who has developed a theory attempting to correlate carcinogenic activity of polycyclic aromatic hydrocarbons with an optimum density of π-electrons at the *K* position (the 3 : 4 bond in benzanthracene). Her calculations for phenanthrene and benzanthracene do not appear to be in accord with our experimental results.

This work is being continued and extended.

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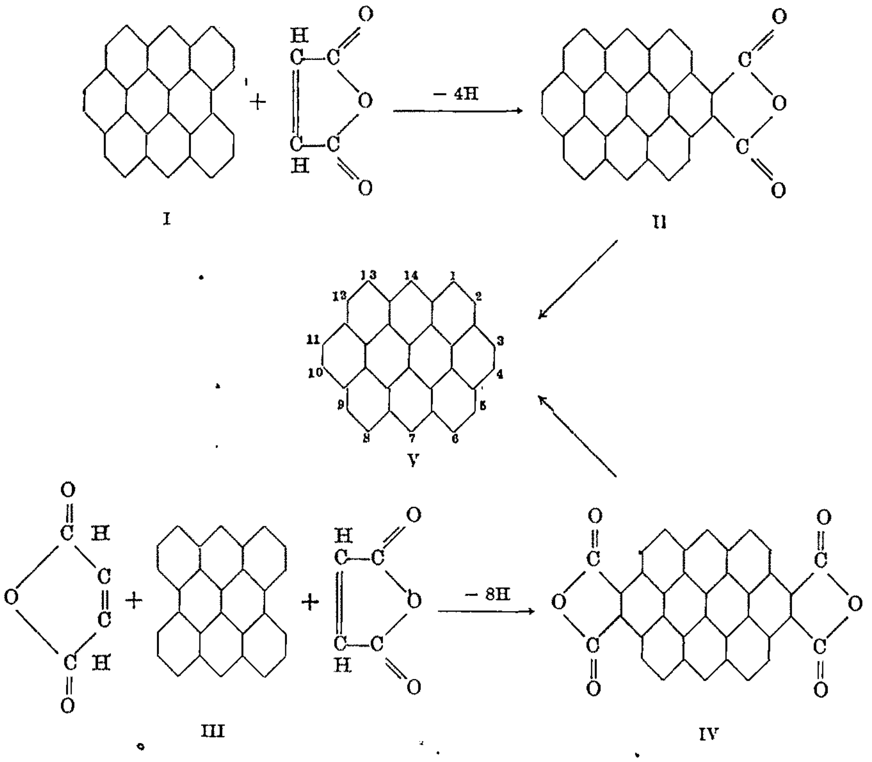
Synthesis of Ovalene

If perylene is boiled with maleic anhydride and nitrobenzene, 1 : 12-benzperylene-1′ : 2′-dicarboxylic acid anhydride is formed[1]. Under the same conditions *meso*-anthra-dianthrene[2] (I) yields quantitatively the anhydride (II), as dark red needles decomposing at 430° (uncorr.) (found: C, 86·48; H, 3·01. $C_{34}H_{12}O_3$ requires: C, 87·17; H, 2·58 per cent),



and *meso*-naphtha-dianthrene[2] (III) reacts twice to form the dianhydride (IV), as dark brown crystals, carbonizing at high temperature.

Both anhydrides II and IV give by decarboxylation with soda-lime at 400° in vacuum the same hydrocarbon (V), which consists of a naphthalene system surrounded by eight benzene rings. I have called it 'ovalene'. In the analogous hydrocarbon coronene one benzene ring is surrounded by six benzene rings. In the series *meso*-naphtha-dianthrene (III), *meso*-anthra-dianthrene (I), and ovalene (V), there is a change in colour from deep blue-green to violet and light orange-yellow, while perylene is golden, 1 : 12-benzperylene pale yellow and coronene paler yellow.

Ovalene sublimes in beautiful light orange needles. It can be recrystallized from 1-methylnaphthalene and melts at 473° (uncorr. evacuated, capillary). It dissolves in concentrated sulphuric acid to give a violet solution which becomes brown. The very dilute solution in benzene shows an orange fluorescence. $C_{32}H_{14}$ (398·43): cal. C, 96·46; H, 3·54; found C, 96·61; H, 3·72 per cent.

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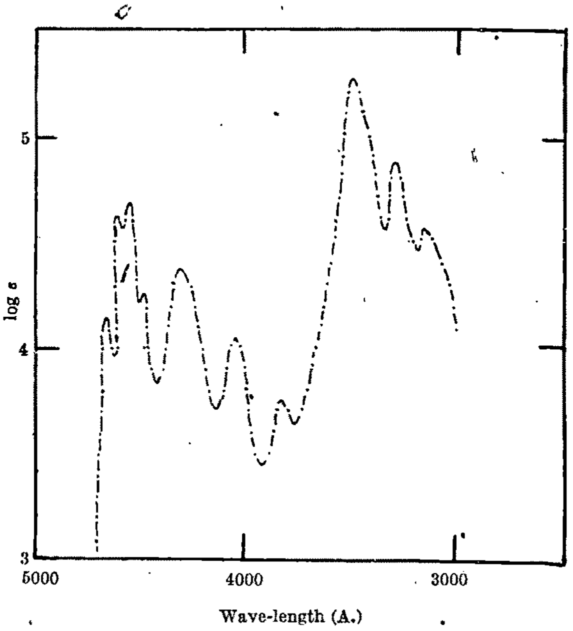

ABSORPTION SPECTRA OF OVALENE, IN 1-METHYLNAPHTHALENE FOR THE LONGER WAVE-LENGTHS UP TO 3400 A., AND IN BENZENE FOR THE SHORTER WAVE-LENGTHS. THE FOLLOWING ARE POSITIONS OF THE BAND MAXIMA IN 1-METHYLNAPHTHALENE IN A.: 4650, 4600; 4560, 4480, 4280, 4035, 3820; 3490; IN BENZENE: 4635, 4585; 4525, 4450, 4250; 3460, 3300, 3150

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Colour Reagents for the Paper Chromatography of Sugars

THE application of paper chromatography to the separation[1], identification, and quantitative microdetermination[2] of the sugars, in investigations of the carbohydrate group, is an advance of no small importance. However, the use of ammoniacal silver nitrate, which gives a similarly coloured dark spot with all the reducing sugars, as colour reagent, often leads to uncertainty, especially when the *RF* values of the sugars are close.

In a current investigation of a polysaccharide, for example, which I carried out at the Chemical Laboratories of the University of Manchester, it was necessary to decide which one of the group, mannose, fructose, arabinose, was present in addition to several other sugars. The fact that the possibles were an aldose, ketose and pentose suggested the use of an acid solution of one of the phenols (phloroglucinol, orcinol, etc.) as a colour reagent. These phenols have long been used to test for the various groups of sugars, but are of limited use when dealing with complex mixtures in solution. This limitation is overcome by the spatial separation of the sugars during chromatography.

It has been found that colour reactions are readily obtained if the chromatogram, after preparation and drying in the usual manner, is sprayed with a solution of the phenol (10 ml. 1 per cent alcoholic solution

Phenols	Time of drying (min.)	Back-ground	Galactose Glucose Mannose	Fruct-ose	Xylose Arab-inose	Rham-nose
Resorcinol	3	—	—	Red	—	—
	10	Pink	—	Red	Blue	Yellow
Naphtha-resorcinol	10	Pink	Grey	Brown	Blue	Green

in 90 ml. 2N hydrochloric acid) and dried for 10 min at 85–95° C.

Phloroglucinol, orcinol, α-naphthol, resorcinol and naphtharesorcinol were tested. Resorcinol and naphtharesorcinol proved of wide application, and the colours obtained are shown in the accompanying table.

About 1 μl. of a 1 per cent solution of the sugar was spotted on filter paper and sprayed. The same colours were obtained in their proper spatial distribution when chromatograms of complex mixtures of the sugars were sprayed.

The qualitative identification of the sugars in a complex mixture is readily obtained in practice by spotting on six alternate spots of unknown and standard mixture. After running and drying, the paper is cut into three strips and sprayed with ammoniacal silver nitrate, resorcinol and naphtharesorcinol respectively. As standard mixture a solution of galactose, fructose, xylose and rhamnose (each sugar in 1 per cent concentration) is most suitable. By comparing the position and the colour of the spots on the strips an accurate picture of the composition of the mixture is obtained. Usually a satisfactory result can be obtained by merely spraying the whole chromatogram with naphtharesorcinol. Mannose and arabinose, which especially present difficulty in paper chromatography, are readily differentiated by a resorcinol spray.

It should be noted that non-reducing sugars such as sucrose also give a positive reaction.

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Oct. 20.

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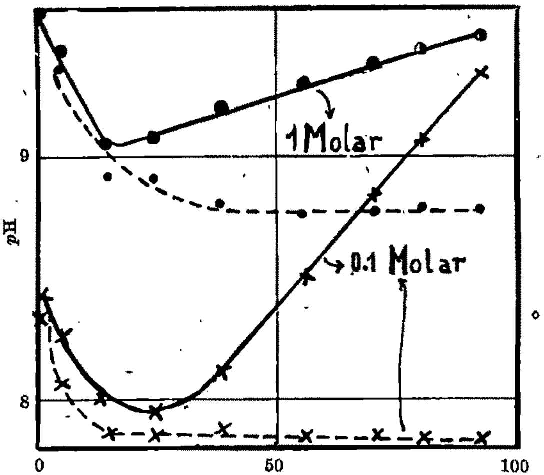
pH of Trisodium Citrate Solutions Stored under Customary Laboratory Conditions

During research on certain metallic complexes of citrate[1,2], we have observed that the pH of trisodium citrate solutions depends somewhat on their 'age'. Solutions, prepared at various times, showed differences of as much as 1·3 pH, though raw materials, methods of preparation and concentrations were identical. In view of the widespread chemical and clinical use of such solutions, it seemed of interest to investigate this phenomenon.

Two samples of a 0·1 molar and two of a 1 molar trisodium citrate solution were prepared by dissolving sodium citrate, gran., B.P. (supplied by Messrs. May and Baker, Ltd.) in distilled water. One sample of each concentration was stored in a 'Duraglas' brand flask (purchased from Messrs. Eimer and Amend, New York), and another in a flask coated with pure paraffin wax. The samples were kept under ordinary laboratory conditions for 92 days (June 2–September 1, 1947) and their pH was measured at intervals of 10–15 days. During this period the mean temperatures in Jerusalem were 22·0° in June, 23·9° in July and 25·0° in August. The measurements were discontinued on the 93rd day, because *Penicillium* moulds made their appearance. The pH measurements were carried out at 30° ± 0·1°, with a precision of ± 0·02 pH, using a Cambridge pH-meter (bench type).



Variation of pH with 'Duraglas' flasks (full lines) and paraffin-coated flasks (broken lines)

Results are plotted in the accompanying graph. During the first two to four weeks, there was a decrease in the pH of all four solutions. From this time onward, however, the solutions in paraffin-coated flasks showed practically *no further change*. Contrary to this, the two solutions stored in flasks with unprotected glass walls exhibited a continuous rise of pH, from the 24th to the 92nd day. This is consistent with the assumption that some of the glass is being dissolved. The rise of pH is about 1·3 for the 0·1 molar solution and only 0·5 for the 1 molar solution, both corresponding to the same approximate increase of the concentration of hydroxyl ions, namely, about 2 × 10^{-5} equivalents per litre.

In order to ascertain how carbon dioxide (which is present both in the distilled water used and in the atmosphere) affects the pH of the solutions, the following experiments were carried out. Solutions of trisodium citrate were prepared, using freshly boiled distilled water, and stored in flasks with paraffin coating. The pH of these solutions was found to be higher than of those prepared with unboiled water. Then, carbon dioxide was bubbled through them for thirty minutes. The pH, measured immediately afterwards, was much lower than any previously observed, but not constant enough for accurate determination. It increased slowly (at the rate of about 0·15 per 15 minutes), obviously because of escaping carbon dioxide. To obtain a constant value, pure nitrogen was bubbled through the solutions and the pH checked at intervals. After three hours, final pH values were reached, which remained unchanged when nitrogen was bubbled through for another two hours. Results of the experiments with carbon dioxide are summed up in the accompanying table.

It appears that the pH of pure uncontaminated trisodium citrate is about 9 in a 0·1-molar solution and 10·3 in molar solution. Solutions exposed to atmospheric carbon dioxide show a gradual decrease of pH (see graph) until constant values (7·8 for the 0·1-molar solution and 8·8 for the molar solution)

ACTION OF CARBON DIOXIDE

Molarity of trisodium citrate	pH						
	In CO_2-free solutions	After saturation with CO_2	After bubbling nitrogen through solutions				
			1 hr.	2 hr.	3 hr.	4 hr.	5 hr.
0·1	8·97	6·20–6·35*	6·91	7·43	7·82	7·86	7·84
1	10·30	6·90–7·03*	7·65	8·20	8·76	8·72	8·70

* *p*H not constant: rises at a rate of about 0·15 per 15 min.

are reached, after the lapse of three to four weeks. The same final *p*H may be obtained within a few hours (see table) by bubbling successively carbon dioxide and nitrogen through the solutions.

Citrate solutions ought, therefore, to be stored in paraffin-coated flasks if it is desired to keep their *p*H constant; furthermore, contamination by carbon dioxide must be avoided.

We have pleasure in thanking Miss T. Rayss for examining the *Penicillium* moulds.

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[1] *J. Amer. Chem. Soc.*, 67, 1824 (1945).

[2] *J. Amer. Chem. Soc.*, in the press.

Preparation of Rare-Earth Chlorides

THE preparation of chlorides of the rare-earth elements directly from monazite by chlorination in the presence of carbon possesses certain advantages over conventional methods. (1) Phosphorus is volatilized as oxychloride in a single operation and the chlorides may be obtained phosphate-free. Conventional methods involve lengthy operations for its complete removal, particularly from thorium. (2) Impurities present in the mineral (as well as those in the added carbon) are largely eliminated as volatile chlorides; for example, as the chlorides of iron, silicon, titanium, aluminium, zirconium and tin. (3) The anhydrous chlorides produced may be extracted either in water or non-aqueous solvents or recovered in a molten state.

The reaction has been studied by briquetting the powdered phosphate with wood charcoal, using rare-earth chlorides as a binding agent. The dried briquettes were heated to reaction temperature in a vertical tube, and a known weight of chlorine passed. Nitrogen was passed through the charge before and after reaction to remove moisture and oxygen and to displace residual volatiles. Condensation of phosphorus oxychloride served as a guide to the progress of reaction. The chlorinated briquettes were extracted with dilute nitric acid (*p*H 2), and the yield estimated by analysis of this solution.

Reaction proceeded smoothly when the phosphate and charcoal were finely ground and when the temperature was as close as possible to the sintering temperature of the briquettes (700–750° C.). The consumption of carbon indicated that the approximate course of the reaction was

$$RPO_4 + 3C + 3Cl_2 \rightarrow RCl_3 + POCl_3 + 3CO.$$

(*R* stands for rare-earth elements: a similar expression holds for thorium.) Some results are given in the accompanying table. The conditions were as follows. Temperature, 700° C.; dimensions of charge: height, 7 cm., cross-section, 2·6 cm.², weight, 50 gm.; weight-ratio monazite/carbon, 6·7; particle sizes, Tyler screens: phosphate, 100%–325, charcoal, 100%–200, briquettes, – 6 + 10; RCl_3, 1 gm. per 50 gm. of charge; monazite analysis: rare-earth oxides, 59·7 per cent; ThO_2, 6·8 per cent; P_2O_5, 27·4 per cent; insoluble in sulphuric acid, 2·0 per cent; ash in charcoal, 7·8 per cent.

Chlorine passed††		Yield*, %		Overall chlorine efficiency**
(gm./min.)	total (gm.)	R_2O_3	ThO_2	
0·19	20	41	0·1	64†
	30	63	2·9	70†
	40	90	14	75†
	50	91	17	61
0·50	20	49	trace	79†
	31	62	0·40	67
	41	73	0·65	58
	95	89	9·2	31
0·70	20	34	Nil	56
	30	47	trace	52
	40	54	0·10	45
	145	90	9·1	21

* Corrected for RCl_3 used as binder.
** Calculated from data in columns 2, 3 and 4.
† No free chlorine evolved.
†† Theoretical consumption of chlorine, 33 gm.

No phosphate was detected in the extracts, which contained only small quantities of impurities, chiefly calcium and magnesium chlorides.

Under optimum conditions, it is therefore possible to obtain a 90 per cent yield of rare-earth chlorides of very satisfactory purity for an overall chlorine efficiency of 75 per cent. The real efficiency is undoubtedly greater than this, because several grams of chlorine are consumed by impurities. The time required to produce a 90 per cent yield is almost independent of the flow-rate; but the rate of reaction falls off very markedly after a 90 per cent yield has been attained.

Thorium is not chlorinated until approximately 50 per cent of the rare earths has been attacked, and thereafter reacts much more slowly than the latter. After extraction of soluble chlorides and separation of unconsumed carbon, a residue is obtained which corresponds in composition to a rare-earth phosphate in which the weight ratio $ThO_2/(ThO_2 + R_2O_3)$ has been increased from an initial value of 0·10 to 0·45.

At 800° C. the reaction becomes rapid, but the chlorides melt and a considerable amount of thorium chloride volatilizes. The reaction at high temperatures is under further investigation. A fuller account of results and experimental procedures will be published elsewhere.

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Mechanism of Conductance by Hydrogen and Hydroxyl Ions in Aqueous Solutions

IT has been suggested[1–5] that the process of electrolytic conduction by hydrogen and hydroxyl ion in water involves, in addition to the mass transport of the hydrated ions, a proton transmission mechanism. This mechanism yields by means of a relatively small motion (*c.* 0·4 A.) of a proton as great a charge transport as would result from a much larger (*c.* 3 A.) motion of the entire ion.

I have attempted to determine whether this mechanism is, in fact, involved by measurement of the conductances of rapidly frozen aqueous solutions of electrolytes—solutions in which the contribution of the mass transport mechanism is presumably greatly depressed. Solutions of hydrochloric acid, nitric acid, hydrofluoric acid, potassium hydroxide, lithium hydroxide, potassium chloride, and lithium fluoride were cooled rapidly to liquid-air temperature, then heated to the temperature at which the conductance was to be determined. The conductances were determined in the temperature range − 120° C. to − 40° C. Each system was studied at temperatures lower than its lowest reported eutectic temperature; at these temperatures the frozen masses appeared solid and felt hard. At liquid-air temperature in all cases the specific conductances were less than the limit of detection (2×10^{-10} mho cm.$^{-1}$) of the apparatus. As the frozen solutions of the acids and bases were warmed to the temperature of measurement, the conductance rose quickly to a maximum, then decreased over a period of hours (presumably the decrease arises from a slow phase separation). The frozen solutions of salts showed no conductance at temperatures below their eutectics; this observation supports the assumption that the mass transport mechanism is insignificant. The maximum conductance was taken as characteristic of the acid and base solutions at each temperature. The measurements were made with a direct-current instrument at fields of 1–10 volts cm.$^{-1}$ and current densities at 10^{-8}–10^{-6} amp. cm.$^{-2}$.

The value of the conductance for a given solution and temperature could be reproduced only to within a factor of two or three, probably because of the cracking of the solid and variations in the amounts of solute 'frozen in'. Following are some typical results:

Substance	Temperature	Specific conductance
0·06 *N* HCl	− 115° C.	6×10^{-9} mho cm.$^{-1}$
0·06 *N* HCl	− 106	3×10^{-8}
0·06 *N* HCl	− 94	9×10^{-8}
0·08 *N* LiOH	− 69	2×10^{-9}
0·08 *N* LiOH	− 51	$1·5 \times 10^{-8}$
0·08 *N* LiOH	− 42	2×10^{-8}
0·056 *N* NHO_3	− 84	3×10^{-9}
0·056 *N* HNO_3	− 70	1×10^{-8}

The observation that the frozen solutions conduct strengthens the suggestion that the proton transmission mechanism contributes to the mobility of hydrogen and hydroxyl ions in aqueous solutions. It may be worthy of mention that estimates of activation energies for the conduction process, made either from ratios of conductances at various temperatures or by application of the absolute rate theory of Stearn and Eyring to the equivalent conductances at each temperature, yield values between 6 and 10 kcal. mole^{-1}. These values are, of course, very uncertain; nevertheless, they may suggest that rotation in the lattice is rate-determining, since the activation energy for rotation of a water molecule in ice has been estimated from the temperature dependence of relaxation time of polarization to be about 8 kcal. mole^{-1}.

In any event, it seems that the pure proton tunnelling mechanism of Bernal and Fowler cannot be the only one involved. Both the strong temperature-dependence of conductance in ice and the fact that deuterium ion in heavy water has an abnormally high conductance lead to this conclusion. Whether the tunnelling effect contributes significantly cannot be decided easily because of the control over the rate by rotation or some other comparatively slow process.

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[1] Huckel, *Z. Elektrochem.*, **34**, 546 (1928).

[2] Bernal and Fowler, *J. Chem. Phys.*, **1**, 515 (1933).

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[5] Frenkel, *J. Phys. U.S.S.R.*, 5, 31 (1941).

Volumetric Estimation of Thallium

A NUMBER of processes have been described for the volumetric estimation of thallium. All these methods are based on the oxidation of thallium from the thallous to the thallic state by potassium permanganate[1], bromate[2], iodate[3] or ceric sulphate[4] solutions; but no attempt has been made to use a precipitation reaction for this determination.

Bromophenolblue (tetrabromo - phenolsulphonaphthalein), which has been used previously as an acid–alkali indicator and as an adsorption indicator[5] in the determination of mercurous ions, has been found by me to be a very suitable indicator for the determination of thallous ions also. 10 c.c. of *N*/10 potassium iodide is mixed with four drops of 0·1 per cent solution of bromophenolblue in alcohol, and thallous nitrate solution (about *M*/10) is run in from the burette. When the exact equivalent amount of the solution has been added, half a drop in excess of the solution turns the yellow-coloured precipitate to a beautiful green colour, the end-point being reversible.

Further work is in progress. The details of the process will be published in detail elsewhere.

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[4] Willard and Young, *J. Amer. Chem. Soc.*, **52**, 36 (1930).

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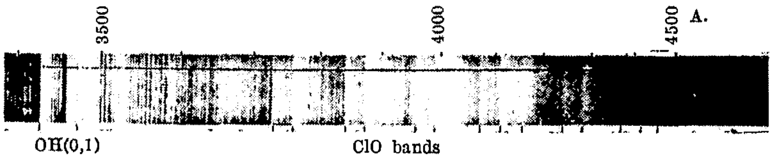
Band Spectrum of ClO in Flames

BAND systems attributed to the monoxides of bromine and iodine have been obtained by Vaidya[1,2] in flames of ethyl bromide and methyl iodide. Recently, Coleman and Gaydon[3] have made a further study of the BrO bands using various flames, including one of hydrogen burning in a mixture of oxygen and bromine vapour; the occurrence of the bands in this flame supports the assignment to BrO. There does not appear to be any detailed record of the corresponding band system of ClO, although Urey and Bates[4] reported the existence of a band system, which they thought to be due to ClO, when chlorine was introduced into an oxy-hydrogen flame. As part of a series of investigations on the inhibitory action of halogen compounds on flames, we have examined the spectrum of a flame of hydrogen burning in an atmosphere of oxygen mixed with a little chlorine. A system of bands has been obtained in the blue to near ultra-violet, which appear to be analogous to the known systems of BrO and IO and



SPECTRUM OF THE FLAME OF HYDROGEN BURNING IN A MIXTURE OF OXYGEN AND CHLORINE

which may therefore be assigned to ClO. The bands do not occur readily when chlorine is introduced into a carbon monoxide – oxygen flame, but have been observed, very weakly, in the outer cone of a methyl chloride – oxygen flame.

The bands, which are superposed on a fairly strong continuous background, are degraded to the red and appear to possess a fairly simple vibrational structure. Unfortunately, the heads are not well defined, and overlapping by strong bands of OH renders accurate measurement and reliable analysis difficult. Photographs have been taken with a medium quartz spectrograph (as in illustration), using plates of high contrast, and also with a large Littrow-type quartz spectrograph giving a dispersion of about 5 A./mm. in the region of the bands. Under the large dispersion the rotational structure is seen to be complex ; heads are difficult to locate, and the chlorine isotope effect could not be found owing to the complexity. With the smaller dispersion, the band heads listed in the accompanying table were measured ; the measures are accurate to about 2 A. in most cases, but in a few difficult cases there is a possibility of errors so large as 5 A. The bands have been arranged into a provisional vibrational scheme using intervals of about 780 cm.$^{-1}$, decreasing to less than 700 for ω'' and about 550 cm.$^{-1}$ for ω'. The bands fall on an open Franck–Condon parabola, and it is not possible to assign definite values for v'' ; it would not be surprising if x in the table was about 3, making ω'' a little more than 800 cm.$^{-1}$.

BAND HEADS OF ClO

λ.	I	ν	v'	v''	λ	I	ν	v'	v''
4502	2	22206	4	$10 + x$	3991	8	25049	1	$4 + x$
4459	3	22420	3	$9 + x$	3957	7	25265	0	$3 + x$
4417	3	22633	2	$8 + x$	3874	10	25806	1	$3 + x$
4373	3	22861	1	$7 + x$	3841	10	26027	0	$2 + x$
4335	1	23062	3	$8 + x$	3761	9	26581	1	$2 + x$
4283	7	23341	2	$7 + x$	3729·5	7	26805	0	$1 + x$
4241	5	23573	1	$6 + x$	3652·5	6	27371	1	$1 + x$
4154	4	24066	2	$6 + x$	3625	3	27578	0	$0 + x$
4114	9	24300	1	$5 + x$	3587	2	27871	2	$1 + x$
4078	6	24515	0	$4 + x$					

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Vaidya, W. M., *Proc. Indian Acad. Sci.*, 7 A, 321 (1938).
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Coleman, E. H., and Gaydon, A. G., *Trans. Farad. Soc.*, in the press.
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nteraction Terms in Molecular Vibrations

IN a recent communication[1], Coulson, Duchesne and Manneback have pointed out that the positive sign of the cross-term constant, g_c, in the P.E. function of the water molecule

$$2V = f_1(\overline{\Delta r_1}^2 + \overline{\Delta r_2}^2) + 2f_{12}\,.\,\Delta r_1\,.\,\Delta r_2 + r_1 r_2 f_\theta . \overline{\Delta\theta}^2 + 2r_1 g_c(\Delta r_1 + \Delta r_2).\Delta\theta$$

can be accounted for by supposing that the hybridization of the oxygen bond-forming orbitals changes during a vibration. We had come to exactly the same conclusion, and our reasons for this are contained in a communication to the Faraday Society which is awaiting publication[2].

We were led to our conclusion more particularly by the sign of f_{12}, which is negative. This implies that, as one OH-bond contracts, the other tends to contract also. We had first supposed that the departure from the simple valency force-field might be due to repulsion between the hydrogen atoms. But, if this were so, movement of one hydrogen atom towards the oxygen atom would force the other away. We were therefore led to conclude that as one OH-bond contracts it assumes more s-character, which results in the other bond assuming more s-character and its equilibrium-length decreasing. This explanation was confirmed by the fact that it accounted for the positive sign of g_c also. So we concluded that the size of the HOH angle was due to the fact that the oxygen bond-forming orbitals in water had considerable s-character, rather than because of repulsion between the hydrogen atoms.

If the repulsion between the hydrogen atoms is given by

$$V = V_0 + A(\Delta R) + \tfrac{1}{2}B(\Delta R)^2$$

for small displacements, ΔR, from the HH distance in the equilibrium configuration, the contribution of A and B to the cross-terms f_{12} and g_c can be shown to be

$$\begin{array}{ll} 0{\cdot}313\,B - 0{\cdot}124\,A & \text{to } f_{12} \\ 0{\cdot}242\,B + 0{\cdot}160\,A & \text{to } g_c. \end{array}$$

The signs of the contributions to g_c and f_{12} will depend, therefore, on the signs and relative magnitudes of A and B. We cannot, therefore, agree with Coulson, Duchesne and Manneback that it is necessary "that the contributions to the interaction constants f_{12} and g_c that arise from the force between the two non-bonded atoms have the same sign". This will only be true when the first terms involving B, d^2V/dR^2, outweigh the second terms involving A, dV/dR. However, in the present case, it does not seem that the force between the non-bonded atoms is an important factor. Urey and Bradley[3] pointed out that this factor was important in accounting for the departures from the simple valency force-field in molecules such as carbon tetrachloride. We have developed their ideas somewhat further for the tetrahalides of some Group IV elements in two other papers that are awaiting publication[4], and have shown that the repulsion that exists is of the magnitude that would be expected if it arises from Van der Waals' type interaction.

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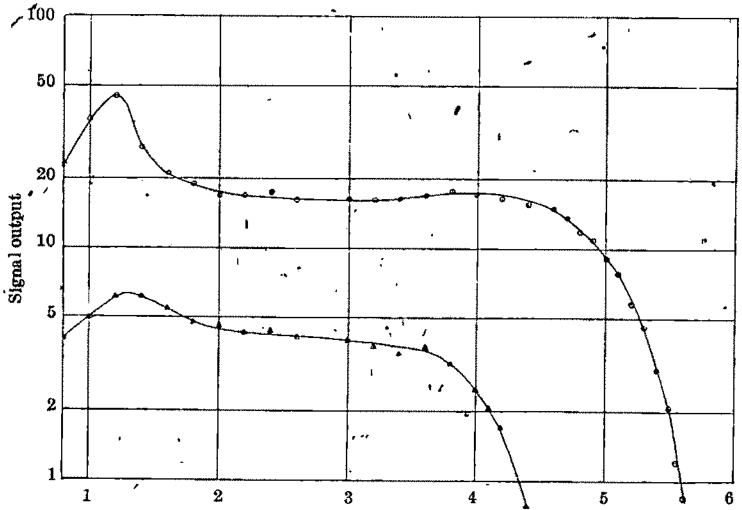
Spectral Response of Lead Selenide

MICRO-CRYSTALLINE layers of lead selenide are known to show photo-conductivity when illuminated by infra-red radiation, in a manner similar to that shown by lead sulphide. Measurements made in Germany during the War indicate that for lead selenide the long wave-length limit of sensitivity lies farther towards the far infra-red[1]. More recent experiments by Blackwell, Simpson and Sutherland[2] on the spectral response of lead selenide confirm this. Up to the present, however, the accurate determination of the long-wave limit has been impossible because of the very strong absorption in this region of the spectrum of 'Pyrex' and other glasses from which the photo-conductive cells have been made. We have recently developed a technique whereby a sensitive layer may be made in a cell with a window of *KRS*5 material (a mixture of thallium bromide and iodide which has a uniform transmission of about 65 per cent from 1 to 35 μ).

The cell is made in an envelope of the usual Dewar flask type except that the outer wall is formed into an elongated neck opposite the layer electrodes, which are on the inner wall. Initially a layer of lead selenide is evaporated on to the electrodes *in vacuo*, and then the end of the glass neck is cut off, ground flat, and the window sealed on with vacuum wax. The layer is then treated by heating to a temperature just below its subliming point (about 405° C.) *in vacuo* for several hours. For this treatment the inside of the Dewar vessel is filled with a molten (low melting point) alloy maintained at the appropriate temperature by means of a small immersion heater. Finally, the layer must be recrystallized by evaporating on to the outer wall of the flask and then back on to the electrodes, when a sensitive, high-resistance layer is obtained. Throughout these processes the window is kept cool by standing in cold water.

The accompanying diagram shows the spectral response of lead selenide for constant incident energy at 195° K. and 90° K. The shift to longer wave-lengths on cooling is analogous to that observed for lead sulphide[3]. Taking the flat portion of the curve as the datum-level, the response at liquid oxygen temperature is down to 50 per cent at 5·0 μ, indicating about 1·0 μ shift from the 195° K. curve.



SPECTRAL SENSITIVITY OF LEAD SELENIDE LAYER, SHOWING SIGNAL OUTPUT FROM THE LAYER FOR CONSTANT INCIDENT ENERGY. ⊙, 90° K.; △, 195° K. (on same scale)

The peak found at 1·2 μ is believed to be due to impurities and not inherently characteristic of the main lattice. At longer wave-lengths the response curve differs somewhat from that of other workers[1,2], who find a slight secondary peak. The presence of this peak may perhaps be connected with the varying transmission of the layer with wave-length. If the layer is too thin, all the incident energy is no longer absorbed at the longer wave-lengths, giving a false impression of the shape of the spectral sensitivity curve.

The layer which is the subject of this note was therefore made relatively thick (estimated as somewhat greater than 1 μ from the mass and area of the layer). Previous measurements in this laboratory have shown that layers appreciably thinner than this have considerable transmission in the region of 5 μ.

The spectrometer used was a double-dispersion instrument using lithium fluoride prisms and having a high degree of freedom from scatter.

Our thanks are due to Dr. G. B. B. M. Sutherland and Mr. O. Simpson, of the University of Cambridge, for communicating to us, before publication, their method of making sensitive lead selenide cells[4] and their recent spectral response measurements[2]; also to the Ministry of Supply for permission to publish this letter.

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Nov. 5.

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[4] Simpson, [*Nature*, **160**, 791 (1947)].

Pinhole Radiography of Magnetrons

'PINHOLE RADIOGRAPHY' is extensively used[1] to study the size and shape of the focal spot of an X-ray tube. Where electrons strike the anode, X-rays are emitted in all directions; a camera, with a pinhole in a sheet opaque to X-rays in place of the lens, can be used to record an X-ray image of the bombarded area.

Hitherto, magnetrons[2] have operated at anode voltages too low for X-rays to escape from the tube envelope in appreciable intensity. We have recently been working on a high-power (2,000 kW.) pulsed 10 cm. magnetron, operating at 47 kV. anode voltage, 90-amp peak, 135-m.amp. mean anode current[3]. Having observed X-ray emission from this valve (10^{-5} r./sec. at 1 metre distance) we decided to make the following experiment.

The normal electromagnet gap of 8 cm. was increased to 11·5 cm., while maintaining the magnetic field at 1,600 oersteds. The valve was set up with one end-plate against a pole-face. A sheet of lead, 2 mm. thick, was placed against the other end-plate, and contained a pinhole situated on the axis of the valve.

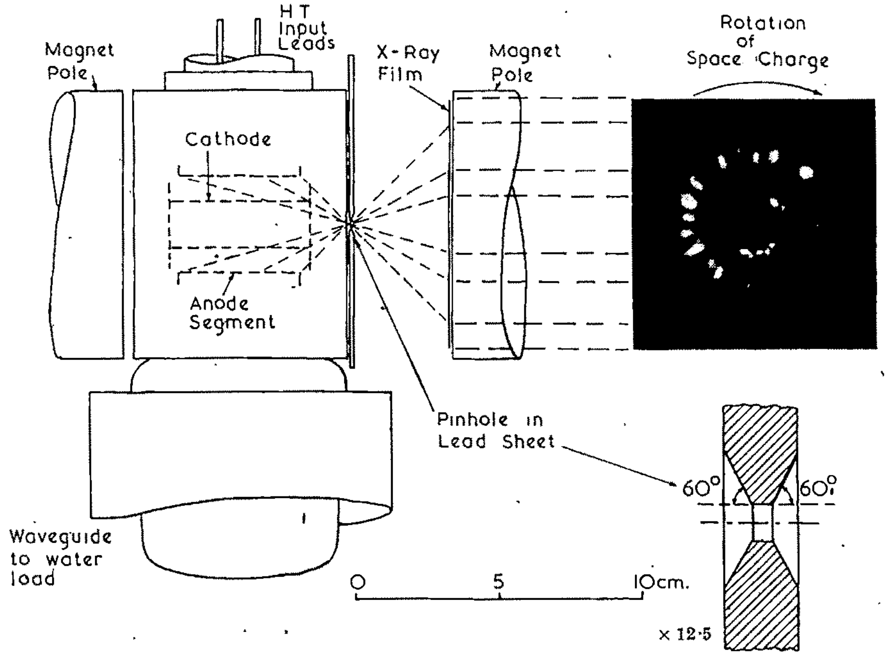
An X-ray film (Kodak 'Industrex' Type *D*) in a black paper envelope was pressed against the second pole-face. The general arrangement is shown in the figure, which includes a detail enlargement of the pinhole.

The accompanying radiograph is reproduced from a print of a negative obtained with a 10-min. exposure. The print shows bombardment of the following areas: (1) the 'far' end of the segments (small central ring of bright spots); (2) the 'near' end of some of the segments; (3) two or three of the spirally disposed 'echelon' strap wires at the near end; (4) limited areas on each segment between the near end and the middle.

The effects (1), (2) and (3) are thought to be incidental to the proper working of the magnetron. (Possibly they arise from the frequent flash-arcs taking place during the run.) On this view, (4) represents bombardment by the 'useful' electrons. It is of interest to note:

(*a*) Marked inequality of intensity on different segments.

(*b*) Concentration of bombardment on each segment in a line at the 'leading' edge and a patch near the 'trailing' edge.



(*c*) The apparent absence of bombardment near the middle plane of the valve, which may be due to increased absorption by the slant thickness (about 1 mm.) of the nickel cathode tube. (All rays recorded are filtered through the nickel end-disk of the cathode, 0·5 mm. thick, and 1·5 mm. of copper in the end-plate of the valve.) However, another exposure, with the pinhole eccentric to avoid absorption by the cathode tube of X-rays leaving the whole of two or three segments, showed no axial extension of the bombardment areas. The concentration towards the near end is perhaps due to the slightly weaker magnetic field near this end.

These first results already show that pinhole radiography can give valuable information about electron motion in magnetrons. We became aware of the value of pinhole radiography, in connexion with other high-voltage electronic valves, by learning of the prior experiments of Mr. A. G. Long[4], of Messrs. Newton and Wright, Ltd., on high-voltage rectifiers.

We desire to thank Mr. L. J. Davies, director of research of the British Thomson-Houston Co., Ltd., for permission to publish this note.

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Jan. 5.

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[1] Herz, article in "Handbook of Industrial Radiography", 59 (London: E. Arnold and Co., 1944).

[2] Willshaw, Rushforth *et al.*, *J. Inst. Elec. Eng.*, Part IIIA, No. 5, 985.

[3] See ref. 2, Sect. 9, and Fig. 34.

[4] Forthcoming paper in *J. Inst. Elec. Eng.*.

Latent Infection in *Coffea arabica* L.

PROF. S. R. BOSE's article[1] dealing with the occurrence of *Phomopsis casuarinæ* F. Tassi throughout the tissues of *Casuarina equisetifolia* Forst. prompts me to record some observations made in 1940 and 1941 on the presence of various fungi in the tissues of Arabic coffee (*Coffea arabica* L.).

While investigating a disease of green coffee berries which is caused by a variety of *Colletotrichum coffeanum* Noack[2], healthy leaf, green berry, stem and pedicel tissues were tested for the presence of latent infections using a mercuric chloride–saponin solution as the surface sterilizing fluid. Practically every piece of tissue tested, down to one millimetre square pieces of leaf tissue, were found to produce fungal growth when cultured on prune agar. *Colletotrichum coffeanum*, in a large variety of forms, was most frequently obtained, but a species of *Phoma* and a species of *Phomopsis* were also frequently isolated. The fact that these fungi are present as latent infections on almost all healthy coffee tissue explains the constancy with which they fructify on tissues which have died from carbohydrate or nitrogen deficiencies, sun-scorch, etc., and explains why a number of physiological diseases have, in the past, been considered to be due to fungal attack.

The strains of *Colletotrichum coffeanum* isolated showed similar variations to those noted by Burger[3] for *C. glœosporioides* Penz. It was observed, however, that certain forms were most frequently isolated from certain parts of the plant. Those with short spores, sparse whitish mycelium and with the chlamydospores simple or absent were mainly found on twigs, whereas those with longer spores, abundant greenish mycelium and abundant convoluted chlamydospores occurred most frequently on green fruits; intermediate forms were found mainly on leaves and pedicels. The form causing the disease of ripe berries, which is known as 'brown blight', is of this type, the extreme development of which is represented by the form which causes the serious disease of green berries known as 'coffee berry disease'. This form is characterized by the spores being produced separately on branches over the entire mycelium instead of being massed on stromata as with all the other forms. The forms on leaves and stems never appear to cause disease symptoms, though certain minute yellow spots on mature leaves may be due to the presence of the fungi. Fructification only occurs when the bark dies (perhaps somewhat prematurely) or the leaves are shed. It is interesting to note that the forms which make up the morphological series appear thus not only to be associated with different parts of the plant, but also with differing degrees of parasitism.

A similar series of forms appears to exist in the *Phoma* sp., again distinguished by increasing length of spores and by increasing coloration of mycelium. The individual forms also show a similar trend of preference for different parts of the plant. None, however, has been observed to produce a noticeably diseased condition. The *Phomopsis* sp., on the other hand, showed no obvious polymorphy.

There is some evidence to suggest that premature shedding of leaf, irregular bark ripening and uneven ripening of the berry may be associated with the development of the less pathogenic latent infection fungi in senescent tissues.

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Oct. 6.

[1] Bose, S. R., *Nature*, **159**, 512 (1947).

[2] McDonald, J., *Trans. Brit. Mycol. Soc.*, **11**, 145 (1926).

[3] Burger, O. F., *J. Agric. Res.*, **20**, 723 (1921).

Persistence of D.D.T. and Benzene Hexachloride in Soil

THE use of 2 : 2-*bis*-(*p*-chlorophenyl)-1 : 1 : 1-trichlorethane (*D.D.T.*) and benzene hexachloride as soil insecticides raises the question of the length of time for which these substances will persist in soil. There is already much indirect evidence that both these substances are satisfactory in this respect; but the possibility exists that they may suffer bacterial[1] or other decomposition in soil, as do many organic compounds. So far as I am aware, this problem of persistence has not so far been the subject of direct chemical investigation.

In experiments commenced here some eighteen months ago, both *D.D.T.* and benzene hexachloride (mixed isomers containing 10 per cent gamma isomer) were incorporated at a high concentration (2 per cent) with acid and with alkaline soils. Treated and control soils were kept in the open, and the residual insecticide determined chemically at intervals. In view of the possibility that a decomposition in soil might involve dehydrochlorination, determinations were also made of soil chloride, chloride leached and *p*H.

Similar determinations were carried out in a second series of experiments in which soils kept under laboratory conditions were subjected to controlled leaching at intervals.

The results reveal the marked persistence of these insecticides under the conditions employed. Thus, even after eighteen months, more than 95 per cent of the *D.D.T.* and 80–94 per cent of the benzene hexachloride can be recovered. The chloride estimations on soils and leachings have not indicated the release of more than traces of inorganic chloride. No regular changes in *p*H have been observed.

Counts of soil bacteria, estimated by the plate method, suggest that neither *D.D.T.* nor benzene hexachloride has an adverse effect on the bacterial population.

While it is recognized that the concentration of insecticide used in these experiments is very considerably greater than would ever be used in practice, it is interesting to note that whereas the *D.D.T.*-treated soils permit normal germination and early growth of cress, oats and wheat, those treated with benzene hexachloride inhibit root development. Further, the benzene hexachloride soils do not permit root development in the case of sugar beet, cabbage and flax. Here the *D.D.T.* treatment results in a somewhat lower percentage germination, although early growth is then normal. Oats and wheat are particularly susceptible to benzene hexachloride, and suppression of the radicle occurs even when the concentration of this substance is reduced to 0·02 per cent by admixture with the control soil.

Details of this work will be published elsewhere.

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Oct. 29.

[1] Matthews, A., *J. Agric. Sci.*, **14**, 1 (1924).

Newly Discovered Submarine Canyons of New Guinea and South Australia

FAIR charts of the Morobe area, New Guinea, which were recently made available to me by the Royal Australian Navy, show three huge depressions across the continental shelf. These are submarine canyons, apparently the first to be discovered off New Guinea. They extend to within less than a mile of the modern coast and their heads oppose outlets of the Rivers Gira, Eia and Waria, after which they have been named. The bottom gradients of the submarine canyons average up to 10 per cent across the continental shelf, which is about ten miles wide. They range to seven and eight hundred fathoms in depth at the shelf edge, and no details are known of the structures more than a mile or two beyond that limit.

The local sea floor is reported to be of soft volcanic muds, while coral growths line the shelf edge, rising from depths of from forty to seventy fathoms as barrier reefs. Minor coral growths occur at intervals along the submarine canyon rims. On the assumption that reef corals do not flourish in water deeper than about 20–30 fathoms, it is inferred that sea-level fell relatively by at least 40–50 fathoms at the time of barrier reef establishment. Unfortunately, nothing is known accurately of local land movements during the interval of canyon formation.

In keeping with Daly's theory[1] of submarine canyon development, which holds that muddy bottom density currents eroded the canyons during low sea-level periods of the Pleistocene, it is considered that canyon development proceeded contemporaneously with barrier reef establishment. However, in the present case, evidence suggests that submarine canyon erosion was initiated by silt-laden river waters entering the sea locally during the low sea-level phases, rather than simply by shore wave action on exposed continental shelf sediments. If the latter process was widely developed, it is thought that barrier reef establishment would have been inhibited or prevented. A possible counter to this argument, namely, that the muddy fraction of the shelf edge sediments would have been winnowed out during the early part of a low sea-level stand, is weakened by the fact that it would reduce the time interval of effective erosion by such inferred shore suspension currents too greatly.

Of the Murray submarine canyons, off the South Australian coast, little is yet known. They were located by the naval survey vessel H.M.A.S. *Lachlan*, by tracing the 100-fathom line for about eighty miles in the vicinity of the Murray River mouth. The deep submarine canyon structures occur in a width of less than four miles, although the remainder of the survey course revealed no other significant break.

The submarine canyons are thought to be genetically related to drowned courses of the Murray River, which is the only large river at present entering the sea locally. Along the line of the echo-sounding traverse, the three structures, named respectively the West, Central and East Murray submarine canyons, bottomed at approximately 550, 625 and 750 fathoms. The central and east members are separated by a low but definite ridge.

It is not known whether the three submarine canyons are essentially parallel structures or part of an elongated dendritic pattern. Investigations to be carried out in the future should solve this problem.

Concerning canyon triplicity, in a paper on the two groups of submarine canyons now in the press[2], I have advanced two theories as alternative possible explanations. Both relate to the repeated sea-level falls of the Pleistocene glacial phases, during which erosion by means of bottom density currents is considered (Daly's theory) to have been at a maximum.

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Oct. 15.

[1] Daly, R. A., "The Floor of the Ocean" (Univ. of North Carolina Press, 1942).

[2] Sprigg, R. C., *Trans. Roy. Soc. S. Aust.*, in the press.

Units and Useful Range in Photo-electric Colorimetry

WE value the remarks of Drs. Edisbury, Taylor and Gridgeman[1] on a new unit in photo-electric colorimetry[2]. Opinions do not seem at variance that measurements should be made at approximately the same optical density[1,2], that—provided the Beer – Lambert law be valid—the relation of the proposed unit $W^{50}_{1\,\text{cm.}}$ to the usual $E^{1\%}_{1\,\text{cm.}}$ can be expressed by:

$$E^{1\%}_{1\,\text{cm.}} = \frac{0\cdot00301}{W^{50}_{1\,\text{cm.}}},$$

and that E (1%, 1 cm.) is certainly less cumbersome to print than $E^{1\%}_{1\,\text{cm.}}$. Title and text of our letter[2], however, should have made it clear that we had photo-electric colorimeters (absorptiometers) in mind. Though it was shown by Twyman and Lothian[3] that 0·4343 is the best density for this type of instrument, it was also stated that ". . . we may use densities between 0·2 and 0·8 without any considerable loss of accuracy". This range covers easily the proposed half-value and adjacent auxiliary readings used for interpolating $W^{50}_{1\,\text{cm.}}$. An even wider range (0·2–1·2) is recommended elsewhere[4] for an instrument other than ours. The statement[1] that E (1%, 1 cm.) is merely a standard expression that does not carry the implication that one must measure the optical density of a 1 per cent solution in a 1 cm. cell may probably be correct, but not necessarily so, and does not seem to be endorsed unanimously; for Guild[5] inferred regarding accuracy in spectrophotometry that ". . . our terminology should be kept in as close correspondence as possible with the physical magnitudes actually handled in our experiments", strongly deprecating the use of derived magnitudes. Though the proposed half-value is inversely related to quantity, this need not impair its applicability; for a similar magnitude, the half-value layer is a standard expression in X-ray technique[6].

Thus the major practical point in dispute seems to be, how far the useful range extends towards both ends of the scale. As many extraneous factors influence the final accuracy, the limits of the useful range have to be established by experiment. To test this, sample and blank are compared, say, twenty times, whence a mean and its standard deviation are obtained. From the mean plus/minus sigma, and from the Beer – Lambert law, the error prevailing at this point of the scale can be estimated. A few pilot measurements towards either end of the scale will readily establish fiducial limits. 920 measurements performed on different concentrations of copper sulphate in water did not reveal any significant difference in accuracy between 10–90 per cent transmission. Within this range, two thirds of all observations fell within the limits ± 0·88 per cent weight of copper sulphate. The corresponding error below and above this range was 2·60 per cent and 2·56 per cent respectively.

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Nov. 3.

[1] Edisbury, J. R., Taylor, R. J., and Gridgeman, N. T., *Nature*, **159**, 777 (1947).

[2] Koch, W., and Kaplan, D., *Nature*, **159**, 273 (1947).

[3] Twyman, F., and Lothian, G. F., *Proc. Phys. Soc.*, **45**, 643 (1933).

[4] Glover, J., Goodwin, T. W., and Morton, R. A., *Biochem. J.*, **41**, 97 (1947).

[5] Guild, J., *Proc. Phys. Soc.*, **45**, 659 (1933).

[6] Pohle, E. A., and Chamberlain, W. E., "Theoretical Principles of Roentgen Therapy" (Lea and Febiger, Philadelphia, 1938).

THE major practical point in dispute is not "how far the useful range extends towards both ends of the scale" (though we believe this to be narrower than many published figures imply), but whether the proposed new unit fulfils any useful function not already covered by the old; and on this issue we have nothing to add to our original arguments. We would ask only that anyone who still prefers to use the 'half-value' should also, for the convenience of the reader, give the equivalent E (1%, 1 cm.) value.

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HIGH-ALTITUDE MEASUREMENTS ON COSMIC RAYS

Penetrating Cosmic Ray Showers

THE penetrating shower set P, described in a previous communication[1], has now been transported to the Scientific Station, Jungfraujoch, altitude 3457 metres (atmospheric pressure = 50 cm.), and the transition curves of penetrating showers, produced in paraffin, aluminium and lead placed over the set P, studied there. In addition to the apparatus illustrated in our earlier note, four unscreened trays of counters, $E_1 \ldots E_4$, of areas 230, 460, 920 and 1,840 cm.^{2} respectively, were placed near the penetrating shower set, P, for recording the presence of air showers. Also the side and end screens of the set, P, were increased from 10 cm. to 15 cm. of lead. The seven-fold coincidences of P were recorded and, in addition, coincidences in P accompanied by a discharge of each of the four air-shower trays were recorded separately.

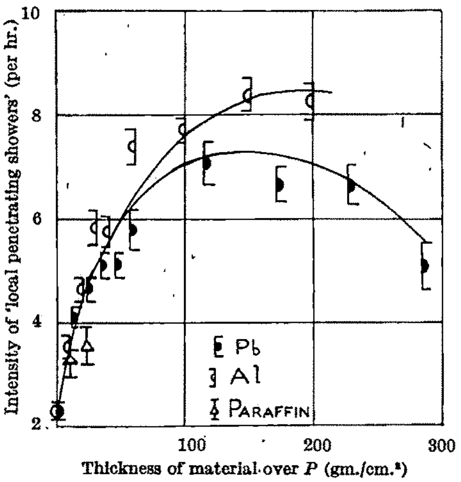

Fig. 1

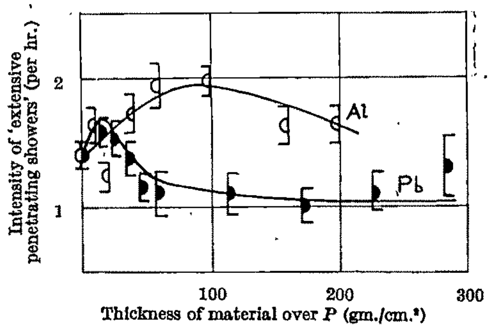

Fig. 2

Following the nomenclature of Jánossy and Broadbent[2], we call seven-fold coincidences in P, unaccompanied by discharges in the trays E, 'local penetrating showers', while seven-fold coincidences in P, accompanied by discharges of the trays E, are defined as 'extensive penetrating showers'. The importance of distinguishing between these two types of penetrating shower is illustrated by the work of Jánossy and Broadbent[2], who have shown that the intensity and transition curves for local penetrating showers are consistent with the view that they are caused by nucleons of the primary cosmic ray flux arriving on the top of the atmosphere. The interpretation of extensive penetrating showers is not so unambiguous at the moment. We discuss our results for these two types of shower separately.

(a) *Local Penetrating Showers.* The transition curves obtained for these showers are shown in Fig. 1, where the abscissæ give the thickness of different materials expressed in gm./cm.^{2}. It will be noted that initially the results all lie on the same curve, the results for lead and aluminium differing slightly for the largest thicknesses studied. This divergence is possibly due to the geometrical difference in the arrangement of the absorbers placed over P caused by the difference in density of the two substances. An attempt was made to counteract this density effect by spacing out the lead, but it is not possible to compensate exactly.

A comparison with the sea-level results of Jánossy and Broadbent shows that the intensity at Jungfraujoch is 28 times the sea-level intensity, which corresponds to a 'range' of the primaries causing them of 120 gm./cm.^{2}, and this again is consistent with the primary nucleon hypothesis.

(b) *Extensive Penetrating Showers.* The transition curves for extensive penetrating showers, measured using the tray E_4, is shown in Fig. 2, plotted on the same mass-scale as Fig. 1. It will be noted that these transition curves are typical cascade curves.

The intensity of this type of shower is only 10 times the sea-level intensity, and this is consistent with the increase of 12 in the intensity of air showers recorded by Auger at this same station.

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Nov. 8.

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[1] George and Jason, *Nature*, **160**, 327 (1947).

[2] Jánossy and Broadbent, *Proc. Roy. Soc.*, A, **190**, 497 (1947).

Penetrating Bursts

MEASUREMENTS at sea-level on the existence of penetrating particles in ionization bursts have already been briefly reported[1]. We have now constructed an apparatus more sensitive to this type of burst, and after a short run at sea-level have carried out measurements on penetrating bursts at the Scientific Station at the Jungfraujoch.

The apparatus is illustrated in Fig. 1. An aluminium ionization chamber B, of 1·5 litres capacity and of wall thickness 1·25 cm., was filled with pure argon to a pressure of 30 atmospheres. Above and below the chamber were placed cylindrical screens of lead A and D, of thickness 15 cm. or greater, as shown. Furthermore, the ends were closed by lead screens of thickness 12 cm. In the lower screen D is a concentric slot E, in which were placed eighteen Geiger–Müller counters. Similarly, under the ionization chamber 9 Geiger–Müller counters C were placed, divided into three groups of 3, as shown. Further, the screens were flanked on each side by trays of counters I, II, III, IV, for the detection of air showers. These air-shower trays consisted of 1, 2, 4 and 8 counters respectively, each counter being of area 230 cm.^{2}.

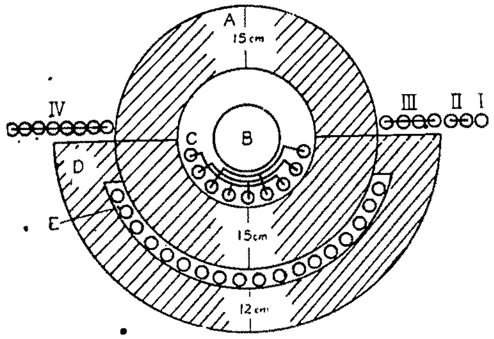


Fig. 1. GENERAL ARRANGEMENT OF APPARATUS

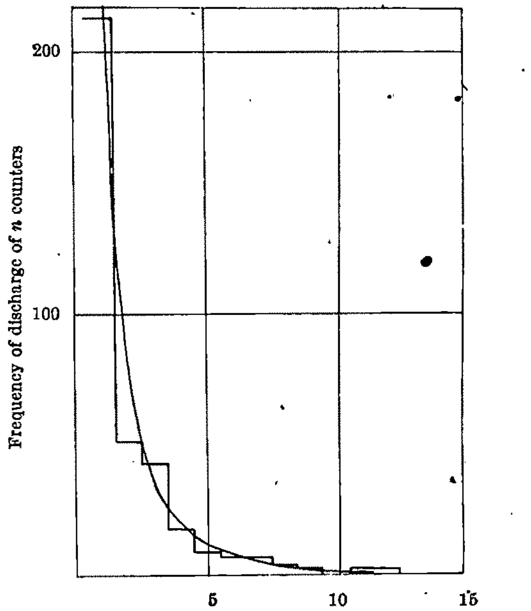
The voltage impulses produced by bursts of ionization in the chamber were amplified and recorded by a continuous camera, in a normal manner. To each of the lower counters 1 . . . 18 in *E*, and the air-shower trays I . . . IV, lamps were connected via separate amplifiers, and a given lamp was energized if a burst occurred accompanied by a three-fold coincidence in the upper counters *C*, plus a discharge in the corresponding counter to which it was connected.

From separate control experiments, it was shown that the majority of bursts accompanied by a discharge of only one of the lower counters was due to accidental coincidences, whereas those bursts accompanied by a discharge of more than one lower counter could not be so. Bursts accompanied by a discharge of more than one lower counter will be defined as 'penetrating bursts'. In the same way that Jánossy and Broadbent[2] showed the importance of distinguishing between so-called 'local' and 'extensive' penetrating showers, so we find it convenient to separate penetrating bursts into those associated with air showers, which we shall call 'extensive penetrating bursts', and those penetrating bursts unaccompanied by a discharge in the air-shower trays I–IV, which we shall call 'local penetrating bursts'. The fact that these two types of penetrating bursts are essentially different is shown in Figs. 2*a* and 2*b*, in which the frequency of discharge of *n* of the lower counters is plotted against *n* for local and for extensive penetrating bursts, observed in a period of 120 hours. While the size distribution for local bursts varies approximately as $1/n^2$, the size-distribution for extensive bursts seems to be given approximately by the Poisson distribution for $\bar{n} = 5$ or 6.

The intensities of the various types of burst are given in the table :

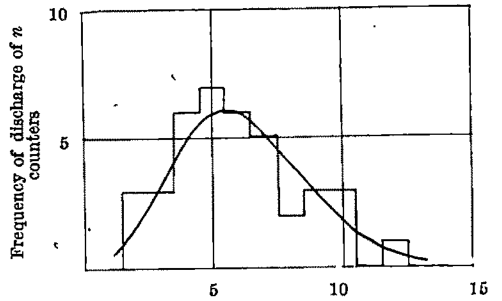
Type of burst	$R(>N)$ = Rate/hour of bursts of size $> N$							
	N							
	20	30	40	60	80	100	150	200
All bursts	12·6±0·34	3·52±0·18	1·81±0·13	0·89±0·06	0·41±0·06	0·25±0·05	0·11±0·03	0·095±0·03
Penetrating bursts	1·56±0·12	0·71±0·08	0·48±0·07	0·33±0·06	0·16±0·04	0·12±0·03	0·10±0·03	0·076±0·03
Extensive penetrating bursts	0·31±0·05	0·20±0·04	0·11±0·03	0·10±0·03	0·095±0·03	0·085±0·03	0·085±0·03	0·066±0·025

These results are plotted on logarithmic scales in Fig. 3. The slope of curve (1) for all bursts is $-2·2$, giving $R(>N)$ = const. $N^{-2·2}$, whereas the size contribution for penetrating bursts is quite different. It will be noted that of the largest bursts measured ($N>200$), the majority are penetrating and also extensive. The increase of burst intensity over the sea-level figure is a factor of 3·9, and this is about the amount by which penetrating bursts have increased with altitude.



No. of counters discharged simultaneously (*n*). Smooth curve, $1/n^2$

Fig. 2*a*. LOCAL BURSTS



No. of counters discharged simultaneously (*n*). Smooth curve, Poisson distribution, $\bar{n} = 6$

Fig. 2*b*. EXTENSIVE PENETRATING BURSTS

Penetrating bursts thus show much less of an increase with altitude than do penetrating showers[3], and we can therefore eliminate the nucleon component as the primary agent of penetrating bursts.

The interpretation of local penetrating bursts is perhaps the simplest. We have divided up these bursts into groups of different size, and measured the total number of lower counters discharged by bursts in the various groups. In Fig. 4 we have plotted the number of counters discharged per local penetrating burst as a function of the mean burst size of the group.

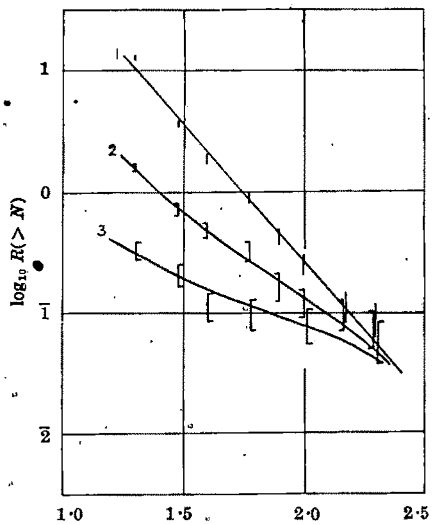


Fig. 3. INTENSITY OF BURSTS: N IS SIZE OF BURST; $R(>N)$ IS RATE/HOUR OF BURSTS OF SIZE GREATER THAN N. 1, ALL BURSTS. 2, PENETRATING BURSTS. 3, 'EXTENSIVE' PENETRATING BURSTS

The relation appears to be linear, and on the average one counter is discharged per local burst of 130 rays. The efficiency of collection of the lower tray is about $\frac{1}{4}$, and it therefore appears possible that local bursts contain on the average 3/130, or about $2\frac{1}{2}$ per cent of mesons, and are apparently caused by mesons.

The extensive penetrating bursts would appear on the average to be associated with the passage of something like eighteen penetrating particles through the lower half of the apparatus.

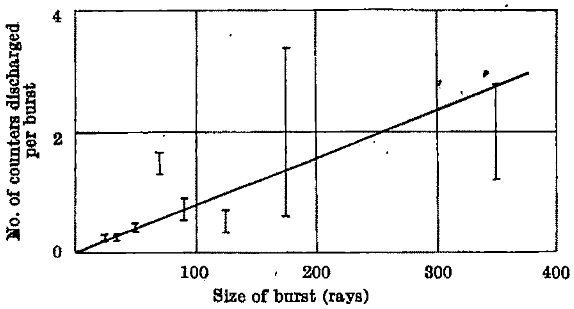


Fig. 4. VARIATION OF NUMBER OF COUNTERS DISCHARGED BY 'LOCAL PENETRATING BURSTS'

It would appear that additional processes are involved in burst production, under thick lead, over and above the creation of high-energy electrons and photons by mesons, and the subsequent cascade development of the former. For bursts of size greater than 100, these additional processes are involved in a large fraction of bursts, and this would appear to invalidate the arguments put forward for assigning the value 0 to the spin of the cosmic ray meson[4], based on measurements of burst production under thick materials.

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Nov. 12.

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[1] George and Jánossy, *Phys. Rev.*, **70**, 773 (1946).

[2] Jánossy and Broadbent, *Proc. Roy. Soc.*, A, **190**, 497 (1947).

[3] George and Jason, see previous communication.

[4] Christy and Kusaka, *Phys. Rev.*, **59**, 414 (1941).

STRUCTURE OF TURNIP YELLOW MOSAIC VIRUS CRYSTALS IN THE ELECTRON MICROSCOPE

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IT is known from examination in the electron microscope that turnip yellow mosaic virus[1] consists, in the dry state, of individual particles of spherical form and about 22 mμ in diameter. It readily forms macroscopic crystals, usually octahedra, from aqueous salt solutions. Preliminary X-ray studies indicate that these wet crystals have a large unit cell, and Carlisle suggests[2] that the lattice may be of the diamond type. Attempts have been made to obtain replicas of the dry crystals, by the method which has proved successful with some other plant viruses[3,4], but these have not shown any regular structure. The failure may be due to the shape of the crystals or to difficulties of drying.

Electron micrographs have been taken (by transmission) of the virus mounted on beryllium films, and some of them show a number of micro-crystals having the appearance of a net formed by hexagonal rings (Fig. 1). Each ring has an electron-transparent hole in the centre, of such a size that the rings appear larger than the size of the individual virus particles. From the photographic density of the images, it may be estimated that the crystalline fragments are only a few molecules thick in the direction of the electron beam. The fainter patches in the background also show similar structure in some regions, and may be only two or three molecules deep.

As the electron micrographs seemed to agree with a diamond-type lattice, measurements were made on the hexagonal network in various directions. The

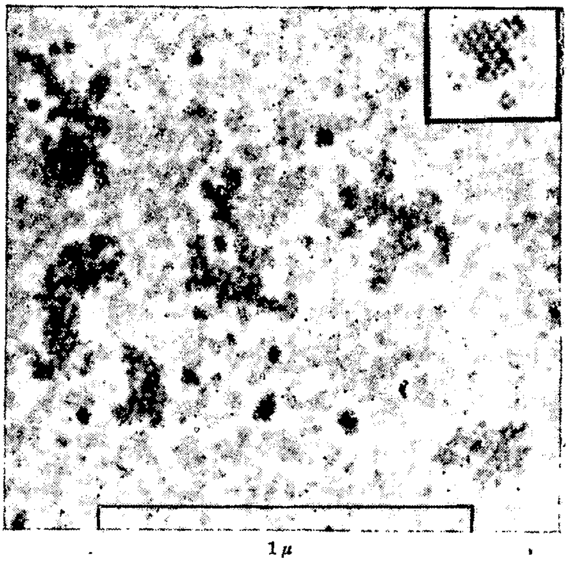


Fig. 1. ELECTRON MICROGRAPH OF FRAGMENTS OF CRYSTALLINE TURNIP YELLOW MOSAIC VIRUS: PHOTOGRAPHED AT 19,000×, TOTAL MAGNIFICATION 48,400×. INSET: OUT-OF-FOCUS PHOTOGRAPH OF MODEL OF DIAMOND LATTICE

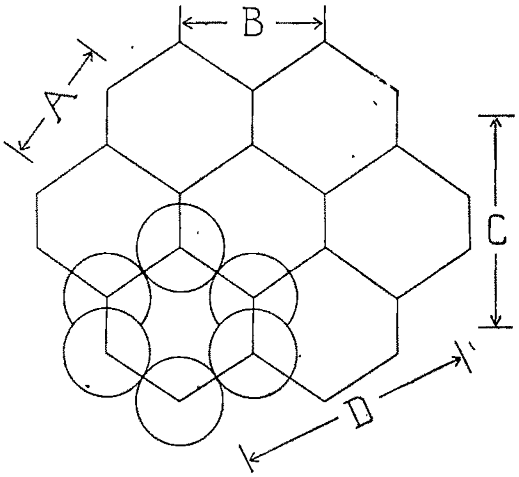


Fig. 2. PROJECTION OF DIAMOND-TYPE LATTICE, VIEWED NORMAL TO 110 FACE

measurements were made easier by the fact that the crystalline regularity extended in places as far as 150 mμ, although in other places there was obvious distortion. Prints of the negatives were made on process plates, and these were projected at a final magnification of 186,500 times on to paper. The centres of the holes were marked, and measurements made with a ruler, the distances between 146 pairs of holes being measured in all. The measurements were made in four principal directions inclined to each other (*A*, *B*, *C*, *D*, in Fig. 2), and suggest that the pattern is not a regular hexagonal one, since for the latter $A = B$ and $C = D$. They do, however, agree well with the hypothesis that the crystal is of diamond type, viewed normal to the 110 face, along the diad axis. The measurements are tabulated in Table 1.

TABLE 1

Axis	Average distance (mm.)	No. of holes measured
A	5·18	42
B	5·40	56
C	8·60	35
D	9·67	13

From the known relative values for the dimensions *A*, *B*, *C* and *D*, the theoretical spacings fitting the above data were calculated by the least squares method and are given in Table 2 in units of the diameter of the particles composing the lattice, assuming them to be rigid spheres.

TABLE 2

Axis	Theoretical value	Value calculated from experimental data
A	1·41	1·44
B	1·63	1·50
C	2·31	2·40
D	2·74	2·70

A photograph of a model of the diamond lattice, taken out of focus to correspond with the lack of resolution of the electron micrograph, has been superimposed on Fig. 1 in order to give a visual comparison of the observed and postulated structures.

The size of the rigid spherical particle best fitting the data is 19·5 mμ in diameter. As the dry virus has a density of 1·45, the molecular weight is about $3{\cdot}5 \times 10^6$. These figures compare with the value of 22 mμ for the diameter, obtained from electron micrographs of individual dry particles and by other methods[5], and with the value of 30 mμ suggested by the X-ray evidence and 28 mμ from the diffusion constant, the latter two values referring to the particles in the wet state. On the basis of these values, the water content by volume of the crystals would be 84 per cent, compared with 62 per cent for bushy stunt virus crystals. However, the formation of a diamond-type lattice, instead of a close-packed type, by the turnip yellow mosaic virus would indicate the existence of tetrahedrally directed bonding forces between the virus particles. It is therefore possible that in the crystal the particles suffer distortion compared with the spherical form which they probably (although not certainly) have in isolation. Such a change in shape in the lattice would allow a smaller water content than that derived on the assumption of rigid spheres.

The beryllium films were prepared according to the method described by Hast[6]. One droplet of the virus suspension in distilled water is placed on a collodion film carried on a nickel specimen grid. After drying, a layer of beryllium approximately 50 A. thick is evaporated on to the surface in a highly evacuated bell-jar. Immersion in pure amyl acetate or acetone dissolves away the underlying collodion, leaving the virus supported by the beryllium alone on the nickel grid. The original micrographs were taken at a magnification of 15,000.

Attempts to observe similar crystals by drying the virus on pre-formed films of beryllium have so far yielded no unambiguous result, although fragments of the same general shape as shown in Fig. 1 are frequently obtained; they are, however, not resolved into molecular structure. It is probable that the evaporation method of making the beryllium film results in an accentuation of contrast in the specimen, the deposited film having a slightly greater thickness to the beam where it is inclined to the plane of the collodion substrate; a similar effect gives rise to contrast in silica replicas of surfaces. It may also be that beryllium atoms reaching the surface are mobile on it for a short while, and aggregate preferentially along edges. Similar preparations of tomato aucuba mosaic virus show such an accentuation of the sides of rods and rod-aggregates (Fig. 3). When this virus is settled on to preformed beryllium films, however, no

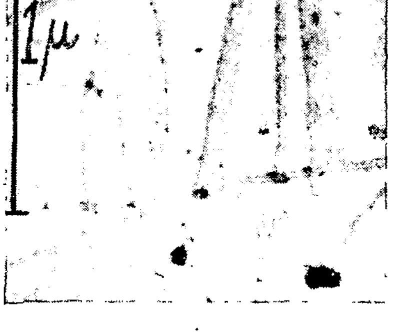


Fig. 3. ELECTRON MICROGRAPH OF TOMATO AUCUBA MOSAIC VIRUS PARTICLES ON BERYLLIUM SUPPORTING FILM: PHOTOGRAPHED AT 16,000 ×, TOTAL MAGNIFICATION 51,000 ×

trace is visible of this effect, making it clear that the particles are not hollow in the centre, as might be inferred from Fig. 3.

Beryllium films allow much clearer micrographs to be obtained of virus and similar particles than when they are carried on collodion films, owing to the greater background scattering given by the latter. Particle-size determination is thereby made more accurate, especially when side-by-side aggregations are obtainable, as in Fig. 3. It is observed, however, that the virus exposed to the electron beam rapidly becomes clouded over and all definition is lost in a few minutes. It is probably as much due to this effect as to the greater background scattering, that the lattice structure in crystalline fragments of viruses has not previously been observed with collodion-supported preparations. The nature of this contamination has been discussed elsewhere[7].

[1] Markham, R., and Smith, K. M., *Nature*, **157**, 300 (1946).

[2] Carlisle, C. H., private communication.

[3] Price, W. C., and Wyckoff, R. W. G., *Nature*, **157**, 764 (1946).

[4] Markham, R., Smith, K. M., and Wyckoff, R. W. G., *Nature*, **159**, 574 (1947).

[5] Unpublished data.

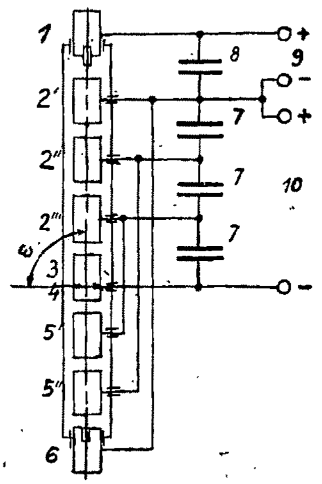
[6] Hast, N., *Nature*, **159**, 354 and 370 (1947).

[7] Cosslett, V. E., Electron Microscope Conference, Leeds, Sept. 1947, in the press.

DISCHARGE TUBE FOR NUCLEAR REACTIONS WITH IMPROVED YIELD

In an article on a "Discharge Tube for Nuclear Reactions with Improved Yield" (*Elektrotechnický Obzor* (Prague), 36, No. 14, 266; 1947), I have described a new discharge tube which, besides giving a better yield and minimized target heating, has the advantage that the acceleration of the particles is effected in two stages: acceleration by means of 100–300 kV. with a current consumption of the order usual for normal discharge tubes using 1–2 MV., and a following principal acceleration by a tension of some megavolts with a current consumption less than five hundredth of usual values.

As shown in the accompanying diagram, particles leaving the ion source 1 are subjected to the first acceleration before the electrode 2, and then they are highly accelerated between the electrodes 2′, 2″; 2″, 2‴; 2‴, 3. The highly accelerated particles go through the target, which is 5 × 10^{-4} cm. thick. Only a small number of them produce nuclear reactions or are diverted from their direct paths. Through the scattering by electrons, the other particles give up that part of their kinetic energy which they have obtained by the first acceleration, and thus heat the target. Then they are retarded into the electrostatic field between the electrodes 3, 5′; 5′, 5″; 5″, 6 to such a degree that they enter into the recombination place 6 with little kinetic energy. After recombination, they are sucked from 6 by a high-vacuum pump into a reservoir or through a high-vacuum pipe of sufficient length back into the ion-source 1. The condensers 7 serve to divide the tension. At the same time they hold it constant, as does condenser 8. The tension for the first acceleration is brought to connectors 9 and that for the chief acceleration to connectors 10.



The greater part of my article relates to the theoretical calculations of the energy conditions in the new tube, and six numerical examples are provided. In order to produce 10^{11} neutrons per second from beryllium 5 × 10^{-4} cm. thick by deuterons, we need for the first acceleration the current-intensity 800μA. at a tension of 300 kV., and for the chief acceleration 0·28μA. at 2·70 MV. If we raise the tension for the chief acceleration to 9·90 MV., the current consumption is 0·016μA. for the chief acceleration and 800μA. at a tension 100 kV. for the first acceleration. In the usual discharge tubes with a massive target, we need under the same conditions a current intensity not less than 150μA. at 3 MV. and not less than 16μA. at 10 MV.

Thus the reduction of current consumption for the chief acceleration is very considerable. Also the target heating is minimized. In spite of this, its cooling (by radiation) is the most difficult problem of the new tube. This point will probably decide whether it will be advantageous to construct the tube.

The principal idea of the new tube, namely, to regain the kinetic energy of the highly accelerated particles by means of retardation in the electrostatic field, can be used with great advantage in the construction of other tubes for nuclear physics. In those, and not in the tube discussed, lies the practical use and importance of the scheme.

Jaroslav Pachner

WAR-TIME RHEOLOGICAL INVESTIGATIONS FOR THE BRITISH ARMED SERVICES

A GENERAL meeting of the British Rheologists Club was held at the Royal Society of Arts o December 17, when papers on war-time rheologica investigations were read by Dr. A. S. C. Lawrenc (Navy), Mr. A. G. Ward (Army) and Dr. E. W. J Mardles (Royal Air Force). Dr. A. S. C. Lawrenc spoke on the experiments done subsequent to th lecture on rheology and Naval problems by Si Charles Goodeve in 1943 ("Essays in Rheology" Pitman, 1947), and by means of photographs h described the icing of ships in the North Atlanti and methods employed for de-icing. Dr. Lawrenc continued with the problem of sea-water – fu emulsions and fundamental work carried out in con nexion with it.

Mr. A. G. Ward spoke on researches carried ou with regard to the elasticity and plasticity characte istics of various propellants and of methods of rhe logical measurement involved, including those resonance and penetration. Dr. E. W. J. Mardle mentioned rheological problems involved in the hig speed and high-altitude flight of aircraft, when ten peratures so low as – 80° C. are sometimes reache with consequent development of tendency materials to fracture. Methods of measurement of the consistency of greases and lubricants at low temperatures had been worked out and were briefly described.

Mr. A. de Waele (in the chair), in opening the discussion, remarked on the wide range of problems dealt with successfully by the rheologist; among the subjects discussed by the meeting were the dispersion phenomena of cellulose derivatives in organic media, the movement of spheres in emulsions and non-Newtonian liquids in general (Stokes' law is not usually applicable), rigidity-thixotropy, and the penetration of clays and other soft solids by piles and other penetrometers. Dr. A. W. Skempton described some recent experiments on clay movement, supporting the findings of A. S. C. Lawrence that the movement of a droplet in a fuel – sea-water emulsion is accompanied by vortex movement extending to at least ten diameters, and of E. W. J. Mardles that similar movements have been observed in thickened liquids during penetration by spheres, disks, rods or cones. The general movement over a wide range of the system, such as when a grease is penetrated by a solid body, may account for the finding of E. W. J. Mardles that the volume displaced by a penetrometer of given weight over a period of time is more or less independent of the shape, and characteristic of the material.

SOCIAL STUDIES OF THE ELDERLY

By ELEANOR FRENCH

IT is interesting to watch the emphasis slowly shifting in the sphere of social welfare to the elderly and their needs and problems, as the relentless march of time forces the effects of our ageing population upon our notice. In 1901 there were 2,408,426 persons in Great Britain over sixty years of age; in 1946 there were 6,587,000 [1], and the assumption in the Beveridge Report is that by 1971 there will be 9,576,000 men over sixty-five and women over sixty in Britain[2].

The two extremes of life thus assume a new importance, and the increasing claims of the ageing must not be met at the expense of the young; but to say this does not mean that those claims should be ignored. The publication of "Old People" by the Trustees of the Nuffield Foundation[3] earlier in the year aroused much interest; this has been followed by a further survey of a particular district: "Old People's Welfare on Merseyside"[4], and in June the British Medical Association published a report on the care and treatment of the elderly and infirm. These three documents give a clear picture of the present conditions in which the elderly are living and make recommendations for improving and supplementing them.

One of the most urgent needs for them (as for everyone else) is better housing: there appears to be little question that old people are badly underhoused, and according to Dr. Elsas[5], in 1939, given a ratio of forty dwellings per hundred adults, the 3·7 million persons over sixty-five should have had 1·5 million dwellings; but there were actually at that time only half a million dwellings in England and Wales consisting of one or two rooms. Conditions have certainly not improved since then, and the Nuffield Survey[3] recommends "that 5% of the houses in any community should be such as are suited to the special needs of old people. . . ."

But though 95 per cent of old people live in private houses[3], the remaining 5 per cent live in institutions, whether public or private, and here, too, conditions are often unsatisfactory. 'Institutions under the local authority are often vast old-fashioned 'barracks': for example, in four of these institutions in Liverpool and Birkenhead on one night in February 1946 there were 2,312 [4] old people of pensionable age: "The sight of a dining room seating 300, a huge dormitory with 110 beds . . . is most depressing"[4]. Old people and children seem to need very similar conditions for their welfare and happiness, and the Report of the Curtis Committee regards large institutions as quite unsuitable for young children also. It is good news that local authorities, or rather 'welfare authorities' as they will be called, have been given power to establish special homes for the aged to house between twenty and thirty.

Adequate medical aids, another pressing want of the aged, will be available under the new National Health Service. When these and other material needs have all been met, there still remain those of the spirit, for old age is apt to bring loneliness, a sense of uselessness, and boredom. Much could be done to remedy these: Dr. Vischer, for example, at Basel, has his homes for the aged attached to the municipal hospital, and their inmates are offered, if they wish, suitable types of work in the clinics and dispensary, for which they are paid a small fee[6]. Such a scheme encourages the old people and gives them a sense of still being useful members of a community, and at the same time it helps the hospital to solve its staff problem. Old age tends to isolate the individual from the main stream of life, but at the same time full utilization of his remaining powers is needed for the benefit of the community of which the aged form an increasing part.

[1] Registrar General's figures.

[2] Report of the Committee on the Care and Treatment of the Elderly and Infirm, *Brit. Med. J.* (June 21, 1947).

[3] "Old People" (Nuffield Foundation).

[4] "Old People's Welfare on Merseyside" (University of Liverpool, Social Science Department).

[5] Elsas, M. J., "Housing and the Family", 91.

[6] Vischer, A. L., "Old Age".

FUEL ECONOMY IN SWITZERLAND

THE World Power Conference is issuing reports on war-time fuel-saving methods in many States. Obviously these differ widely.

The problem in Switzerland* was given a particular interest by clear-cut circumstances and limitations. That country lacks substantially all native solid or liquid fuel resources except wood, and this plays an insignificant part. The only freely available source is hydro-electric power, and this provides only a minor part of the need. Furthermore, it is essentially seasonal in supply, being dependent on the variable flow of streams. Summer is the principal season for the production of water-power, whereas winter is the time when power is in greatest demand. Available storage facilities are inadequate to compensate for this disparity. At most, available water-power provides for the needs for lighting and motive power, but by no means for heating or the industrial demands for electrothermal and chemical needs.

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* Reports on Fuel Economy since 1939. Swiss National Committee. Pp. 20. (Central Office of World Power Conference, 201–202 Grand Buildings, Trafalgar Square, London, W.C.2.) 1*s.* net.

The experience of the First World War stimulated the development of hydro-electric resources and the use of electricity for railways, lighting, power and special heating, where it offered a preponderating advantage. It could only be used in summer for general heating and for electrochemical or electrometallurgical purposes. By 1938, 98 per cent of the railway traffic was electrically operated, but electricity provided 5 per cent only of the total supply of thermal energy. Three-quarters of the heat was supplied by imported coal. Moreover, between 1913 and 1938 the consumption of coal altered little. There was only a change in the distribution of the load.

When war broke out in 1939 it was not surprising that rationing became drastic and realistic. All production of electricity by fuel-fired boilers—except back-pressure units—was suspended. Coal was allocated according to priorities. Domestic heating, which in 1938 absorbed 50 per cent of the imports of coal, was 'mercilessly' cut to nil in 1943–44, and gas to 21 per cent in 1945–46. In winter, electricity would be prohibited for space heating, water heating and steam generation, these being termed 'low-efficiency uses' of electricity. Industrial coal-fired boiler plant offered little scope for fuel saving, owing to the high efficiencies current in peace-time. To meet the high cost of fuel, boiler efficiencies of 75–80 per cent were the rule, even in small plants. Figures such as these are uncommon in Great Britain.

In conclusion, the report says that in spite of the abundance of water-power, half of which is already developed, Switzerland remains dependent on imported coal. There need be no illusions of its replacement by hydro-electric power. The supply of electricity is limited by natural causes. Its proper application is the supply of power, and in winter its use for low-grade heating is not encouraged.

NEW ITALIAN COSMIC RAY LABORATORY

A NEW high-altitude research laboratory for cosmic ray work at a height of 11,500 ft. on the upper slopes of Monte Rosa was opened by the Italian Centre for Research in Nuclear Studies on January 11. The laboratory portion of the station at present consists of one large experimental room, and a small fully screened room for a Wilson cloud chamber. The equipment is very complete, and includes a three-phase 30 kW. power supply, a separate lighting supply, and two high-capacity battery sets with a petrol generator in case of main power failure. The station is also equipped for two-way direct radio contact with the parent laboratory at Rome, a useful facility at all times, but particularly necessary when the Laboratory is likely to be cut off from the outside world for days at a time in mid-winter.

The Laboratory is situated on an exposed ridge on the Italo-Swiss frontier, and is actually half in Switzerland. It is served by a cable railway, which—under normal weather conditions—runs from Breuil (Cervinia) in the valley, 4,500 ft. below. Breuil is itself connected with the rail-head at Chatillon by a road which is kept open throughout the winter. The problems of supply are, therefore, very much less than might reasonably be expected at such an altitude.

At the present moment, the Laboratory has living accommodation for four workers, with bunks, a small kitchen and bathroom. Water is obtained by melting snow with an immersion heater, the water then being pumped to a roof-tank. Waste disposal is by a double-walled heated pipe. The building itself is of aluminium and cork construction, and is securely anchored against the high winds which sweep the ridge.

The work at present going on in the Laboratory includes the exposure of nuclear plates, which in suitable weather can also be carried out up to 3,000 ft. above the Laboratory. Experiments on meson decay are also being carried on, and it is expected that later some Italian geneticists will be undertaking work at the station on mutations induced by cosmic rays. The director of the Laboratory is Prof. Gilberto Bernadini, who, with the director of the Centre for Research in Nuclear Studies, Prof. Edoardo Amaldi, is already well known in Britain for his work in this field. It is expected that at least one British physicist will be working at the Laboratory in the near future.

The inauguration ceremony was performed by Minister of the Treasury, Del Vecchio, in the presence of some sixty distinguished Italian scientific workers, and representatives of various industrial firms and the Italian Air Ministry. At the invitation of Profs. Bernadini and Amaldi, British science was represented by Dr. Tahourdin, science officer in Italy of the British Council.

VETERINARY EDUCATIONAL TRUST

THE Veterinary Educational Trust was formed in 1942, to provide for the education of graduate and postgraduate students of the best type who would not otherwise be able to proceed with their studies; means were to be found to ensure that training was provided of a type not otherwise available in Great Britain, so that veterinarians and other men of science would be equipped to undertake original research.

In the course of the ensuing years, it has been found that the original aims require to be extended. It has been decided to embark upon a plan to develop research stations dealing with the management and diseases of the different species of domesticated animals. An Equine Research Station at Balaton Lodge and Lanwades Park near Newmarket (director, Prof. W. C. Miller), a Canine Research Station (director, Mr. S. F. J. Hodgman), and also a Poultry Research Station (director, Dr. R. F. Gordon) have been opened; all these directors are veterinary surgeons.

A group of farm livestock research stations will be opened; negotiations are in progress for sites for such work. All these stations will be established within a few miles of each other and of the University of Cambridge. In developing these centres, care is being taken to ensure that there is close contact between them and the workers in the field, and there will be close co-operation with practising veterinary surgeons. The research stations will link up with a series of hospitals for large and small animals, and there will be joint laboratory diagnostic service. The aim will be to have a hospital in every county and in the larger towns.

Modern veterinary hospitals require elaborate design and equipment and cannot usually be provided by the private practitioner. Under the schemes now envisaged, they will be managed in such a way that whole-time staffs are available, and private practitioners and specialists will co-operate in the care of the patients. At the same time, the aim is to organise cadres of trained animal nurses and technical assistants, probably coupled with a system of training, certification and registration.

Since the Trust was inaugurated in 1942, forty-eight undergraduates have been awarded scholarships or studentships in the United Kingdom and Eire. Deserving students who are well embarked on their studies, but have suffered an adverse change in their financial circumstances and, otherwise, would have been unable to proceed with their studies, have been assured an opportunity of obtaining their qualifications. £7,320 has been expended on the assistance of such students. In addition, nineteen Evans Final Year Studentships have been awarded to the best students in the previous four years of study at the respective veterinary colleges.

The Wellcome Trust, the Goldsmiths Company, Messrs. Cooper, McDougall and Robertson, Ltd., the British Oil and Cake Mills, Ltd., and Imperial Chemical Industries, Ltd., have provided funds for research fellowships held under the Trust. Details have been given of eleven such fellowships now held by British veterinary and other science graduates for studies of a very varied nature at scientific institutions in the United Kingdom and the United States of America.

At the annual general meeting of the Trust, held in October 1947, a detailed account of progress was given. It was attended by an influential body of people, including, in addition to the officers of the Trust, senior representatives of the livestock and other interests concerned, such as the secretary of the Agricultural Research Council, the president of the Royal Agricultural Society of England, the president of the Royal College of Veterinary Surgeons, the president of the National Veterinary Medical Association of Great Britain and Ireland, and many others. Influential committees have been appointed to cover the several special interests concerned. The Duke of Norfolk is president and the Duke of Beaufort is the honorary treasurer. Dr. W. R. Wooldridge is the scientific director. The income for the year ended August 31, 1946, was £39,240 and the expenditure was £21,558. The assets amounted to £137,410, with a mortgage of £20,000 on property held.

Complementary to the scientific, educational and other activities, an organisation is being developed for acquainting the public throughout the country with what is being done and for collecting the money required for the operations of the Trust, the address of which is 232–35 Abbey House, Victoria Street, London, S.W.1.

VEGETABLE TANNING MATERIALS OF INDIA

THE Forest Research Institute at Dehra Dun has issued a series of Forest Leaflets dealing with the vegetable tanning materials of India (Nos. 72, 73, 74, 75 and 76, published in 1944–45).

Leaflet No. 72 dealt with a general survey of the vegetable tanning materials of India (Part 1); No. 73 with the same heading (Part 2), the tanning materials of *avaram* (*Cassia auriculata*); No. 75, the tanning materials obtained from the well-known Myrobalan (*Terminalia chebula*).

In Leaflet No. 74 (Civil and Military Press, Prem Nagar, Dehra Dun, 1945) the tree dealt with is the *Acacia arabica*, the best-known vernacular names of which are *babul*, *kikar* and *babar*. The tree has several varieties. The information given deals with the bark and the pods, their tanning content and its variation with age, part of the plant from which obtained, and the locality of its tree growth. Information is also given on the yield obtained from the bark and the pods, the quantities of bark used and its origin and price, the methods of collection and preparation for the market; the tanning properties and manufacture of the extract are also discussed.

Some data interesting to the forester are given with reference to the sylviculture of this tree, and the use of the bark and the timber are briefly dealt with. For a long period babul bark was one of the most firmly established tanning materials of India. It is now said to be losing its ground owing to two factors: it is not marketed as satisfactorily as its chief competitor, wattle bark, and there has been a failure in replacing by replanting trees as fast as they have been felled. Investigations on a wider scale are being carried on into some of these points.

In Leaflet No. 76, the black wattle (*Acacia molissima*) is discussed, with notes on other wattles growing in India, and their tanning content. In view of the remarks already made about *Acacia arabica*, this leaflet affords some valuable indications from various analyses made, such as variations in tanning content and, for black wattle, the yield of bark in South Africa and Java and the probable yield in India. Methods of collection and preparation for the market, tanning properties and manufacture of the extract are dealt with, and statistics of South African production, Indian imports and prices, and world use of wattle and other tanning materials are given. It is concluded that Indian-grown wattle could be made of equal tanning value to the South African bark, but more research is necessary.

The value of these researches into vegetable tanning materials is of obvious importance, since there are those who consider that this type of tanning material will always be superior to the chemical tannings.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 16

EUGENICS SOCIETY (at Manson House, 26 Portland Place, London, W.1), at 5 p.m.—Mr. W. Russell Brain: "Some Reflections on Genius" (Galton Lecture for 1948).*

ROYAL PHYSICAL SOCIETY OF EDINBURGH (at the Royal Scottish Geographical Society, Synod Hall, Castle Terrace, Edinburgh), at 5.15 p.m.—Prof. C. H. Waddington, F.R.S.: "Animal Development".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (at the University, Manchester), at 5.30 p.m.—Prof. R. E. Lane: "National Industrial Life and the Doctor" (Percival Lecture).*

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Mr. H. W. Cremer: "Water, a National Asset" (Jubilee Memorial Lecture).

Tuesday, February 17

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the MANCHESTER SECTIONS of the SOCIETY OF CHEMICAL INDUSTRY and the ROYAL INSTITUTE OF CHEMISTRY, at the Gas Showrooms, Town Hall Annexe, Manchester), at 10 a.m.—Opening by Dr. Norman C. Wright of the Ministry of Food B.I.O.S. Exhibition; at 10.30 a.m.—Mr. F. C. White: "New Developments in the German Dairy Industry"; Mr. H. J. Bunker: "Wartime Production of Food Yeast in Germany"; at 2.30 p.m.—Mr. J. F. Hearne: "German Albumen Substitutes"; Mr. R. Perdue: "German Soapless Detergents".

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. C. B. Symes: "Control of Insect-borne Diseases in the Colonies—Some Recent Progress and Future Prospects".

Society of Chemical Industry, Agriculture Group (in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Prof. T. Wallace: "Methods of Determining Mineral Deficiencies in Plants"; Dr. D. J. D. Nicholas: "Chemical Tissue Tests for the Determination of Mineral Status of Plants".*

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. A. E. Mourant: "The Use of Blood Groups in Ethnology".

Institution of Civil Engineers (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. B. D. Richards: "Tidal Power, its Development and Utilization".

Conway Discussion Circle (at Conway Hall, Red Lion Square, London, W.C.1), at 7 p.m.—Dr. Meyer Fortes: "The Social Basis of Primitive Religion".*

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Mr. G. S. Moore: "The Last Ounce of Speed".

Institution of the Rubber Industry (at Caxton Hall, Caxton Street, London, S.W.1).—Symposium on "Latex".

Wednesday, February 18

British Society of Animal Production (at the Royal Agricultural Society of England, 16 Bedford Square, London, W.C.1), at 10.15 a.m.—Annual General Meeting; General Topic: "Animals and Grass".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Dr. Sutcliffe, Mr. Priestley and Dr. Sawyer: "The Mechanics of Weather Systems".

Royal Microscopical Society (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5 p.m.—Mr. Frank Baker: "Scope and Applications of Direct Microscopy to the Investigation of Starch and Cellulose Breakdown in the Digestive Tract".

Oil and Colour Chemists' Association, London Section (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Dr. A. W. Johnson: "Synthesis from the Acetylenes, including Methods of Making Vinyl and other Polymer Resins".*

Thursday, February 19

University College London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Kathleen Lonsdale, F.R.S.: "The Structure of Solids".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. A. R. Clapham and Dr. H. Godwin, F.R.S.: "Studies of the Post-Glacial History of British Vegetation", Parts 8–10.

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Walter Frayne: "The Development and Introduction of a New Process for the Economic Recovery of Minute Quantities of Gold from Lead-Silver Bullion derived from the Bawdwin Ores"; Mr. A. L. Austen: "Notes on Labour Organisation and Performance at the Badhia Mine, Indian Copper Corporation, Ltd.".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. E. Taylor: "Banach Spaces of Functions Analytic in the Unit Circle".

Chemical Society (in the Chemistry Lecture Theatre, University College, Nottingham), at 6 p.m.—Dr. E. R. H. Jones: "Synthesis in the Vitamin A Field".

Chemical Society (joint meeting with the Hull and District Section of the Royal Institute of Chemistry and the University College Scientific Society, in the University College, Hull), at 6 p.m.—Prof. E. G. Cox: "The Optical Properties of Molecules".

Chemical Society (at Burlington House, Piccadilly, London, W.1) at 7.30 p.m.—Sir Edward Mellanby, K.C.B., F.R.S.: Sir Frederick Gowland Hopkins Memorial Lecture.

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. B. G. Maegraith: "The Pathological Processes in Malaria"; Dr. W. H. H. Andrews: "Liver Lesions in Malaria".

Friday, February 20

Institute of Navigation (at the Royal Geographical Society Kensington Gore, London, S.W.7), at 5.30 p.m.—Lieut. P. G. Satow: "Radar and the Weather—Problems in Marine Navigation".

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. E. Bradshaw, Mr. S. A. Husain, Mr. N. Kesavamurthy and Mr. K. B. Menon: "Absolute Measurement of High Voltages by Oscillating Electrode Systems".

Institution of Mechanical Engineers (joint meeting with the Institution of Electrical Engineers, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. J. R. Rylands and Mr. J. R. Jenkinson: "Corrosion of Heating Surfaces".

Manchester Statistical Society, Statistical Methods Study Group (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 5.45 p.m.—Mr. J. A. Hough: "An Analysis of Co-operative Statistics".

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. R. G. Manley: "The Analysis and Interpretation of Vibration Records and similar Traces in Engineering"; Dr. F. H. Todd and Mr. W. J. Marwood: "Ship Vibration".

Society of Engineers (at 17 Victoria Street, London, S.W.1), at 6.30 p.m.—Mr. L. J. Merry: "Technical Education".

Institute of Industrial Administration, Manchester Centre (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. G. Cheliotí: "Management and Research".

Paper Makers' Association (Technical Section), Northern Division (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Dr. Julius Grant: "Some New View-points on the Problem of Pulp and Paper Mill Effluents".

Textile Institute, Dublin Section (at the Mansion House, Dublin), at 7.30 p.m.—Mr. A. Nisbet: "Emulsions and their Use in the Textile Industry".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. E. Raven: "Some Neglected Aspects of the History of Science".

Saturday, February 21

Institution of Chemical Engineers, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. P. Hamer: "Water Treatment".

Manchester Literary and Philosophical Society, Social Philosophy Section (at the Portico Library, 57 Mosley Street, Manchester), at 5.30 p.m.—Prof. D. M. Mackinnon: "The Moral Implication of the Atomic Bomb".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Laboratory Technician to Hospital Physicist—The Secretary, University College Hospital, Gower Street, London, W.C.1 (February 21).

Chief Technician—The Director, South London Blood Supply Depot, Benhill Avenue, Sutton, Surrey (February 21).

Demonstrator in Anatomy—The Registrar, The University, Sheffield (February 21).

Agricultural Economist in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (February 27).

Lecturer (experience in Stratigraphy or Applied Geology desirable) and Assistant Lecturers (2) in Geology, Lecturers (2) and an Assistant Lecturer in Geography, a Lecturer in Social Psychology, and a Lecturer in Moral Philosophy—The Secretary of University Court, The University, Glasgow (March 1).

Assistant Lecturer in Mycology—The Registrar, The University, Manchester 13 (March 6).

Petrologist on the Geological Survey of the Gold Coast—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1 (March 8).

Chair of Psychology—The Secretary of University Court, The University, Glasgow (March 11).

Cytologist (Scientific Officer grade)—The Director, Welsh Plant Breeding Station, Agricultural Research Building, Penglais, Aberystwyth (March 13).

Analytical Chemist, and a Geologist, in the Department of Geological Survey, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (March 15).

Lecturer and an Assistant Lecturer with qualifications in Pure Mathematics, a Lecturer and an Assistant Lecturer with qualifications in Applied Mathematics or Mathematical Physics—The Registrar, The University, Manchester 13 (March 15).

Senior Scientific Officers (about 30) and Scientific Officers (about 170) in Government Departments—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, S.W.1, quoting No. 2114 (March 15).

Studentships at a British University in preparation for Field Research in one of the Social Sciences in the Colonial Empire—The Secretary, Colonial Social Science Research Council, Palace Chambers, Bridge Street, London, S.W.1 (March 31).

Director of Meteorological Services in the Department of Transport, Pretoria—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, W.C.2 (March 31).

Chair of Geology at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (April 3).

Professor in charge of the School of Social Work, Victoria University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (April 17).

I.C.I. Fellowships for research in chemistry, physics, and allied subjects—The Registrar, The University, Manchester 13 (April 30).

Turner and Newall Fellowships for research in engineering, inorganic chemistry, physics, and allied subjects—The Registrar, The University, Manchester 13 (April 30).

Chair of Organic Chemistry—The Registrar, The University, Sydney, Australia (May 31).

Analytical Chemist at the Tung Experimental Station, Nyasaland—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

Senior Technician in the Department of Industrial Metallurgy—The Professor of Industrial Metallurgy, The University, Edgbaston, Birmingham 15.

Good Instrument Maker (Ref. Chemistry/2), and a Technician with knowledge of electricity (Ref. Chemistry/3), in the Department of Chemistry—The Secretary, University College London, Gower Street, London, W.C.1.

Research Fellowship for advanced archæological research in Turkey—The Hon. Secretary, British Institute of Archæology at Ankara, c/o Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1.

UNIVERSITY REPRESENTATION IN THE HOUSE OF COMMONS

BY the terms of the Representation of the People Bill now before Parliament, it is proposed that parliamentary representation shall be limited solely to county and borough constituencies, each returning a single member; and that residence shall be the qualification for the franchise, with the usual conditions that electors must be British subjects of full age and not subject to any legal incapacity to vote. Hence the university constituencies would be abolished.

For some generations, there has not been any kind of redistribution of seats in the House of Commons, much less of redistribution by way of destroying one kind of seat, without preliminary attempts to find the maximum agreement. On this occasion there has been a Speaker's Conference, which recommended, without a dissentient voice, the retention of the university seats. Although all the supporters of the single transferable vote agreed that it was not applicable to constituencies with less than three members, yet it was preserved for the two-member university seats precisely to make it plain that it was desired to give the second largest party among university voters every possible advantage. So recently as October 1947, the present Lord Chancellor, when promising a Bill for electoral reform arising out of the recommendations of the Committee of Electoral Registration, the Speaker's Conference, and the Committee on Electoral Law Reform, proclaimed that if his questioner was familiar with all the proceedings in those Committees, he would be able to forecast precisely what the Bill was going to do. It is difficult to see how Speakers' Conferences can in future be as friendly and non-partisan as they have not unsuccessfully striven to be in the past, if now those parts of the last Conference's recommendation which seem electorally damaging to the present majority in the House of Commons are to be treated so cavalierly.

University constituencies have existed in Britain for about a dozen generations; there is a vague pre-history even older than that. For what antiquity is worth, therefore, they have a title to consideration. Of something the same nature is the argument that university parliamentary representatives are now all that is left to keep alive the old principle of representing corporations. It was the rural corporations which were counties, and the urban corporations which were boroughs, that were represented in the old House of Commons; and to them James I added the 'learned corporations', that is, the universities.

Looking down the list of those who have represented, for example, the University of Cambridge, it is easy to pick out distinguished names. Very early, Cambridge elected Francis Bacon. John Coke, Thomas Eden, a couple of Cromwells, George Thurloe, George Monk followed within half a century; and in the next generation, Sir William Temple, Sir Isaac Newton, and others scarcely less memorable. In the eighteenth century, a very high proportion indeed of the Cambridge men were lawyers of the highest distinction. Towards the end of that century, William Pitt long sat for the University, and after him there were Palmerston, Copley (Lord Lyndhurst), Speaker Manners-Sutton, and others who held high office as ministers or judges, or were men of eminence in more purely intellectual fields. The Oxford list also includes many distinguished names; and the other universities represented in Parliament have, considering the relative lateness of their entry into the field, a scarcely less significant record of service in the House of Commons.

The arguments against university representation can be reduced to two only. One is that it produces members whom the objector dislikes on personal or political grounds. This argument could be valid only if it be agreed that the members elected have been such as the House of Commons would have been better without. The many distinguished men, and more recently women, who have entered Parliament as members for the universities provide sufficient answer to this; it can scarcely be questioned that the House of Commons would have been much the poorer without them.

The other argument used against university representation is that it interferes with strict arithmetical proportion between the House of Commons and the voting public. But does anyone take this principle seriously in these times? It is generally admitted that from the arithmetical point of view Scotland and Wales are properly over-represented, and should continue to be over-represented, in virtue of their national and historical significance. (Incidentally, a similar argument might well save the City of London, which is also threatened with the loss of its representatives.) It is agreed also that the difficulty of representing remote and thinly populated districts is such that they ought to have more members than arithmetical justice would confer upon them; and accordingly, as the House of Commons is at present constituted, and as the Bill now before the House proposes to reconstitute it, there is variation of the number of constituents needed to return a member, in accordance with remoteness from London and with excessive area. Indeed, anyone who really thinks the purely arithmetical principle the necessary dominant in the question is almost driven to proportional representation, with large numbers of seats per constituency, say six or seven, and to annual parliaments, if not to the right of recall by electors.

University members hold less than 2 per cent of the seats in the House of Commons, and nobody suggests that they should hold more. In the two- and three-member university seats, election is by a kind of proportional representation which gives special advantage to the second largest party. It is not reasonable to suggest that any great section of opinion need despair of carrying a university seat, unless it has a very remarkable faculty for antagonizing university graduates. Indeed, there has been no attempt to organise university representation in a tightly partisan way. Any such attempt would almost certainly be doomed to defeat by opinion among graduates, and also, as already indicated, by the method of election in two- and three-member seats.

In any event, it cannot be a bad thing that there should be a few constituencies which are not local, in which the voters are scattered all over the country and indeed all over the world, and in which the rival candidates compete in long, reasoned statements rather than in slogans. *The section of a university constituency resident overseas is a peculiarly important part of the nation. There is little doubt that a very high proportion of British subjects in important posts in Asia and Africa are university graduates. Very many of these men and women have no vote in other constituencies.* A very high proportion indeed of them know their university member, or at least know the sort of man he is, and have friends who do know him directly. There is here a channel of communication between Westminster and Whitehall on one hand, and British subjects serving in public or private posts abroad on the other hand, which has a great and growing value.

The universities of Britain are the highest educational institutions of the country. It is not necessary to think their officers and representatives are over-complacent about them; but they may fairly claim that the universities compare favourably, both in the quality of performance of their function and in public opinion about it, with other great institutions and productive agencies. Yet it is certain that the political and economic tendencies of the last two generations have made it far more difficult for universities and colleges to be independent and self-subsistent than they used to be, and far more difficult also for them to hope for re-endowment from any extra-governmental source. Incidentally, in connexion with Government grants to the universities, it was as well, during the latter years of the War and in the period immediately following, that there should have been men in close touch not only with the leading figures at the universities, but also with Westminster and Whitehall, who preserved a critical faculty about blithe presumptions that in the immediately post-war period there would be, easily and of course, more and better education, with much more money and much more material at its disposal. Surely we are now at a moment when it is peculiarly evident that higher education, and especially the highest education, should have some guarantee of direct two-way communication between the universities and Westminster otherwise than by the relations between the official academic authorities and the Treasury and other Government departments, good and valuable though such relations are. The universities of Britain, as the culminating point of the educational system of the country and also as the symbols of a broad and cultured outlook on human affairs, are likely to increase in importance in the years to come. As such they are entitled to seats in the House of Commons, quite apart from the influence on the course of debate exerted by men of the type sent to Westminster by the universities. No satisfactory case can be made for the abolition of the university franchise.

A SHORT HISTORY OF SCIENCE

The Growth of Physical Science

By Sir James Jeans. Pp. x + 364 + 14 plates. (Cambridge: At the University Press, 1947.) 12*s*. 6*d*. net.

THE reputation of Sir James Jeans as an interpreter of science for the educated layman stands deservedly high. His wide interests and broad sympathies, aided by an exceptional power of exposition and a lucid and dignified prose style, have won him a very considerable circle of readers; and his writings have done much to substantiate the claim that science, in spite of the technicalities with which it is necessarily surrounded, has a cultural value, and some right to be regarded as one of the 'humanities'. The strength of the reaction provoked by his books from the philosophers on one hand and from the upholders of the strictly utilitarian conception of science on the other may be taken as a measure of his achievement.

In "The Growth of Physical Science", his last volume, the proofs of which were revised by him just before his death in September 1946, Sir James Jeans breaks fresh ground. It is true that, in the last chapter, he brings us again to the frontiers of knowledge; but he is, in the main, concerned to trace the long and devious route by which the physical sciences have advanced to their present position. "I have thought," he writes in the preface, "I might usefully try to describe the main lines of advance of physical science, including astronomy and mathematics, but excluding all points and side-issues, in language non-technical enough to be understood by readers who have no scientific attainments or knowledge." The last clause must not be taken too literally. It is, of course, scarcely possible to discuss the history and development of mathematics intelligently without the use of some mathematical symbols and processes. The reader, particularly in the earlier chapters, will find it necessary to evoke some memories of his school 'maths', and may, incidentally, find that subject glowing with an interest it had not awakened before. Nor can the reader "with no scientific attainments" be promised that he will understand every word of the highly condensed account of the era of modern physics contained in the last chapter. He may find himself confessing (like Alice after reading the immortal "Jabberwocky"), "Somehow it seems to fill my head with ideas—only I don't know exactly what they are". Even this degree of apprehension may be well worth-while; it is, after all, with the history rather than the details of scientific discovery that the book is concerned.

It is no easy matter to compress within some three hundred and sixty pages the history of three great sciences; to do full justice to the genius of the ancients, facing absolutely new problems with nothing to guide them, and yet to give due space to the spate of discoveries and theories of modern times; to estimate the relative historical importance, say, of a Pythagoras and an Einstein, of Archimedes and Faraday. In the present volume roughly one third of the space is concerned with classical times, ending with the burning of the library at Alexandria; another third brings us to the end of the age of Newton; leaving some one hundred and thirty pages for the two hundred and fifty years since that date. One cannot help feeling that the pace, towards the end, is becoming a little breathless. No one but Jeans could have condensed so much into so small a space without reducing his text to a mere catalogue; and the book is certainly not that, even when it is most condensed. One can only wish that Sir James, with his wide sympathies and penetrating judgment, had dealt with this final quarter of a millennium more nearly on the scale of the earlier chapters of the book.

Science is an activity of human beings and its progress must be influenced by, and in turn must influence, the religion, the philosophy and the social structure of its age. Any true history of science must take these interactions into account, and Jeans has dealt with them with the objectivity and impartiality which one should expect from a man of science, but which have been conspicuously lacking in some recent popular writings on the subject.

"The Growth of Physical Science", though not altogether free from historical errors, is a very human and a very fascinating volume, which holds the reader like a well-told tale. It is possible that the general diffusion of an understanding of the methods and purpose of science, which all regard as urgent, may be most easily attained through a study of its history. If, as we are told, a study of the past holds the clue to the present, it may be that in the history of science we may find some hints for a solution of some of those vital problems with which the dominance of scientific discovery confronts our civilization to-day.

J. A. Crowther

CALCULUS BASED ON THE FUNDAMENTAL CONCEPT OF NUMBER

Differential and Integral Calculus

Functions of One Variable. By Prof. Francis D. Murnaghan. Pp. x + 502. (Brooklyn: Remsen Press, 1947.) n.p.

In the evolution of the teaching of mathematics, many thoughtful teachers frequently examine critically the basic concepts of the subject in order to make quite sure that the edifice they are constructing is sound and stable. As Prof. Bell[1] points out: it may seem strange "to build up vast systems of knowledge without seeing first whether the foundations will bear the superstructure, and mathematics did precisely that". This is especially true of the calculus, and experience has often shown that, in the case of non-specialist technical students, the calculus is sometimes regarded as a system of purely formal operations. Indeed, Prof. Murnaghan declares in the preface of the book under review: "Many teachers seem to feel, and have no hesitation in expressing their feeling, that it is impossible to teach calculus correctly. The best one can do, they claim, is to give some idea of what the subject is about and to impart, by repeated drill and practice, proficiency in the manipulative details of the subject." It may be remarked here that this refers obviously to the teaching of calculus in America. Is such an experience shared by English teachers? Undoubtedly, many cases could be cited where practical students become fairly expert in manipulative technique without a real understanding of the meaning and necessity for the operations involved. The subject thus becomes purely formal instead of an intelligent aid to calculation.

A brief survey of the history of the concepts of the calculus reveals that many of our great mathematicians left gaps to be filled. As Carl Boyer[2] states: "Although it was Cauchy who gave to the concepts of the calculus their present general form, based upon the limit concept, the last word on rigour had not been said, for it was Karl Weierstrass who constructed a purely formal arithmetic basis for analysis, quite independent of all geometric intuition. . . . In order to secure logical exactitude, Weierstrass wished to establish the calculus (and the theory of functions) upon the concept of number alone." In the great work of Cauchy, two conspicuous failures are noticeable—his omission to define precisely the notion of an infinite aggregate, as well as that of number. Here, it seems, we reach the bedrock of the matter, and it is upon this idea that the present book has been written. To quote again from the author's preface: "We have tried to teach the science of calculation, i.e., of finding the numerical values of functions, without taking the trouble to explain what a number is". The fifteen chapters of the text are thus based upon a lucid discussion in the opening chapter, occupying 48 pages, on numbers, variables and functions. This leads to differentiable functions, the calculation of derivatives, maxima and minima, the theorem of the mean, inverse functions, length of arc, trigonometric functions, antidifferentiation, definite integrals, plane curves, infinite series, tests for convergency and the application of integration. Special emphasis is placed on differentiability rather than on the derivative, and differentiable functions are treated before continuity is considered. Null functions form the basis of the study of limits, and the exponential function is introduced as the inverse of the logarithm.

There is no doubt that "the calculus is the greatest aid to the discovery and appreciation of physical truth; but the basis for this success in all probability is to be found in the fact that the concepts involved were gradually emancipated from the qualitative preconceptions which result from our experiences of variability and multiplicity"[3]. Again, as J. W. N. Sullivan[4] remarks: "A great deal of modern mathematics is the outcome, not of the merely formal development of what was known before, but of a profound critical examination of the foundations of the science".

Prof. Murnaghan's treatment of the subject is thus designed to give the student a deeper understanding of its methods by founding it upon basic concepts. It is therefore a judicious mixture of theory and practice, with the result that many of the explanations have to be very detailed which, in places, renders them somewhat lengthy. On reading through the text, one wonders whether such a treatment will not tend to detract from the interest that should be developed. The whole course is logically sound and marks a commendable break away from the routine methods; but, after all, too great an emphasis upon fundamental concepts is not always an effective introduction to any subject. As many experienced teachers may well ask: Is it not better to defer the consideration of fundamental refinements until a later stage when a student has learned to appreciate some of the difficulties arising from the theoretical basis of the calculus?

Nevertheless, the book may be recommended as a distinct contribution to the subject; but whether it will fulfil its lofty aim, only experience and time will show.

F. G. W. Brown

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[1] "The Queen of the Sciences", p. 130.

[2] "The Concepts of the Calculus", pp. 284–5.

[3] "The Concepts of the Calculus", p. 309.

[4] "The History of Mathematics in Europe", p. 109.

THE PRESENT OUTLOOK IN ARMY EDUCATION

By MAJOR-GENERAL CYRIL LLOYD, C.B., C.B.E., T.D.
Director of Army Education

THE experience gained by Army educationists between 1920 and 1939, the story of Army education during the Second World War and release period, together with the broad principles of post-war development, have been the theme of previous articles (*Nature*, **158**, 775, 821, December 1946). The contrast between the condition of education in the Army after the First World War and after the Second is clearly marked. It is the difference between the newly formed Army Educational Corps struggling against apathy, suspicion and even hostility, and a Corps recognized as an integral part of the national system and a pioneer in the field of further education.

The educational obligation of Service authorities has been defined in the National Service Act of 1947, in which a direct cross-reference to the Education Act of 1944 establishes the full responsibility of the Army to provide further education for all service personnel and to co-operate to the full with all local education authorities to ensure adequate facilities for that education.

The issue of Army Council Instructions authorizing the implementation of a definite plan for Army education which shall supersede that of the release period brings to maturity a scheme which has been in process of preparation for nearly two years. Each stage of the plan has been considered and endorsed by the Army Education Advisory Board under the chairmanship of Sir Philip Morris. The general plan has been designed to meet the educational needs of the peace-time Army and to form an integral part of its training and working programmes. The present transitional stage between the Army Education Scheme for the release period and the greater development towards this post-war scheme is to be known as the interim period.

The object is to provide for the soldier that which is required, educationally, to improve him both as a soldier and as a citizen and to meet his needs as an individual. As part of the national system, its aim is integrated as closely as possible with civilian education, and care has been taken to weld into the scheme provision for both the national service man and the regular soldier. Hitherto the machinery of the Central Advisory Council for Adult Education in H.M. Forces has been instrumental in securing civilian assistance for Army education. Negotiations are now proceeding which will, it is hoped, secure the continuance of this valuable work on a basis suited to the conditions of the peace-time Army on one hand and civil education on the other. Arrangements have also been made with the Ministry of Education for His Majesty's inspectors to co-operate in an advisory capacity with the military inspectors of the Directorate of Army Education, thus placing their experience and knowledge at the disposal of the Army.

The main types of education which will be provided are described as (*a*) general education and (*b*) individual education. The vast majority of the men and women entering the Army are catered for by general education. The soldier must first acquire that fundamental knowledge without which he can be neither an efficient soldier nor a satisfactory citizen. For the first six weeks he will receive instruction for two hours a week in current affairs and citizenship; thereafter time will be increased to three hours weekly, and English, mathematics, history/geography and general science will be added to the curriculum. Courses will be graded in three standards and there will be variations and exemptions for men above average, who will be catered for in ways appropriate to their particular educational needs. At the end of a year's service the national service man will leave the Army; but the regular soldier who remains will continue this work for four hours weekly during a further twenty-four months, after which only current affairs and citizenship will be compulsory, though he may continue his education in working time if he so desires.

The syllabuses are progressive, and these, together with specimen tests of attainment, are to be found in the General Education Handbook. This Handbook was designed for the use of instructors and, used with flexibility and careful selection, it will provide a guide for the establishment of a continuous liberal course of study. The approach in all subjects is adult and is based on the experience and interest of the individual.

General education will be carried out in working time; its counterpart, individual education, will be done in the soldier's off-duty hours in unit classes, educational centres, and Army colleges, under arrangements made with civilian education or by means of the War Office Correspondence Course Scheme. The soldier may undergo courses or pursue activities either to improve his prospects in civil life, or to satisfy his cultural needs or his desire for profitable leisure-time employment. An important aspect of individual education will be the resettlement education of the regular soldier and the development of a resettlement advice service. These activities are additional to continuation studies for those individuals who have reached the standard of School Certificate or other equivalent examination and whose guided reading periods will be catered for by the unit or higher formation reference libraries.

Men of exceptionally low standard will, immediately after enlistment, be given a special full-time course at a preliminary education centre to fit them to join the main stream of general education at a later date. The Royal Army Educational Corps has had considerable experience in combating the problem of illiteracy and as a consequence has evolved practical methods which, combined with sympathetic attention to the personal needs of each individual, have been found to produce a remarkable improvement in the reading age and general attitude of the backward adult.

The scheme will be staffed by full-time Royal Army Educational Corps instructors on an overall scale of one per 240 men, assisted by part-time instructors provided by units. The work of instructors will be supervised by R.A.E.C. officers, of whom, one will be allotted to every 2,400 men. Each supervising officer will act as a travelling headmaster, exercising control over the work of instructors in a group of units. The smoothness of administration and organisation of the Corps is the duty of the R.A.E.C. staff officers provided in the War Office and on headquarter staffs. In the unit it is the commanding officer, with the assistance of his unit education officer, who is responsible for the educational progress of his men, and only through his co-operation can any plan succeed. The regimental officer is responsible for conducting discussions on current affairs and will always be chairman of such discussions.

Many of the present R.A.E.C. instructors are young in experience and, although graduates and trained teachers are to be found within their ranks, it will take time to build up a corps of instructors with a predominance of experienced and academically qualified personnel. The other major difficulty which only time can resolve is that of ensuring continuity of instruction. This will only be fully achieved when the Army as a whole becomes more stable in composition, so that the soldier's service is spent in two or three units at most. Despite these limitations, certain aspects of the plan are already in operation and working well; notably, perhaps, the work with illiterates at preliminary education centres. Here the adult approach through activity is reviving and stimulating interests and skills which have in some cases been dormant for years and in others barely existed. Much valuable work is also being done in the initial stages of the soldier's service, both in the special attention paid to current affairs and citizenship during basic military training, and in the care with which, before being sent overseas, the soldier is briefed as to conditions in the theatre to which he will go and in the historical, geographical and cultural background of the countries concerned. In this latter connexion, a comprehensive series of teaching aids in the form of posters, study briefs, films, film strips, exhibitions, etc., has been prepared and is already in production. In the case of more advanced students, too, there are indications that both unit and centralized library facilities are being used, there is an encouraging demand for correspondence courses, and in many areas civilian resources are being used to the full.

Stated simply, Army education shows to serving men and women how they fit into society as soldiers and citizens, and indicates how individual experience and self-expression may best contribute both to the development of the individual and to the common good. It is not only the future of the Army which is staked upon the training of young service men and women; as the result of their service experience they should return to the civilian community better informed, more self-reliant, in better shape physically, and better equipped both for work and play. In this process it is the task of Army education to give the soldier something which he will recognize as being of permanent value whether he thinks of himself primarily as a worker, as a citizen, or as an individual.

STRUCTURE AND PHYSICAL PROPERTIES OF METALS

THE autumn meeting of the X-ray Analysis Group of the Institute of Physics, held in Birmingham during November 20–21, 1947, was devoted to metals and alloys. The place of X-rays in their study was put in proper perspective: in some of the researches described they provided the main method of attack; in others they were subsidiary.

Dr. W. H. Taylor opened the first session by giving a general account of transformations, referring to the importance of the study of simple alloys as a basis for the study of the more complicated commercial ones. He instanced the order–disorder transformation, and pointed out that X-ray methods permit the study of long-range order, whereas the relationships between near neighbours are physically more significant. The use of crystal-reflected radiation may overcome this disadvantage by allowing changes in background scattering to be observed before ordinary superlattice lines appear[1].

Dissociation has also been studied[2] in the alloy Cu_4FeNi_3. X-ray powder-photographs show 'ghosts' at the sides of the main diffractions, and these are interpreted as evidence of a pseudo-periodic structure due to the incipient dissociation into two phases of similar structure.

A still more detailed investigation has been made of duralumin[3]. Streaks on Laue and oscillation photographs of a single crystal were ascribed to the segregation of copper atoms on sheets parallel to the (100) planes; the break-up of these streaks into spots showed that a metastable structure, $CuAl_2$, was forming, 'keyed' to the main lattice; this structure finally transformed to the stable $CuAl_2$ phase. Thus the changes occurring in age-hardening have been followed in great detail by means of X-rays.

Dr. H. Lipson gave an account of recent work on the alloy $AuCu_3$. Alloys of this type can have a domain structure, and this results in broadening of the superlattice lines with respect to the main lines. Attempts to determine the sizes of the domains from the breadths of the lines, however, yielded inconsistent results[4], and a further condition—for example, that the gold atoms tend to avoid each other[5]—must be imposed. The diffraction effects produced by this condition are unusual; in reciprocal space the superlattice reflexions are represented by disk-shaped volumes of differing orientations[6], and attempts have been made to detect these by means of oscillation photographs of single crystals. MacGillavry and Strijk[7] were unable to find the effect, and claimed that all the spots had cubic symmetry. Edmunds, Hinde, and Lipson[6], with a much smaller crystal, found it, and so did Guinier[8]. Quantitative confirmation, however, is still required, but the investigations promise to provide interesting evidence about transformations on the atomic scale.

Dr. A. J. Bradley presented a different approach to the study of alloys—that of metallography. He emphasized, however, the importance of previous study by X-rays, and gave as an example the system Fe-Ni-Al, in which the results of Köster[9] had been shown to be wrong because the possibility of three-phase regions had not been envisaged[10]. Although slower than the X-ray method, the microscopic method enables the dispositions of the various phases to be studied; Dr. Bradley showed many beautiful examples of photomicrographs of magnification up to 4,000, and claimed to be able to distinguish between ordered and disordered structures. The microscope is of particular value when changes in temperature are to be considered; X-ray methods fail in the Fe-Ni-Al system because high-temperature structures tend to transform on quenching. A high-temperature camera is required, and progress depends upon the production, in the near future, of a suitable instrument.

Mr. H. J. Goldschmidt showed how Dr. Bradley's results had enabled him to interpret some of the X-ray data he had obtained on the permanent-magnet alloys, 'Alnico' and 'Alcomax'. He found 'ghost' lines similar to those given by Cu_4FeNi_3, and said that the pseudo-periodic structure they indicate could be related to some of the microphotographs shown by Dr. Bradley. He also showed how reactions can take place even when the final state is the same as the first, and attributed the changes to Ostwald's law of successive reactions.

In the second session, Dr. G. V. Raynor gave a lecture on the "Electron Theory of Metals". Although this theory is only a part of a much greater whole, in some systems its effects outweigh others; for example, in the copper–zinc system the atoms are so similar in other respects that their difference in valency leads theoretically to results of practical importance.

In metals, the valency electrons are shared by each complete crystal grain—an extreme case of covalent binding. These electrons still have to obey Pauli's exclusion principle that only two (of opposite spin) can occupy the same state; thus the total energy of the valency electrons is quite large, despite the fact that, because of the size of the crystals, the differences in energy between the various states is vanishingly small. The energy is such that the majority of electrons have velocities of the order of 10^9 cm. per sec.

The periodic structure of metals must, however, also be taken into account, and wave mechanics provides a neat method of introducing it. A particle of mass m and velocity v can be considered as a wave-packet of wave-length $\lambda = h/mv$, and if the particle is an electron with velocity 10^9 cm. per sec., λ is about 10^{-8} cm.—the value for X-rays. Thus the electrons can be diffracted by the lattice in which they are moving, and this is the essential feature of the theory.

Suppose we plot, from a fixed origin, radius vectors representing the momenta of the electrons. The momentum defines the electronic state and thus the space—k-space—is, by Pauli's principle, uniformly populated. Owing, however, to the diffraction mentioned above, the distribution of energies between the electronic states shows characteristic variations. It can be shown that those electrons which satisfy the Bragg equation have momenta that lie on planes in k-space, and these planes outline zones known as Brillouin zones; it can further be shown that electrons in states that lie just within the surface of a zone have energies less than the value $\frac{1}{2}mv^2$ for free electrons. Thus structures in which the occupied states reach almost to the surface of the zone will have less electronic energy and consequently a lower total free energy (other things being equal) than those for which the surface is farther away.

Dr. Raynor showed some drawings of Brillouin zones. That for the face-centred cubic structure is far from spherical; thus the addition of zinc to copper allows the electrons to reach the surface, and the advantage of the depressed energy is utilized; but with further addition of zinc, the energy increases rapidly because the electrons have to be accommodated in the more remote corners. The rapid increase sets in at about 1·4 electrons per atom, in agreement with the solubility of zinc in copper. The body-centred cubic structure is more nearly spherical, and the γ-structure still more nearly so; this, then, explains the sequence and compositions of phases in the Cu-Zn system. In the hexagonal structures that occur in zinc-rich alloys, the nature of the overlap into the second zone is of importance, and Dr. Raynor showed how the variation of axial ratio in these phase fields can be accounted for on the electron theory.

Dr. Raynor concluded by giving an account of the experimental work he is pursuing in order to test further predictions of the theory and to investigate the modifications introduced by other factors.

The final session was devoted to matters of more industrial interest. Dr. T. Ll. Richards described the application of X-ray methods to the study and control of preferred orientation and consequent anisotropy in non-ferrous alloys. The deleterious effect of such anisotropy in annealed copper strip was well illustrated by a pressing in the form of a cup made from the strip; this should have had a flat top, but instead had four pronounced 'ears'. Anisotropy in cold-rolled strip, however, is not necessarily due to preferred orientation; it can be due to structural defects on the planes of maximum resolved shear, inclined at 45° to the rolling direction. This effect was illustrated in a photograph of a strip of considerably over-rolled aluminium alloy.

A preferred orientation of crystals is developed by both hot- and cold-working. In the cold rolling of face-centred cubic metals, for example, the crystal grains tend to orient themselves so that a given plane, for example, (110), is parallel to the plane of rolling, and a given direction in that plane, for example, [112], is in the direction of rolling. Many such combinations are possible[11], but the twin (110) [112] textures are predominant in heavily cold-rolled copper strip. Depending on the magnitudes of the initial grain size, cold-rolling reduction, and the final annealing temperature, the twin textures merge together on annealing[12] to form the single (100) [001] texture, so that the resulting material has almost the anisotropy of a single crystal, with the resultant unwelcome directional properties. A clear understanding of the influence of these factors is necessary for the production of directionality-free strip.

Dr. A. Hargreaves described a corresponding research on rolled magnesium alloy. Since magnesium is hexagonal and thus has one unique direction in each crystal grain, the number of possible modes of reorientation after working is less than in cubic crystals. In practice, it is found that this unique direction [001] is approximately perpendicular to the plane of the sheet, and that the variation (of about 25°) is mainly along the direction of rolling. If, however, the direction of the [001] axis is examined at different depths in the sheet, by means of surface-reflexion photographs from successively etched surfaces, it is found not to be random; it starts at 0° in the surface and increases within the body of the sheet to 15°. This is so for both surfaces, and thus in the body of the sheet there is a mixed orientation of (0001) planes making angles of about 30° with each other[13]. Dr. Hargreaves showed that transmission photographs with a hard radiation would give only an average of these results; the detailed variation with depth would be missed.

Dr. Hargreaves described a moving-film method with which metallic textures could be determined, and pointed out the advantages of obtaining on a single film the information normally obtained only from a series.

Mr. N. F. Astbury read a paper, prepared in conjunction with Dr. Scholefield and Mr. De Barr, on the iron–silicon alloys used for transformer sheets. These alloys, which contain about 4 per cent silicon, have the body-centred cubic structure of α-iron. It is known that magnetic saturation of a single crystal of iron is produced with lowest field-strength if this field is applied in the [100] direction, and thus, if the alloy can be prepared with the [100] direction in the direction of rolling, the magnetic performance in this direction will be superior to that obtained with randomly oriented material. Thus preferred orientation is sought for, not avoided.

Mr. Astbury described the treatment that has been found to work in practice. He emphasized, however, that other considerations are important; traces of carbon or sulphur can more than cancel out the gains made by the processing.

Several methods are in use for examining the texture; X-ray methods are not necessarily the most useful, since the large grain-size introduces difficulties in obtaining ordinary polycrystalline photographs, and in some cases other methods such as measurement of magnetic or strain anisotropy, or optical reflexion from etch pits, are more informative. X-rays still provide a basis for interpretation of the other results.

Each session of the conference was followed by discussion in which many of the points made by the speakers were enlarged upon. These discussions brought out very well the importance that metallurgists attach to X-ray methods and the interest the X-ray crystallographers have in the metallic state.

H. LIPSON

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GEOLOGY OF THE SALT RANGE OF THE PUNJAB

IN the issue of *Nature* of March 23, 1946, p. 359, I gave a résumé of a "Symposium on the Age of the Saline Series of the Punjab", held at Poona in 1944 under the auspices of the National Academy of Sciences of India (published 1945[1]). At the time I wrote, a second symposium had already been held on the same subject at Udaipur in 1945 (published 1947[2]). Page references in the sequel refer to this second symposium.

The point at issue, it will be remembered, is whether the Punjab Saline Series, which commonly occurs beneath fossiliferous Cambrian at the foot of the Salt Range escarpment, is of Cambrian or Tertiary date. The interval between the appearance of the reports of the two symposia has been well employed by the main protagonists, E. R. Gee and B. Sahni. Gee has led two additional excursions to exposures which he considers leave no doubt of the 'natural' superposition on the Saline Series of, in some places, Cambrian Purple Sandstone, and, in others, unconformable Carboniferous Talchir Boulder Bed. His companions have been, at one locality or another, J. B. Auden, J. Coates, B. S. Downward, W. D. Gill, B. S. Lamba, G. M. Lees, E. S. Pinfold, B. Sahni and M. R. Sahni (pp. iv, 95; Gee, Coates, Lamba, Pinfold and B. Sahni have published in the second symposium, though Coates only in the general discussion, p. 240). Sahni, as well as accompanying Gee on the two excursions, has had much to do with mobilizing further palæontological evidence, now published by himself, M. S. Mani, J. Hsü, R. N. Lakhanpal, B. S. Trivedi and R. V. Sitholey (see list of contributors). Furthermore, Sahni has taken advantage of a visit to Britain to give a number of demonstrations (p. xxxix). I shall always treasure the memory of how perfectly Sahni and Pinfold, out-and-out opponents, co-operated on one of these occasions at the British Museum (Natural History) to make certain that those who attended should understand all sides of the question.

Eleven other authors, not mentioned above, have sent in contributions to the second symposium, though for the most part they had not undertaken recent special investigations; and two more, similarly situated, are recorded among those who joined in the general discussion. In what follows I make no detailed attempt to attribute particular ideas to particular authors; but for brevity treat Sahni as representing the Tertiary correlation, and Gee the Cambrian. I also assume that readers can turn back to my previous digest. I confess that I have not reached a firm conclusion; but I do incline to the view that Sahni is correct. I say this in the full knowledge that most of my brother field-geologists will disagree with me.

Let it be granted that so many specimens of the Saline Series have been sampled that we know there is throughout its components (salt, saline marl, dolomite, oil-shale) a quasi-universal distribution of organic debris in the form of almost microscopic dust.

This proposition, advanced by Sahni, does not seem to have been challenged by anyone. It has been argued that the dust may have been introduced into the host-rocks long after the formation of the latter, and may have no more significance for dating these rocks than water or oil commonly found in sandstones. I confess that we have here a conception, so wonderful, regarding subterranean travel of dust, that I shall feel more than compensated for my incredulity if such migration be eventually proved. My incredulity is for the present strengthened by learning that Gee seems as unwilling as myself to invoke migration to account for the contents of certain oil-shales that he accepts as an integral part of the Saline Series (p. 96). "It is agreed," he says, "that the kerogen and free oil is indigenous in the shales, and that it has been derived from either vegetable or animal remains." But he adds: "No evidence of animal remains within the oil-shales has been met with, though many geologists have made an intensive research. What is the evidence of the plant remains that have so far been recognized in these oil shale strata; can they not possibly represent a Cambrian flora?" Sahni's reply is: "Mr. Gee's statement that 'no evidence of animal remains within the oil shales has been met with' evidently refers only to macrofossils. The microfossils described and figured by Messrs. Trivedi, Mani and Lakhanpal and by myself are on the table, open to inspection, along with the rocks from which they were prepared" (p. 246). Another, though less potent, argument against the subterranean dust-diffusion hypothesis is that, in three localities tested in detail, "while angiosperm and insect remains always occur in the Saline Series rocks (that is, below the suspected thrust-plane) there is no trace of these groups in any of the samples taken from the overlying Palæozoic beds, respectively the Purple Sandstone, the Lower Gondwana shales within the Productus Limestone, and the Talchir shales in the Talchir Boulder Bed" (p. 245; also pp. xviii, xl, 92). Of course, Gee, Sahni and everyone else recognize that the saliferous members of the Saline Series are peculiarly liable to subterranean contamination from without. The only difference of opinion is as to the possibility or impossibility of quasi-universal contamination by introduced dust.

Let it be granted that the dust found everywhere in the Saline Series includes so many examples of recognizable debris of conifers, angiosperms and insects as to be on the whole clearly post-Cambrian. This second proposition I am prepared to take as a working hypothesis from Sahni and his co-workers. I admit that it involves two separate debatable sub-propositions:

(1) Sahni and his co-workers are certain that the dust particles, which they recognize as remains of conifers, angiosperms and insects, are unmistakable. They publish numerous illustrations, some of them photographs. If botanists and zoologists are withholding criticism out of regard for the authors, they are doing a disservice to science. Gee has asked whether the chitinous dust might not have come from trilobites, rather than insects, and has received an apparently satisfactory answer (pp. 233, 235).

(2) Sahni and co-workers are certain that the particular dust particles, which they identify as bits of conifers, angiosperms and insects, have the same wide distribution as the organic dust as a whole. It might otherwise be suggested that such identifiable material is probably in small proportion and reasonably assignable to contamination. This idea seems to be implicit in Gee's question as to whether the organic remains in the oil-shales might not present a special problem (p. 96), and prove free from post-Cambrian types; but the answer given by Sahni and co-workers is clear, for they maintain that remains of conifers, angiosperms and insects do occur in the oil-shales (pp. ix, xvii, xxii, 53, 187, 204, 205, 207, 220).

Let it be granted that Gee has demonstrated, on three occasions to first-class audiences in the field, exposures which seem to prove that the Saline Series is 'naturally' overlain by unquestionably Palæozoic formations.

Five of Gee's companions have openly adopted his interpretation. Only Sahni himself has said in print that he has seen and disbelieved. The evidence derives in part from lack of manifest disturbance at the contact, and in part from contained fragments in the base of the Talchir Boulder Bed, where this latter happens to be the lowest member of the overlying succession.

Above are stated the three assumptions which for the time being guide my conclusions. I think Sahni is right in interpreting the organic dust in the Saline Series as wind-borne, and contemporaneous. Accordingly I think that the apparent sub-Cambrian stratigraphical position of the Saline Series is misleading. I realize how seldom a major thrust can escape detection in a non-metamorphic, well-exposed succession; but I do know one case in Scotland, that of the Kishorn Thrust, a mile south of Broadford, where Torridon Sandstone is brought on to Durness Limestone in such a manner that any one of us might be deceived if he did not know the answer in advance. Let us hope that further research will soon put the Salt Range problem beyond dispute, one way or the other.

Since this review was written, I have read an extremely important letter by A. K. Ghosh and A. Bose (*Nature*, December 6, 1947, p. 796), in which the discovery is announced of plant dust of apparent post-Palæozoic type in the Salt Pseudomorph Beds. These beds intervene between the Talchir Boulder Bed, above, and the fossiliferous Cambrian, below, instead of underlying the latter as does the Saline Series so far discussed. The elaboration of this find may well lead to decisive results. At first sight it seems rather to weaken Sahni's position.

In conclusion, it is right to express admiration for the organisation displayed by the National Academy of Sciences of India. Perhaps one suggestion may be proffered. Readers would greatly appreciate guidance from page headings.

E. B. BAILEY

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[1] Symposium on the Age of the Saline Series of the Punjab, *Proc. Nat. Acad. Sci. India*, 14, Pt. 6, i–xxxii, 205–334, 9 plates, 29 text-figs. (1945). Price, including postage, Rs. 4/8 (India); Rs. 5 (foreign).

[2] Second Symposium, *Proc. Nat. Acad. Sci. India*, 16, Pts. 2–4, i–l, 29–257, 45 plates, 44 text-figs. (1947). Price, including postage, Rs. 12/8 (India); Rs. 15 (foreign).

SIR CHARLES SHERRINGTON AND DIPHTHERIA ANTITOXIN

AT a recent informal gathering of some men of science an important matter of scientific interest was brought up by Dr. A. N. Drury, director of the Lister Institute, recording an incident in which Sir Charles Sherrington had played a part more than half a century ago.

The incident concerned the very first occasion on which diphtheria antitoxin was made in England. Dr. Drury exhibited one of the hooves, suitably mounted, of "Tommy", the first horse to be injected in England with diphtheria toxin with the object of obtaining diphtheria antitoxin for clinical use; and he explained how the Brown Institution came to be associated with the British Institute of Preventive Medicine—as the Lister Institute was then called—which had accommodation for small animals only in the kitchen of the private residence in which it was housed. Dr. Drury described how "Tommy" was stabled at the Brown Institution, and how that, here, Dr. Armand Ruffer, then secretary of the British (now Lister) Institute, and Sir Charles Sherrington, who was at that time professor-superintendent of the Brown Institution, made those first injections and withdrew those samples of blood which yielded the first British-made diphtheria antitoxin. Listeners were also interested to learn that "Tommy's" performance as an antitoxin-producer would rank high even at the present day. Many other attendant circumstances of the incident and the time (August 1894 and the later months of that year) were reported by Dr. Drury, among which may be mentioned the lively interest of Sir Joseph Lister (as he then was); the sending of diphtheria antitoxin from Paris to be tried on patients in England pending the material from the horse "Tommy" and, no doubt, other horses immunized by Dr. Ruffer and Sir Charles Sherrington, becoming available; Pasteur's interest and concern that those attempting its preparation in England should benefit by the experience of those colleagues in France who had succeeded in preparing this entirely new type of medicament; and the clinical experience of English medical men who were privileged to use these early preparations. A letter from Dr. Roux of the Pasteur Institute, and others from practitioners who used the antitoxin, were read and exhibited.

Dr. Drury's clear exposition of this historic event, and the unique character of the exhibits connected with it, aroused the greatest interest, and it was agreed that Sir Charles Sherrington's interest would be even greater. A letter was accordingly written and the following is an extract from his reply dated November 15, 1947:

". . . Thank you for kindly writing. Yes, the story was just as you say; except that dear Ruffer's first name was *Armand*. Poor fellow, he was torpedoed and drowned by the Germans in the 1st world war. He was brother-in-law to Bouchard of Paris, the leading French physician in his line.

"The story of the horse at 'the Brown' had a dramatic sequel which perhaps Dr. Drury has not heard; if he has, he will, I hope, forgive my telling it; it may interest you. Ruffer and I had been injecting the horse—our *first* horse—only a short time. We were badly in the dark as to the dosage to employ, and how quickly to repeat the increasing injections. We had from it a serum partly effective in guinea pigs. Then, on a Saturday evening, about 7 o'clock, came a bolt from the blue. A wire from my brother-in-law in Sussex. 'George has diphtheria. Can you come?' George, a boy of 7, was the only child. The house, an old Georgian house, 3 miles out of Lewes, set back in a combe under a chalk down. There was no train that night. I did not at first give thought to the horse, and, when I did, regretfully supposed it could not yet be ripe for use. However, I took a cab to find Ruffer. No telephone or taxi in those days—'93 or '94. Ruffer was dining out. I pursued him and got a word with him. He said 'By all means you can use the horse, but it is not yet ripe for trial'. Then by lantern-light at 'The Brown' I bled the horse into a 2-litre flask duly sterilized and plugged with sterile wool. I left the blood in ice for it to settle. After sterilizing smaller flasks, and pipettes and some needle-syringes I drove home, to return at midnight, and decant the serum, etc.

"By the Sunday morning train I reached Lewes. Dr. Fawssett of Lewes—he had a brother on the staff at Guy's—was waiting in a dog-cart at the station. I joined him carrying my awkward package of flasks, etc. He said nothing as I packed them in, but, when I had climbed up beside him, he looked down and said, 'You can do what you like with the boy. He will not be alive at tea time.' We drove out to the old house; a bright frosty morning. Tragedy was over the place, the servants scared and silent. The boy was very weak; breathing with difficulty; he did not seem to know me. Fawssett and I injected the serum. The syringes were small and we emptied them time and again. The Doctor left. I sat with the boy. Early in the afternoon the boy seemed to me clearly better. At 3 o'clock I sent a messenger to the Doctor to say so. Thence forward progress was uninterrupted. On Tuesday I returned to London, and sought out Ruffer. His reaction was that we must tell Lister about it. The great surgeon (not Lord Lister then) had visitors, some Continental surgeons, to dinner. 'You must tell my guests about it', he said, and insisted—so we told them in the drawing-room, at Park Crescent. The boy had a severe paralysis for a time. He grew to be 6 ft. and had a commission in the 1st world war.

"If Drury has not heard of this sequel to the first horse at 'the Brown' he may like to hear it; please give him my best remembrances. . . . Thank you so much for writing. . . ."

OBITUARIES

Prof. A. N. Whitehead, O.M., F.R.S.

ALFRED North Whitehead was born on February 15, 1861, the son of the Rev. Alfred Whitehead, at that time the headmaster of a private school in Ramsgate, and later vicar of St. Peter's, Isle of Thanet, and honorary canon of Canterbury. From Sherborne School he proceeded in 1880 to Trinity College, Cambridge, of which foundation he became a fellow in 1884 and lecturer in 1885.

As a young man, he had a place apart among Cambridge dons by reason of his interest in the outlying and comparatively unknown branches of mathematics. In the nineteenth century, this category included non-Euclidean geometry and non-commutative algebras, such as matrices and symbolic logics; and on these subjects he published in 1898 a massive and very original volume, under the title "A Treatise on Universal Algebra, with Applications".

It is interesting to observe how Whitehead's prophetic instinct led him to take up subjects which were at the time neglected and unknown to most professional mathematicians, but which have since played a great part in the interpretation of Nature. Matrix theory first came into its kingdom in 1925, when Heisenberg, Born and Jordan showed that by its aid quantum theory could be constituted as a complete logical structure. The non-Euclidean geometry of spaces of constant curvature has found its chief application in the cosmological investigations of Eddington and others from 1930 onwards, though Euclidean space had been dethroned fifteen years earlier by Einstein's theory of general relativity. The "Universal Algebra" was acclaimed on all sides as a splendid work of learning and research, and the reputation based on it led to Whitehead's election as a fellow of the Royal Society in 1903.

Of the scholars of Trinity who sat at Whitehead's feet during the last decade of the nineteenth century, there was one who became a specially attached disciple and played a great part in his subsequent life and work. This was Bertrand Russell, who entered the College in 1890 and was elected a fellow in 1895. In 1900 he and Whitehead attended an International Philosophical Congress in Paris, at which they heard an account of the work of Giuseppe Peano, who in the years immediately preceding had invented a new ideography for use in symbolic logic. They realized that Peano's symbolism was vastly superior to anything that had been known previously, and resolved to devote themselves to its development, and in particular to try to settle by its means the vexed question of the foundations of mathematics.

The thesis which they now set out to prove was that *mathematics is a part of logic*; it is, as they said, the science concerned with the logical deduction of consequences from the general premises of all reasoning; so that a separate 'philosophy of mathematics' simply does not exist. This, of course, contradicts the Kantian doctrine that mathematical proofs depend on *a priori* forms of intuition. They soon succeeded in proving that the cardinal numbers 1, 2, 3, . . . can be defined in terms of concepts which belong to pure logic, and which can be represented by Peano ideograms. From this first success they advanced to the investigations published in the three colossal volumes of "Principia Mathematica", which appeared during 1910–12 and contain altogether just under 2,000 pages.

In 1910 Whitehead resigned the Trinity lectureship and removed to London. During 1911–14 he was on the staff of University College, and from 1914 until 1924 he held a chair of mathematics in the Imperial College of Science and Technology.

There was to have been a fourth volume of the "Principia", dealing with geometry. But as Whitehead worked in preparation for it, he found himself more and more involved in questions which really belonged to epistemology and metaphysics. During 1915–17 he published several papers of a definitely philosophical character, and these were followed by two books in which he propounded a new philosophy of the external world, "An Enquiry concerning the Principles of Natural Knowledge" in 1919, and a volume of Tarner Lectures on "The Concept of Nature" in 1920. He first cleared the ground by rejecting the conceptions of Nature which then formed the accepted starting-point of physics: namely, that space and time provide, so to speak, a stage, on which ponderable bodies, æther, and electricity maintain an unending performance. In place of this, he put forward the doctrine that the ultimate components of reality are *events*. For example, a university lecture is an event: obviously it includes other events, such as the professor at his rostrum and the students at their desks; moreover, it may in its turn be regarded as a part of a larger event, such as the aggregate of all the lectures given in the same building at the same hour. This property of *extending over* other events is characteristic of events, and is the fundamental relation on which Whitehead's philosophy of the external world is based.

An event is never instantaneous; it always endures over a certain (though perhaps very short) duration of time: "the ultimate fact for observational knowledge", as he said, "is perception through a duration". The notions of an *instant* of time and a *point* of space are not truly primitive notions: to obtain them, he introduced what he called the *method of extensive abstraction*. The idea of this method is to consider a set of events each of which includes all the subsequent members of the sequence, like a nest of boxes each slightly larger than the one next inside it; if the events ultimately diminish indefinitely (or in more precise language, if no event is extended over by every event of the set) then they may be regarded as defining a limit: points of space and instants of time may be defined in this way; so that time and space are derivative concepts, they are abstractions which express relations between events.

In 1924 Whitehead resigned his chair at the Imperial College in order to accept a professorship in the Philosophical Department of Harvard University, which he occupied until his final retirement in 1937. In the session 1927–28 he returned to Britain for a time in order to deliver the Gifford Lectures in the University of Edinburgh. These, which were published in 1929 under the title "Process and Reality: an Essay in Cosmology", may be regarded as the definitive exposition of his mature philosophy, to which he gave the name 'Philosophy of Organism'. In his own words, "Speculative Philosophy is the endeavour to form a coherent, logical, necessary system of general ideas in terms of which every element of our experience can be interpreted". His point of view in this endeavour must first be made clear. He turned his back on German idealist philosophy (Kant, Fichte, Schelling, Hegel), which was concerned chiefly with mind, and had little interest in the study of Nature by the methods of mathematical and experimental science. In this sense his philosophy is, as he said, "a recurrence to pre-Kantian methods of thought". In regard to particular features, he was under obligations of one sort or another to Descartes, Leibnitz, Locke, Berkeley and Hume, and among moderns to Bradley, Bergson and Alexander; but the main roots of his doctrine were to be found in Greek philosophy, and it bore a relation to modern science which may be compared with that which Platonism bore to the Pythagorean mathematical concept of the intelligible element in Nature.

The philosophy of Whitehead is in the first place a cosmology. Now one famous philosophical cosmology has come down to us from the ancient world, namely, that set forth in the "Timæus" of Plato; and the resemblances between it and Whitehead are so striking that "Process and Reality" may be described, in a first rough approximation, as the "Timæus" brought up to date. The fundamental idea in both is the gradual evolution of order out of a primeval chaos, by a process of divine achievement. The *demiourgos* of the "Timæus" corresponds to Whitehead's God, and the Platonic 'Ideas' or 'Forms' correspond to Whitehead's 'eternal objects', which have a potentiality of 'ingression' into the becoming of actual entities, just as the 'Forms' have participation (*methexis*) in visible things. The primitive plastic substratum in which copies of the 'Forms' are made (*chora*) corresponds to Whitehead's concept of 'creativity'.

"Process and Reality" is not an easy book to read, chiefly because of the multitude of new words, and new senses of old words, with which it teems. Only time can show how many of these will be retained as a permanent enrichment of the philosophical vocabulary.

Whitehead died at Cambridge, Mass., on December 30, 1947.

EDMUND T. WHITTAKER

ON November 12, 1947, it came my way to spend, alone, a couple of hours in the evening with the late Prof. Whitehead, and Mrs. Whitehead, in their apartment within a stone's throw of the centre of Harvard. It seems likely, therefore, that I was the last person from Britain to see the great man before he died.

We talked of Trinity ("Such a good place", he whispered) and its 'characters', of whom he spoke affectionately, coupled with an occasional sly dig, as entrancing as it was kindly. He was devoted to the country of his adoption: a remark stands out in my memory—"The Americans have a streak of tenderness, yes, how valuable that is these days". Many people have used gracious words about our trans-Atlantic cousins, but it was left to him to state, quite simply and naturally, their noblest trait, and the one holding out hope for the world.

In appearance, Whitehead had become almost 'other-worldly' (something which others besides myself had noticed), as if, for him, the veil was wearing very thin. Yet there he sat, erect in his big arm-chair, full of life and interest in other people. I thought he might be getting tired, and rose to go. He, rather slowly, grasped my hand and held it, saying "Come again". But that was not to be.

F. IAN G. RAWLINS

Prof. J. N. Brønsted

PROF. JOHANNES NICOLAUS BRØNSTED died in Copenhagen on December 17, 1947, after holding the University chair of physical chemistry for nearly forty years. He was born in 1879 and spent his childhood in Jutland, where his father was employed as an engineer in connexion with land reclamation. Both his parents died while he was still a boy, and after going to school in Aarhus and Copenhagen, he began training as an engineer at the Polytechnic Institute in Copenhagen in 1898. However, it soon became clear that his interests were in chemistry, and he took the *Magister* degree in this subject in 1902, being appointed as assistant at the University Chemical Laboratory in 1905. He very soon became engrossed in the application of thermodynamics to physico-chemical problems, a subject which was to prove a central theme in all his subsequent work. A long series of papers in the years 1906–21 dealt with the theory and measurement of affinity changes, and it was the third of this series (dealing with binary mixtures) which was presented for his doctorate degree in 1908. In 1909 he was appointed (after close competition with Niels Bjerrum) to the newly instituted chair of physical chemistry, and was also made director of the physical chemistry laboratory of the Polytechnic Institute, where a great deal of his later work was carried out.

Some of Brønsted's work on affinity had dealt with electrolyte solutions, and in the period 1918–24 these became a special focus of interest. In particular he carried out an extensive series of solubility measurements, and was able to establish several simple and important general laws. When the theory of Debye and Hückel was published in 1923, it was satisfactory to find that its predictions agreed essentially with the relations already established by Brønsted, and the solubility measurements of Brønsted and LaMer (1924) still constitute some of the best evidence for the Debye–Hückel theory.

At about the same time Brønsted became interested in the kinetics of reactions in electrolyte solutions, and our present understanding of kinetic salt effects rests largely on his papers of 1920–24, which clarified a confused subject in a remarkable manner. This work directed his attention to acids and bases, and it is in this connexion that his name is most widely known to-day. The modern definition of acids and bases (proposed simultaneously in 1923 by Brønsted and by T. M. Lowry) has had a great clarifying influence in many branches of chemistry. In particular, it led to the idea of general acid-base catalysis, and although this idea had been previously suggested by H. M. Dawson and others, it was most clearly presented and justified in a series of papers by Brønsted and his colleagues on the decomposition of nitramide, the mutarotation of glucose, and various hydrolytic reactions.

In 1930 Brønsted moved to the new Physico-chemical Institute, where he enjoyed much better experimental facilities and a charming official residence. Here he continued work on reaction kinetics, especially in non-aqueous solvents, but also returned to thermodynamic problems. These latter included studies of the effect of molecular size on the thermodynamic properties of hydrocarbons, polymers and colloids. He also published several papers on the fundamental basis and formulation of the laws of thermodynamics, a subject which occupied his attention increasingly right up to his death.

Brønsted's fame to-day probably rests largely on his work on reaction kinetics and his definition of acids and bases, and it is perhaps not always realized how much he contributed to the fundamental thermodynamics of solutions. This firm foundation in thermodynamics left its mark on all his work, where an exact and elegant formulation of experimental conclusions was often coupled with a reluctance to speculate in terms of molecular models. Although he contributed little to the elaboration of practical techniques, his experimental work showed great skill in the choice of methods and of systems for investigation. He preferred to work independently of others, and the only notable example of collaboration outside his own field is his well-known work with G. von Hevesy on the separation of the isotopes of mercury. He did not suffer fools gladly among his research students; but it was a great inspiration to work under his guidance, and many foreign visitors enjoyed the hospitality of his laboratory from 1920 onwards. Brønsted himself travelled widely in Europe and paid one visit to the United States as a visiting professor at Yale. He received many honours from learned bodies abroad, such as the American Academy of Arts and Sciences, the Chemical Society of London, and also from the University of London.

Brønsted was a man of great personal charm and took a keen interest in the art, literature and natural history of several countries besides his own. During most of his life he played little part in public affairs, but the German occupation of Denmark led him to think more deeply on national and international questions, and in 1947 he became a member of parliament, though his last illness prevented him from taking his seat. He was one of the small band of great men of science who have given Denmark a scientific reputation quite out of proportion to her size, and he will be mourned by friends and colleagues in many parts of the world. R. P. BELL

Mr. Orville Wright

THE death on January 30 of Orville Wright marks the passing of the second of the great co-pioneers of mechanical flight (Wilbur Wright died in 1912), and of the man who actually made the first controlled and sustained flight in an aeroplane. Orville was born at Dayton, Ohio, on August 19, 1871, and was the fourth son of Bishop Milton Wright, Wilbur being the third. The two brothers grew up inseparable in youth and manhood; so close was their collaboration that their experimental work can be regarded only as a single achievement—though Wilbur, on account of his age and special gifts, may have been the leader.

In contrast to some other investigators, the Wright brothers approached the problem of flight by the method known to have been employed in Nature many millions of years ago, namely, through the evolutionary process of gliding, which they saw to be obligatory. Their contribution was, essentially, the devising of a complete system of control where none had previously existed; the design of effective cambered wings, determined by wind-tunnel research; the development of airscrews and the adaptation of a petrol engine; and, finally, the incorporation of all these devices in a practical machine.

The unique distinction of being the first man to fly in the true sense—which fell to Orville at Kitty Hawk, North Carolina, on December 17, 1903—was borne by him with dignity and charm. After the untimely death of his brother Wilbur, he took a less active part in aeronautics, though his interest never waned. More recently, he was concerned with establishing the credit properly due to them for their historic achievement, and in 1928 he sent the original biplane of 1903 to the Science Museum in London in order to receive that unqualified recognition which he feared was not forthcoming in some quarters of his own country. The machine is still on exhibition there.

M. J. B. Davy

We regret to announce the following deaths:

Dr. Bernard Dyer, well-known agricultural chemist and public analyst, formerly president of the Society of Public Analysts and Other Analytical Chemists, on February 12, aged ninety-one.

Prof. R. B. Thomson, emeritus professor of botany, University of Toronto, well known for his work on plant anatomy and morphology, on July 31, 1947, aged seventy-six.

NEWS and VIEWS

Dr. S. E. Sheppard

Dr. S. E. Sheppard, well known throughout the photographic industry, retired on January 1, 1948, after thirty-five years with the Eastman Kodak Research Laboratories, Rochester, U.S.A. Dr. Sheppard graduated at University College, London, where he later obtained the degree of doctor of science, submitting a thesis on the formation of the latent photographic image and the chemistry of development. The work was done jointly with Dr. C. E. K. Mees, now a vice-president of the Eastman Kodak Company, and was published as "Investigations on the Theory of the Photographic Process", so well known by photographic research workers. In 1913 the Eastman Kodak Research Laboratories were newly organised and Dr. Sheppard went to the United States to join the staff as a chemist, and since then he has made valuable contributions in many fields of photographic research. Perhaps his best-known work relates to the function of gelatin in photographic emulsions. He and his co-workers found that the sensitizing action of gelatin is influenced by the presence of certain sulphur compounds, among the most important of which are derivatives of mustard oil. This work has led to the comment among those familiar with photography that if the cow had not a taste for mustard we should have no fast photographic emulsions. Dr. Sheppard made a special study of colloid chemistry which, apart from its obvious influence on his work on gelatin, led to such unrelated work as the development of a colloidal fuel for use in submarines during the First World War and investigations into the properties of cellulose and rubber. He has published some two hundred and fifty scientific papers and written several books; the value of his contributions to photographic science has been recognized by honours conferred upon him by photographic and chemical societies on both sides of the Atlantic.

Harrison Memorial Prize: Dr. D. H. R. Barton

The Harrison Memorial Prize for 1947 has been awarded to Dr. D. H. R. Barton. Dr. Barton studied at the Imperial College of Science and Technology, London, where he graduated in 1940 with first-class honours, being awarded the Hofmann Prize for special distinction in organic chemistry; he is now an I.C.I. Research Fellow in the Department of Inorganic and Physical Chemistry at the Imperial College. The Harrison Memorial Prize is awarded by a committee, consisting of the presidents of the Chemical Society, the Royal Institute of Chemistry, the Society of Chemical Industry and the Pharmaceutical Society, to a British chemist less than thirty years of age for original chemical investigations during the previous five years.

British Museum (Natural History)

The Principal Trustees of the British Museum have appointed Mr. David Dilwyn John and Dr. Francis Charles Fraser to be deputy keepers in the Department of Zoology of the British Museum (Natural History). Mr. John, who is forty-six, has been in charge of Recent echinoderms at the Museum since he joined the staff in 1935. He studied zoology in the University of Wales and served during 1925–35 on the scientific staff of the "Discovery" Investigations, during which period he took part in three commissions in Antarctic waters. On the third of them, while he was scientific officer in charge, the Antarctic continent was circumnavigated, chiefly in the winter months. He has been awarded the Polar Medal. During the War he served in the Royal Artillery. Dr. Fraser is forty-four years of age, and served with "Discovery" Investigations during 1925–33, and has received the Polar Medal for three periods of service in the Antarctic. He joined the Museum staff in 1933, since when he has been in charge of the osteological collections, and has made a special study of whales.

British Institute of Archæology in Ankara

The British Institute of Archæology in Ankara was formally inaugurated on January 15 by H.E. Resat Semsettin Sirer, Turkish Minister of National Education and H.E. the British Ambassador, Sir David Kelly, in temporary quarters at 8 Istiklâl Caddesi, Ankara. Members of the Turkish Council of Ministers and the Diplomatic Corps were present, and were received by Prof. John Garstang, director of the Institute, and Mrs. Garstang. The Institute is a newly founded body, designed to carry out work similar to that of the other British Schools of Archæology at Athens, Rome, Jerusalem and Baghdad. It will form a centre of research to which British students of archæology and kindred subjects such as anthropology and ethnology will go to carry out their work. For this purpose the Institute is bringing together a library and collections of archæological objects, photographs and squeezes of inscriptions in so far as these are necessary to supplement the collections in Turkish museums. It is offering this year a scholarship of £300 to a student wishing to carry out researches in Turkey in some aspect of Anatolian archæology. It is also hoped to offer such a scholarship annually and a fellowship of £350 to an advanced student.

As a contribution to research in the archæology of Turkey and as a valuable means of training students, the Institute will undertake, as soon as funds are forthcoming, a programme of excavation of sites in Turkey and of archæological exploration on the surface. It will also give all assistance possible to approved British expeditions for excavation or other research. For the information of would-be students, the following rough estimate of expenses may be useful: living in Turkey, average £T5 per day for 100 days (say, £50); travelling from Britain and back £120; incidental expenses during stay £30; balance for travel and expenses of research in Turkey £100 (total £300). The Institute is organised under a committee in London, on which there are representatives of the British Academy, the British Museum, the London Institute of Archæology, the British School at Athens, the Society for Hellenic Studies, the School of Oriental Studies, the Royal Society, the Society of Antiquaries, the Royal Asiatic Society, the Royal Anthropological Institute, as well as official representatives of the Universities of Oxford, Cambridge, London and Edinburgh. The committee's honorary secretary in London is Miss K. Kenyon, c/o Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1.

Transit Circle for the Royal Observatory, Greenwich

WHEN the Royal Observatory moves from Greenwich to Herstmonceux, the Airy transit circle, which was installed in 1851 and which marks the zero meridian of longitude, will be left at Greenwich, along with a collection of older instruments dating back to the time of Halley. They will form an interesting historical exhibit. The Airy instrument has reached the end of its useful life; the objective has twice been repolished and refigured and is too thin for a further repolishing which is now needed; many of the circle graduations have been almost obliterated by repeated cleaning; the instrument is non-reversible and obsolete in various respects. The Observatory possesses a modern reversible 7-in. transit circle, made by Cooke, Troughton and Simms, and installed in 1936, which is required primarily for fundamental observations. A second transit circle is needed for differential zone observations.

When the Astronomer Royal, Sir Harold Spencer Jones, was in Australia last year, he visited the Melbourne Observatory, which was recently closed. Much of its work has been taken over by the Commonwealth Observatory at Mount Stromlo near Canberra. There he saw an 8-in. reversible transit circle, of 12-ft. focal length, with two circles of 3-ft. diameter. It was made by Troughton and Simms, and installed in 1884; an impersonal micrometer has since been provided for it. The instrument had been used with care and was in excellent condition. When the Government of Victoria was made aware of the requirement for such an instrument by the Royal Observatory, it generously decided to present the telescope. The instrument was dismantled and packed with the assistance of the Royal Australian Navy, and has recently arrived at Greenwich. It will be installed at Herstmonceux in due course.

The Biometric Society: British Region

THE Biometric Society, a new international organisation the aim of which is the furtherance of quantitative biology in all its aspects, came into being at a conference held in Woods Hole, Massachusetts, during September 1947. Its president is Prof. R. A. Fisher, and its secretary, Dr. C. I. Bliss, of New Haven, Connecticut. It is hoped to hold international meetings every few years, and all members will receive the journal *Biometrics*. For the purpose of more local activities, the Society is organised into regions, of which it is proposed that a British Region shall form one. A provisional committee, under the chairmanship of Dr. J. W. Trevan, vice-president for the Region, is now engaged in drafting proposals for the regional organisation and activities, which it is intended will primarily provide a means of bringing together all those biologists and biochemists who are interested in the application of quantitative methods, with the statisticians and mathematicians who can co-operate in developing these methods. It is hoped shortly to present these proposals to an inaugural meeting of the Region. Further information can be obtained from the Regional Secretary, Dr. K. Mather, of the John Innes Horticultural Institution, London, S.W.19.

Breeding of Avocets in Britain

PRIOR to 1938, when two pairs of avocets were reported to have nested in Ireland, ornithological records contained no reference to the breeding of these birds in Britain for more than a century. During the summer of 1947, however, two small colonies of avocets (*Recurvirostra avosetta*) established themselves in East Anglia. According to P. E. Brown and E. Lynn-Allen (*British Birds*, 41, No. 1, January 1948), nine pairs of adult birds, of which at least seven pairs nested, were present during the breeding season. Altogether sixteen young birds were known to have reached the free-flying state. The Royal Society for the Protection of Birds has already taken measures to ensure that the birds will be adequately safeguarded should they return in 1948.

School Ecological Studies: Blundell's Scientific Publication

THE second number (1947) of the *Magazine of the Blundell's School Science Society* is, like the first, worthy of special note since it has carefully avoided the usual mistake of becoming a rather extravagant, even useless, potpourri of miscellaneous information and has again developed a theme—that of ecology. In fact, it is a good though elementary collection of articles mainly of ecological interest. In an article on "Butterflies of the Tiverton Area", M. A. Lyne describes twenty-seven species found within a ten-mile radius of Blundell's School. P. R. Freeth's interest lies mainly in bird watching and bird ringing, and records that the British Birds Marking Scheme was revived at the School in 1947 after a lapse of eight years. Thirty-nine birds were ringed. O. H. D. Portsmouth describes the flora of a local marsh meadow. The marsh is divided into a wet area dominated by *Carex panicea* and a drier area dominated by *Juncus communis*. This article gives the floral ecology in detail and reveals an extraordinarily sound grasp of the principles of ecological study by such a young author.

R. Honey reports on a survey of the marine algæ of Guernsey, giving a systematic list and dealing with ecological factors, distribution and relations between flora and habitat. G. O. Mackie confines himself to a more intensive ecological study of the flora and fauna of rain gutters. Other articles, all ecological in approach, are the animal ecology of a field drainage scheme by J. S. Miller, some factors affecting the distribution of the may-fly by R. H. Champion, fauna of a stream by E. W. Sturton, and observations in bird territory by J. A. Shepherd. The entire publication reveals a sound biological training, indicates that the young students are stimulated to a healthy enthusiasm (they are fortunate in that their school is situated in a biologist's paradise), and offers its contributors a rare opportunity for training in setting out their observations, results and conclusions concisely and accurately.

Quarterly Journal of Experimental Psychology

THE Experimental Psychology Group, a small private society the membership of which is drawn from the teaching and research staffs of British universities and research institutions, and the object of which is to further the experimental and scientific study of psychological problems, has decided to found a new journal, to be known as the *Quarterly Journal of Experimental Psychology*. While the volume of scientific work within the general field of psychology and the neighbouring fringes of physiology, medicine, biology and physics has greatly increased within the past few years, publication has been severely restricted by lack of a journal devoted exclusively to these fields. Much work has appeared in journals representing other branches of science. The intention is to produce a small journal of high quality in which scientific psychological work, whether experimental or clinical, and whether carried out in psychological or in other research institutions, may find a focus and an outlet. The journal will be edited by R. C. Oldfield, of the Institute of Experimental Psychology, University of Oxford, who will be assisted by an editorial board of six other members of the Experimental Psychology Group, and it will be published by Messrs. W. Heffer and Sons, Ltd., Cambridge (subscription, 30*s*. a volume of four parts). It is hoped to produce the first part in March.

Submarine Gravity Survey in the English Channel

THE Department of Geodesy and Geophysics, University of Cambridge, is to make a gravity survey on board H.M. Submarine *Talent* in the English Channel during May. The project is being carried out under the auspices of the Royal Society with the full co-operation of the Royal Navy. The object of the expedition is to obtain information about the structure of the channel basin which should help in interpreting the relation of the geology of southern England to that of the Continent. The cruise will last for four weeks and cover the area between England and France from Plymouth to Hastings. H.M. Submarine *Talent* will be manned by her normal complement of officers and men of the Royal Navy, but three civilian scientific workers, Mr. B. C. Browne, Mr. R. I. B. Cooper and Mr. R. L. G. Gilbert, will also be on board. She will be equipped with special apparatus, some of which has generously been lent by the Danish Geodetic Commission. Accurate measurement of this kind can only be made under very steady conditions, such as those found by a submarine at a depth of 100–200 ft. This method of working was originally devised by the Dutch geophysicist, Prof. F. A. Vening-Meinesz, and has been widely used by him. Similar work has also been carried out by the United States, France, Italy, the U.S.S.R., Japan, and Britain. A British expedition in August 1946 on board H.M.S. *Tudor* surveyed an area from the north coast of Spain to the Rockall Bank. Besides valuable scientific results, the experience gained showed how the apparatus and technique might be improved.

The Berlin Herbarium

MR. A. H. G. ALSTON, of the British Museum (Natural History), writes: "I have received the following information from a correspondent in Germany: The portion of the herbarium, which was evacuated from Berlin to Bleicherode, has quite recently been handed over officially to the Berlin University, and deposited in the Russian sector of Berlin. It was generally believed in Germany that these collections had been transported to the U.S.S.R., but, in fact, they remained at Erfurt until 'the President of the Moscow Academy of Science decided not to take over German *Kulturgut*'."

Ramsay Memorial Fellowships for Chemical Research

THE trustees will consider in June applications for Ramsay Memorial Fellowships for chemical research, one of which will be limited to candidates educated in Glasgow. The value of each Fellowship will be £400 per annum, to which may be added a grant for expenses of research not exceeding £100 per annum, and it will normally be tenable for two years. Full particulars can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College London, Gower Street, W.C.1, to whom applications must be forwarded not later than April 17.

Announcements

THE Linnean Society of London has awarded the Linnean Medal for the year 1948 to Dr. Agnes Arber, F.R.S., of Cambridge. The Medal will be presented at the anniversary meeting on May 24.

THE Council of the University of Bristol has made the following appointments in the Department of Physics, to take effect on the retirement of Prof. A. M. Tyndall at the end of the present session: Prof. N. F. Mott, to be Henry Overton Wills professor of physics and director of the Wills Laboratory; Dr. C. F. Powell, to be Melville Wills professor of physics; Dr. S. H. Piper, to be assistant director of the Wills Laboratory.

THE following elections to the Paris Academy of Sciences have been announced: André Boivin, *correspondant* for the Section of Rural Economy, in succession to the late M. Henri Vallée; and Dr. Theodor Mortensen, director of the Department of Invertebrates, Zoological Museum, Copenhagen, *correspondant* for the Section of Anatomy and Zoology, in succession to the late M. Edouard Chatton.

DR. E. W. FELL has been appointed senior assistant in metallurgy at the Bradford Technical College. He was educated at Haileybury and the Universities of Birmingham, Aachen and Cambridge, and has many years of varied experience in the practice of metallurgy.

AT the annual meeting of the Manchester Joint Research Council held on February 16, Sir Raymond Streat was elected chairman and Sir Charles Renold honorary treasurer.

THE Association of British Science Writers is now open to accept associate members. Associate membership is intended for non-professional science writers, that is, those who do not earn the major part of their income from science writing. Those interested should apply for particulars to the honorary secretary, Mr. Maurice Goldsmith, at 81 Hillside Gardens, Edgware, Middlesex.

SIR JOHN MYRES writes, referring to his review of "A Glossary of Greek Fishes" (*Nature*, Feb. 7, p. 185), "the words *weel* and *péganon*, which I queried as misprints, are both correct".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Animal Tissue Cells in Protein-Free Media

FEW attempts have been made to maintain (or grow) animal tissue cells in protein-free media, although it has been shown[1] that the low molecular weight substances of blood plasma are of the utmost importance for the life of tissue cells, which rapidly perish in dialysed blood plasma. It has further been possible[1,2], by the addition of a number of amino-acids together with glutamine, glutathione and hexose diphosphate to a medium containing only dialysed plasma proteins and dialysed embryonic extract, to obtain survival and growth of the cells. The few attempts made to devise completely synthetic media have met with only partial success because of lack of a suitable technique, and because very little is really known about the fundamental nutritional requirements of animal tissue cells during survival and growth.

M. R. Lewis and W. H. Lewis[3] obtained migration and growth of cells in hanging-drop cultures in media containing inorganic salts, dextrose or maltose, amino-acids and polypeptides. As they also obtained migration and growth in a medium containing inorganic salts only, there could, however, be no doubt that their results were complicated by insufficiently defined residual growth phenomena originating from the use of rather large tissue explants and small volumes of media. P. R. White[4] has recently, by means of a modified roller tube technique, obtained migration and growth of long duration in a synthetic medium containing a large number of substances supposed to be of importance for the maintenance and growth of animal tissue cells *in vitro*. The manner in which White prepared the tissue explants and placed them in the cultivation tubes does not seem to ensure, however, that the reaction of the cells was due solely to the constituents of the synthetic medium (cf. also ref. 2).

In order to be able to study the effects of some protein-free media, I have made use of hanging-drop cultures made according to the technique of Lewis and Lewis[3]. By the use of very small explants (of embryonic heart tissue; 8–9 day embryos) it apparently became possible to avoid contamination of the media by substances given off from the explants. The following results were obtained:

(1) In Tyrode solution no migration of cells was obtained, undoubtedly because a solution containing only inorganic salts and dextrose cannot maintain the life of animal tissue cells.

(2) Tyrode solution containing the following nine amino-acids was made up: *d*-lysine dihydrochloride (0·006 per cent); *d*-arginine (0·003 per cent); *l*-tryptophane (0·002 per cent); *d,l*-methionine (0·001 per cent); *l*-histidine monohydrochloride (0·001 per cent); glutamic acid (0·006 per cent); *l*-aspartic acid (0·002 per cent); *l*-proline (0·002 per cent); *l*-cystine (0·0006 per cent), (cf. ref. 1). Zones of migrating cells were formed around the explants. The number of migrated cells showed great variation (from a few hundred to about 1,500 cells). The mitotic frequency was very low (about 1 per 4,000 cells). The cells survived two or three days, looking apparently normal. The addition of glutamine (0·05 per cent), glutathione (0·01 per cent) and hexose diphosphate (0·03 per cent) did not change the result.

(3) Dialysate obtained by dialysis of blood plasma (adult cock) against an equal volume of Ringer's solution (0·1 per cent dextrose). Large zones of migrating cells were observed (the number of migrating cells varying between a few hundred and more than 2,000). The mitotic frequency was very low (1 per 2,500). Dialysates of pig and ox serum have so far given no cellular migration.

A number of experiments have also been made, placing the tissue explants at the bottom of Carrel flasks (volume of medium 0·5–1 c.c., one explant in each flask). The *p*H was adjusted to 7·6–7·8 by regulation of the amount of carbon dioxide present. The large volume of the medium, and frequent renewals, made it possible to keep its composition constant—this is scarcely possible in hanging-drop cultures for any long period of time.

In this way, survival of zones of migrated cells in the amino-acid mixture (in Tyrode solution) or in plasma dialysate up to ten to twelve days was achieved; no migration of cells could be obtained in Tyrode solution alone. It is, moreover, possible to isolate zones of migrated cells placed at the bottom of Carrel flasks, the original explants being removed after one or two days.

Using the procedures described here makes it possible to study the effects of protein-free media on tissue cells *in vitro*.

AAGE BOHUS JENSEN

Biological Institute,
Carlsberg Foundation,
Copenhagen.
Nov. 5.

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[1] Fischer, A., *Acta physiol. Scand.*, **2**, 143 (1941).

[2] Fischer, A., Astrup, T., Ehrensvärd, G., and Oehlenschlager, *Proc. Soc. Exp. Biol. Med.* (in the press).

[3] Lewis, M. R., and Lewis, W. H., *Anat. Rec.*, **5**, 277 (1911).

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Failure of Sulphanilamide to Inhibit Calcification of Bone

BENESCH and co-workers[1] have reported almost complete absence of calcification in the bones of rat fœtuses at term, following administration of large doses of sulphanilamide and sulphapyridine to the mothers during the last seven to ten days of the gestation period. Their report was based upon hæmatoxylin-staining of decalcified bones, with the reservation that this method might not be reliable, and upon X-ray examination of the bones of the fœtuses from sulphonamide-treated rats, no mention being made of control observations upon normal fœtuses. The results of observations upon mice were stated to be equivocal.

We have administered sulphanilamide to pregnant rats under conditions similar to those reported by Benesch *et al.*, and have observed the new-born rats from both treated and untreated mothers by positive staining of bone salt in undecalcified bones and by X-rays. Our observations do not confirm those of Benesch *et al.*

Four pregnant rats received 720 mgm. of sulphanilamide/kgm./day during the latter 5, 7, 11 and 16 days, respectively, of pregnancy. Three new-born rats of each litter were examined by X-rays and autopsied within fifteen hours after birth. X-ray films were made with 10 m. amp. current and 1 sec.

exposure; the technique of development was identical for all. Undecalcified histological preparations stained by the von Kóssa method, as described by McLean and Bloom[2], were made from sagittal sections through the knee joint. Litters from five normal untreated rats were similarly examined and served as controls.

The findings in all these animals were comparable to those described by Bloom and Bloom[3] in embryonic and new-born rats, and we have been unable to detect any differences between rats born from treated and untreated mothers. It is true that there are "striking defects in various parts of the skeleton" of new-born rats, as shown by X-ray examination; but these defects are not peculiar to the offspring from mothers treated with sulphonamides.

Benesch *et al.* began their work with the hypothesis that sulphanilamide, which inhibits carbonic anhydrase, might interfere with calcification, with the expectation that sulphapyridine, which does not have any effect on this enzyme, would have no effect on the deposition of bone salt. In view of their reported findings, which appeared to indicate that both sulphonamides inhibited calcification, they offered the interpretation that this effect was due to inhibition of the activity of bone phosphatase. Silver and Golding[4] have shown that bone phosphatase is inhibited by sulphonamides *in vitro*, but the concentrations required (250–1,500 mgm. per cent) and the degree of inhibition (50 per cent or less) would make it extremely unlikely that this mechanism could have physiological significance.

This work was supported by a grant-in-aid from the United States Public Health Service, Research Grants Division.

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Bilirubin-Serum Protein Complexes and the van den Bergh Reaction

RECENT work by N. H. Martin[1], showing complex formation between bilirubin and the α-globulin as well as the albumin components of plasma, is not only of great theoretical and practical significance from the point of view of the physical chemistry of the proteins, but also may have important implications regarding the interpretation of the van den Bergh reaction. The binding of bilirubin to different plasma protein fractions might be related to the alleged two forms of bilirubin postulated by many workers to explain the different types of direct van den Bergh reaction.

We have examined a small number of jaundiced sera by the electrophoresis technique and can confirm Martin's findings that a small but definite fraction of the bilirubin migrates with the α-globulin fraction, in addition to the migration of the main fraction of the bilirubin with the albumin. In all cases, bilirubin migrated in much the same proportions with the albumin and α-globulin fractions respectively, whatever the nature of the jaundice or the type of direct van den Bergh reaction. One of the jaundiced sera we examined was obtained from a patient with retention jaundice and contained 16·2 mgm. bilirubin per 100 ml., gave an almost completely negative direct van den Bergh reaction and a direct–indirect quotient (*D.I.Q.*)[2] of 9 by the 30 min. Malloy and Evelyn method. The bilirubin of this serum behaved in the electrophoresis apparatus in precisely the same way as bilirubin of sera from patients with obstructive jaundice or acute hepatitis and containing similar amounts of bilirubin but giving typical positive direct van den Bergh reactions and *D.I.Q.* values greater than 50. We are therefore compelled to conclude that the binding of bilirubin by different fractions of the plasma proteins bears no direct relationship to the nature of the direct van den Bergh reaction.

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Nov. 10.

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Alkaline Phosphatase in Fish Gut

SINCE Gomori[1] and Takamatsu[2] adopted a histochemical test for the demonstration of alkaline phosphatase, many investigators have examined the distribution of the enzyme in animal tissues; the majority, however, employed material from mammals.

I have recently been studying the distribution of the enzyme in the alimentary tract of certain freshwater fishes, namely, three species of the family Cyprinidæ. The results are not without interest. For example, the concentration of the enzyme varies from species to species as well as in the various segments of the otherwise comparatively uniform intestine. The sites of activity of the enzyme are the free border of the absorptive cells, and the granular cells which are found in the submucosa and which invade the intestinal epithelium (these are known to be derived from granulocyte leucocytes, Duthie[3]). The enzyme occurs also in the connective tissue, blood vessels, and in the stratified epithelium lining the buccal and pharyngeal cavities. The presence of the enzyme in the Golgi zone of the absorptive cells is not a constant feature of these fish, contrary to what Emmel[4], and Deane and Dempsey[5] have found in certain mammals.

It is generally accepted that the enzyme is involved in a phosphorylation process of glucose[6,7]. Its presence in the stratified epithelium, especially concentrated in the stratum germinativum, is therefore of interest; and it is suggested that in such epithelium, where the intercellular substance is very scanty, glucose may pass into the epithelium by a chemical process of phosphorylation, initiated by the enzyme secreted at its base, rather than by diffusion.

Gomori and Takamatsu incubated the sections with the substrate at 37° C., which corresponds roughly to the body temperature in mammals. In a few experiments, incubation has been carried out at 28° C. with fish material, and very good results were obtained; the optimum temperature for the enzyme in cold-blooded vertebrates is not necessarily the same as in mammals. This, and also the optimum pH, needs further investigation.

In view of these facts, and that our knowledge of the comparative histochemistry of the lower vertebrates is slight, a comparative study of the distribution of alkaline phosphatase in the alimentary tract of lower vertebrates, and an experimental investigation of the conditions under which the enzyme acts in these animals, are needed, and seem likely to yield results of considerable interest in the histochemical field. The work is now proceeding, and it is hoped to publish a full account in the near future.

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Nov. 12.

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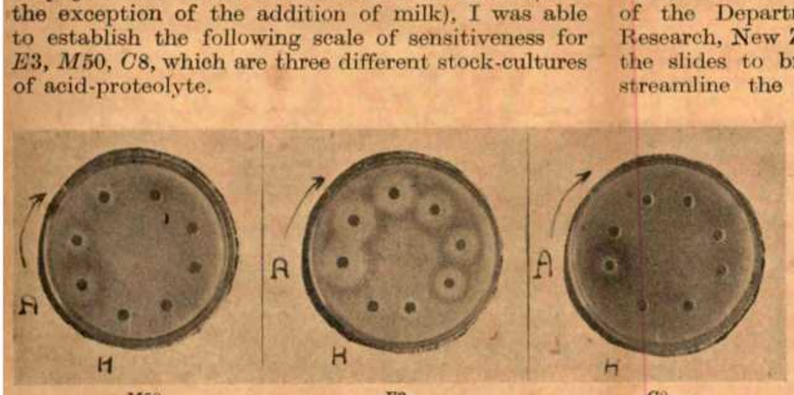
Behaviour of Gorini's Acid-Proteolytic Lactic Cocci with Penicillin

THE study of penicillin resistance is interesting particularly if observations are made on the usual substratum of the bacteria, that is, in the optimum conditions of life. Basing my work on the observation of C. Gorini[1] that the colonies of his cocci inoculated in agar broth with milk form around each colony a transparent zone due to proteolysis that has dissolved the casein, I carried out tests by the following method: the Petri plates, containing 15 ml. of melted agar broth flooded with 20 per cent of milk, were inoculated with 1 ml. of a 48-hour milk-culture of the stock in question. Holes were made on the slides, as is done in routine testing of penicillin, and in each was put a drop of serial dilutions of crystallized sodium penicillin *C.S.C.* The method proved simple, quick and very sensitive. The zones of inhibition showed themselves as cloudy circles where the casein had not been proteolysed, whereas the rest of the plate became clear, the vitality of the bacteria there being shown by their proteolytic power.

Comparing the diameter of the circles observed with the acid-proteolytes and those obtained with *Staphylococcus aureus* under the same conditions (with the exception of the addition of milk), I was able to establish the following scale of sensitiveness for *E*3, *M*50, *C*8, which are three different stock-cultures of acid-proteolyte.

Staphylococcus aureus Oxford	Acid-proteolytic lactic cocci Gor.		
	*E*3	*M*50	*C*8
1	1/5	1/100	1/200



*M*50 *E*3 *C*8

BEHAVIOUR OF THREE STOCKS OF ACID-PROTEOLYTIC LACTIC COCCI GOR.

In the holes of every plate there are the following serial dilutions of penicillin: O.U./ml.: from *A* to *H*, 100, 25, 10, 2, 1, 0·4, 0·2, 0

This method, devised for the fuller study of the properties of the acid-proteolytes, has led to the following interesting observation: around all the cloudy circles of inhibition, zones of increasing clearness are noticed in regard to the rest of the slides, which I interpret as showing greater strength of proteolytic activity of the bacteria in these places.

As the photographs show, a background zone of proteolytic activity can be seen in the plates, a circle (immediately around the drop of penicillin) of non-activity, and a larger circle (around the first) of the maximum proteolytic activity. The most plausible explanation is that a zone of different bacterial activity is being dealt with. I have seen multiple concentric circles with *Staphylococcus*, too; but in the case described above they are of a regularity and clearness that require fuller study.

The investigation shows that the sensitivity to penicillin of the Gorini acid-proteolytic lactic cocci stock examined (in conformity with their great variability as stated by C. Gorini[1]) varies between a minimum of 5 O.U. for the most sensitive and a maximum of 200 O.U. for the most resisting. Tests on the liquid of a four-day milk-centrifuged culture show very little inhibitory power on penicillin not due to penicillinase but to heat-resisting substances.

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Milan. Oct. 29.

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Aerobiology on Commercial Air Routes

WHILE I was a passenger from New Zealand to the United Kingdom in September 1947, I was able to expose microscope slides on a stick held out from commercial flying boats, and I trapped as many as 143 pollen grains and 273 fungal spores on 7·5 sq. cm. of adhesive surface exposed for five minutes at 140 knots (about 160 m.p.h.). Proctor[1] outlines a number of complicated constructions for exposure of slides from aeroplanes; but the simple method I have used makes it possible for biologists travelling as ordinary passengers on commercial aircraft to contribute to our knowledge of aerobiology. The method is due to a suggestion by Mr. E. A. Madden of the Department of Scientific and Industrial Research, New Zealand, to run a leading wire before the slides to break up the pressure cone, and to streamline the stick behind in order to prevent turbulence from increasing its apparent width. At the lower speed of their aircraft, this may not have been necessary for the single slides of Polunin *et al.*[2] and of Stakman *et al.*[3]; but the larger surface of Stakman's multi-slide trap may have required some such provision, and hence its poorer performance. My exposures were made through the astro-hatch of the Empire-class flying boat *Aotearoa*, over the Tasman Sea, and through the window of the steward's pantry on the Hythe flying boat, *Hobart*, thereafter.

Using nutrient agar (a potato-dextrose agar with addition of protein, etc., used in and supplied by the Laboratory of the Wellington (N.Z.) Public Hospital; commonly used for *Brucellus abortus*, and recommended for a wide range of organisms) on the slides, and establishing controls over every phase of the operation, I have obtained very few colonies growing: a different strain of *Cladosporium herbarum* Link ex Fr. (kindly identified by Mr. H. A. Dade, assistant director, Imperial Mycological Institute (letter dated Oct. 14, 1947)) over each of the Gulf of Carpentaria, the Island of Sumbawa and the Strait of Bonifacio, while 200 miles off Sydney, over the Tasman Sea, some eight colonies (of four or five different kinds) of organisms appeared (identifications are awaited from Sydney). The methods used may have missed some possible colonies, but this scarcity of viable (on that agar) organisms (six other exposures were made, but without growths) contrasts with the profusion of growths on the Petri dishes (of unstated size) exposed by Polunin *et al.*[2] in the Arctic. Their still unwrapped dishes, however, were no control whatever for the probable contamination from the arm (sleeve ?) along which they slid the lid of the dish during exposures. My agar surface was about 10 sq. cm.

The chief results of my work will be from slides carrying an area of 7·5 sq. cm. of glycerine jelly, containing a little carbol fuchsin. Prepared in the way usual for allergy studies, where only large numbers are significant, these slides showed a little contamination. For studies such as the present one, where small numbers are significant, more rigorous methods of preparation should be used. The slides were stored under 'Cellophane' arranged so that successive removals left the remaining slides still protected from dust. A cover-slip was added after exposure. Out of the ten exposed slides and four controls, only the three from the Tasman Sea and one control have been examined in detail to locate the objects caught. An analysis of these slides is as follows:

Slide number and position	61, control covered at Cambridge	51, at 2,100 ft. 37° 08′ S.; 173° 40′ E. 50 miles off N.Z.	52, at 4,500 ft. 35° 58′ S.; 163° 00′ E. 700 miles off Aust.	53, at 4,000 ft. 34° 40′ S.; 155° 20′ E.† 210 miles off Aust.
Pollen grains	4	2	16	143
Fungal spores	1	3	14	273
Pieces of hypha	0	1	2	26
Other biota*	8 (+ 15)	11 (+ 17)	14 (+ 19)	47 (+ 11)
Total	28	34	65	500

* Mites', etc., eggs were reported present at time of preparation. They are represented by the figure in brackets and show no correlation with exposure.

† The exposure was made 15 minutes later than this position.

Slide No. 51, so near land, should be regarded as showing no catch in view of the control slide, No. 61, the pollen grains on both being likely contaminants from the laboratory where the slides were prepared. On the meagre information available, Dr. R. G. Simmers, acting director of the Meteorological Service, New Zealand, suggests (letter dated Oct. 22, 1947) that the wind of direction 200° at the position of the slide had "likely" crossed New Zealand from south-east to north-west (that is, at a direction of 135°). Harmonizing these two directions would bring the "crossing" in the neighbourhood of the Cook Strait region. If this were so, it would explain the absence of particles here, a contrast with Erdtman's[4] near-land experience on a North Atlantic steamer crossing.

Slides Nos. 52 and 53 represent 75 and 875 pollen grains, respectively, and 70 and 1,680 fungal spores, respectively, per 100 c. metres of air, assuming that the volume of space traversed represents the volume of air 'swept'. This is a great contrast with Erdtman's[4] 0·7–18·0 (pollen and fern spores) for his North Atlantic crossing in May–June, 1937.

The routes of the air masses to which these two slides were exposed have also been indicated by Dr. Simmers. For No. 53 the air crossed the coast of Australia about 100 miles south of Sydney. For No. 52 it possibly crossed southern Victoria or even came through Bass Strait. The pollen of *Callitris* sp. was represented by 84 grains on No. 53 and 5 grains on No. 52. The flowering times and distribution of *Callitris* species, according to Ewart[5], would satisfy the route for air met by No. 53, but would require for the air of No. 52 a more direct route over southern New South Wales or a curved route from north-west Victoria or South Australia. The first route would give transport of 900 miles approximately (200 over land, 700 over sea) from southern New South Wales. The second route would give transport of about 1,200 miles, at least, from north-west Victoria. The lesser distance is distinctly greater than the 500–700 miles, depending on interpretation of wind, given by Meier[6] for living spores over the Caribbean Sea.

Other interesting objects observed were numerous spores of *Cladosporium herbarum*, many multicellular conidia of Fungi Imperfecti, about twelve rust (Uredinales) spores on No. 53, and hyphæ probably of sooty mould fungi. It should be noted that even for slide 52 the particles still had 4,500 feet to fall.

These incomplete data and simple methods are brought forward to encourage others to follow suit if opportunity arises in the form of an aeroplane journey. It is interesting also to note the possibility of employing pollen studies for elucidating paths of air masses in areas deficient in meteorological recordings, such as the Tasman Sea region.

I am indebted to the airway companies concerned and the crews of the aircrafts for their generous co-operation, and to friends who helped in the preparations. Full acknowledgment will be made in the detailed account being prepared.

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At the Botany School,
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Jan. 26.

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An Undescribed Structure in the Rodent Rhinarium

DURING a survey of the detailed sculpturing of the specialized naked integument of the mammalian rhinarium, what appears to be a hitherto undescribed tactile organ has been noted in almost all members of the Rodentia examined, except the Hystricomorpha. Developed in incipient form in the Lagomorpha, it becomes more defined in the Sciuromorpha, but attains its highest differentiation in the Myomorpha.

In most rodents the naked rhinarium is comparatively restricted and frequently partially or completely overshadowed by folds from neighbouring hair-clad parts of the muzzle. But the internarial septum and the immediate margins of the nares are generally free from hairs or at least glabrous. At the medial angle of the narial opening is a more or less raised area of rounded or oval outline. Relatively little raised in *Lepus* and *Oryctolagus*, it becomes more prominent in Sciuromorpha and Myomorpha, encroaching upon the internarial region sometimes to the extent of being separated from its fellow merely by a median vertical sulcus.

The surface of the above-mentioned elevation is variously sculptured in different species. In *Sciurus* it is merely papillated. In the Lagomorpha the anterior two thirds is finely papillated, the papillæ being arranged in longitudinal rows, but on the posterior third the papillæ appear to have fused to form a series (five to six) of longitudinal ridges closely simulating the papillary ridges of the Primate cheiridium. In the Myomorpha the whole surface is definitely ridged in the same manner as the Primate hand, the pattern being generally a simple one. In *Rattus norvegicus*, for example, there is an arrangement in arches, with their summits directed medially. In at least one genus, *Lophiomys*, a suspicion of a triradius was observed. It remains to be seen what degree of individual variation, if any, occurs in the pattern. The nature of the nerve endings in this specialized apparatus will also require investigation.

Details are being published elsewhere.

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Chromosome Number of *Cardamine pratensis*

THE chromosome number of *Cardamine pratensis* L. has been investigated by a number of cytologists and, as is shown in the table, several numbers have been reported.

Author	Locality of specimens	Somatic chromosome number
Manton[1]	Cambridge	*c.* 32
Manton[1]	Double varieties from botanic gardens	*c.* 64
Lawrence[2]	Merton, London	30
Flovik[3]	Spitsbergen	64
Lövkvist[4]	Southern Sweden	30, 56, 60, 64, 68, 72 and 76

The work of Lövkvist is of considerable interest in that he found a relationship between chromosome number and dampness of habitat; plants with 30 chromosomes being found in the higher parts of meadows, plants with 56–68 chromosomes being found in the lower parts and plants with 72 and 76 chromosomes near or in the water. This work also suggested that chromosome counts of wild British plants might be interesting.

Plants from three localities near Cambridge (Grantchester Meadows, Milton and Wicken Fen) and one plant from High Lane, Cheshire, have now been examined. All these have been found, from second metaphase plates of pollen mother cells (Feulgen stained squashes), to have a chromosome number of $n = 28$ (that is, a somatic chromosome number of 56). All these plants came from rather wet situations, and it also appears that Lawrence's material from the John Innes Horticultural Institution's garden came from a rather dry place. There thus seems to be some confirmation of Lövkvist's findings.

The systematic position is somewhat obscure and Lövkvist goes no further than suggesting that "*Cardamine pratensis* and *C. dentata* are probably the extremes in a series of types having more or fewer traits from the one or other of the two species". Lövkvist also states that he only found meiotic irregularities in forms having 30 chromosomes. In my material, however, two univalent chromosomes were common in the 56 chromosome plants.

My thanks are due to J. P. Cooper for the High Lane plant and to V. Chapman for making the cytological preparations.

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[1] Manton, I., *Ann. Bot.*, **46**, 509 (1932).

[2] Lawrence, W. J. C., *Genetica*, **13**, 183 (1932).

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Chronometric Observations of the Song of *Fringilla cœlebs* Linn.

DURING the 1946 breeding season of the common chaffinch (*Fringilla cœlebs* L.), 5,468 observations were obtained of the song interval, that is, the time taken by the cock bird to utter his characteristic sequence of notes[1]. A split-second hand chronometer was used to record the duration of the interval to the nearest tenth of one second, and a correction was applied to eliminate the personal equation of the observer. Corrected times are considered accurate to ± 0·1 sec. No particular care was taken to ensure that successive records were obtained from the same birds, since it was desired to examine a typically representative cross-section of the local chaffinch population. Recording was made under a variety of weather conditions to assess the possible influence of certain meteorological factors on the duration and frequency distribution of the interval value defined previously.

The chief results of analysing the complete data may be briefly summarized as follows:

(i) The mean value of the song interval, based on 10-day averages of all the observations, is found to be 1·9 ± 0·1 sec. The 10-day average values exhibit a well-marked seasonal fluctuation yielding a single, flat maximum of amplitude 0·6 sec. This trend is shown by the data of Table 1.

TABLE 1. SEASONAL MARCH OF AVERAGE SONG INTERVAL

Days from onset of singing	5	15	35	55	75	105	125	135
Mean duration of song interval in tenth-sec.	15	16	17	20	22	22	20	18

By interpolation it is found that the maximum value of the mean song interval is attained by about the ninetieth day after the onset of singing. Both previous to, and subsequent to, this date the interval is shorter, the rate of variation being most rapid towards the end of the season (the marked rise observed between the thirty-fifth and fifty-fifth days most probably resulted from an abnormally low air temperature during the preceding twenty days).

(ii) Of the four meteorological factors studied in conjunction with the chronometric records, relative humidity affects the song interval most markedly.

Thus a change from moderately dry to damp air (60 to 90 per cent *R.H.*) shortened the average interval value from 21 to 18 tenth-seconds, a variation amounting to three times the observational error.[1] Air temperature, degree of cloudiness and wind-strength were found to exert a significant, though less pronounced, influence on the magnitude of the song interval.

(iii) On grouping the recorded interval values in order of frequency of occurrence, a significant pattern is exhibited consisting of at least seven dominant values which range from 0·7 sec. to 3·7 sec., and are separated by an apparently constant difference of 0·5 sec. This distribution is illustrated by the data of Table 2, where the maximum frequency of occurrence has been arbitrarily chosen as 100.

TABLE 2. FREQUENCY DISTRIBUTION OF DOMINANT INTERVALS

Days from onset of singing	Dominant interval (tenth-seconds)						
	07	12	17	22	27	32	37
5	25	100	33	25	0	0	0
75	0	8	78	100	50	8	3
135	0	26	100	44	6	0	0

The occurrence frequency of the dominant intervals undergoes a systematic fluctuation in step with the seasonal cycle of the male bird, low values occurring around the dates of onset and cessation of singing; while higher values are restricted to the period which corresponds closely with the maximum phase of sexual activity. The causes underlying the changes just described are, in all probability, highly complex. It is hoped that other workers, more qualified to appreciate the zoological aspects of the problem, may be led to undertake further research, preferably using a microphone and electronic time-base to record the song interval objectively.

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Nov. 5.

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[1] Garstang, W., "Songs of the Birds" (London: John Lane, Bodley Head, 1922).

Earliest Known Prehistoric Industry

MR. J. E. SAINTY and the late Mr. Reid Moir have reported the occasional finding, in the Sub-Crag deposits of Norfolk and Suffolk, of flint flakes which they ascribed to human manufacture. Being so sporadic, these flakes have been doubted by some (including myself) as definite indication of the presence of man or of a man-like form. My own doubts have been completely dispelled by the discovery of an excellent flake industry at this horizon occurring at five different sites near Cromer.

The industry consists mostly of side-bulb flakes produced in two fashions. They have been struck freely from undifferentiated asymmetrical and pebble cores, of the Clactonian form I have described elsewhere as the most primitive; or they have been produced by the bi-polar technique, splitting a fresh flint cobble by placing it upon another as a stock and striking with a third as a hammer. (These techniques should not be confused with the peculiarly misnamed 'block-on-block technique' said to be typical of the free-flaking Clactonian *sensu stricto*.) Most of the flakes have, necessarily, much cortex remaining on the reverse surface, but some show preparatory working associated with pebble cores.

Retouch is always from the flake surface, either free, with small 'running' flake scars, or step, closely similar to the typical Moustierian. Indeed, one specimen shows a perfect convex working edge as good as most Moustierian side scrapers. Other forms of working edge are deep and shallow single notches, points, double notches and abrupt-nosed ends. Small elongated cobbles, broken across, have been retouched on the scar edge like the so-called Darmsdenian, and large simple and asymmetrical cores have been used as hammers and choppers. One site, 13 ft. by 2 ft. 4 in. deep, has yielded an assemblage of more than three hundred flakes and tools distinctly reminiscent of the modern Tasmanian. I may add that my selection was most rigorous, involving the rejection of all pieces not certainly flakes, or showing flake scars.

The stratum, resting on Chalk, is a sub-aerial accumulation of flint cobbles weathered out over a long period and held together by sand and occasional clay, and is immediately overlain by the marine Weybourne Crag and by the Cromer Forest Bed series undisturbed with, in places, nearly 200 ft. of Pleistocene boulder clays, conglomerates, gravels, sands and loess-clays yielding palæolithic, and on top, later artefacts. Reid Moir traced the horizon beneath the Red Crag of Ipswich, making it the equivalent of the 'Stone Bed'. If this is so, the industry is pre-Pleistocene, assuming the base of the Pleistocene to be the Red Crag, the equivalent of the Rousillon, Astian and Tatrot, first glacial, and the Norwich Crag the equivalent of the Séneze, Villafranchian and late part of the Tatrot (Pinjor being first interglacial). The industry cannot be later than first glacial, but on several grounds it is most likely pre-Pleistocene.

We may confidently believe that here in East Anglia we have the most extensive sequence of prehistoric remains, and by far the earliest 'man'-made industry known to archæologists and geologists, opening up a new field of speculation on the antiquity of man.

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Nov. 20.

Combined Radar, Photographic and Visual Observations of the Perseid Meteor Shower of 1947

DURING the past two years, considerable attention has been given to the radar reflexion from the ionization produced by meteors in our upper atmosphere. Significant results using frequencies of 2·7–212 mc./s. have been published by a number of investigators in both Britain and the United States[1]. In these papers there has been a general lack of any large quantity of correlated visual data giving the accurate times and positions of the meteors in the sky.

In August 1947 the Dominion Observatory in Ottawa and the National Research Council of Canada collaborated in an effort to secure correlated radar, visual and photographic records of meteors. The radar equipment was designed and operated by the National Research Council; the visual and photographic programmes were carried out by the Dominion

Observatory. The radar operated on 32·7 mc./s., with 150 kW. peak power, 8 microsec. pulse width, and receiver sensitivity of 5 × 10^{-14} watt. Both transmitter and receiver employed simple horizontal dipoles oriented north–south. An *A*-scope display was used for monitoring, while a range–time display on a long-delay screen cathode ray tube was employed for recording and photographing the echoes. Visual meteors were plotted and timed to the nearest second by six experienced observers. The direct and spectrographic cameras were equipped with a synchronously driven rotating shutter covering the lens ten times per second. The radar transmitter and receiver and the main visual and photographic stations were at the radio field station of the National Research Council, four miles south of Ottawa. A secondary visual and photographic station was operated at Luskville, Quebec, twenty-two miles distant. In a total of approximately thirty hours of observation on the five nights, August 9–14, 3,700 radar echoes, 1,100 visual meteors, and 20 meteor photographs were recorded.

A total of 101 radar echoes with durations of 5 sec. or longer coincided in time (mean effective time difference 1·5 sec.) with the brighter visual Perseid meteors, mean apparent magnitude 0·5. Statistical considerations indicate that not more than three of the above number might be chance coincidences. The mean echo duration was longer for the brighter meteors, and the correlation between the radar range and the visual altitude indicated that the radar echo originated at the position of the visual meteor. If α is defined as the elongation from the radiant, meteors moving head on will have $\alpha = 0°$; those moving at right angles to the line of sight, $\alpha = 90°$. The distribution of this group of meteors with respect to α was fairly uniform, being roughly proportional to the corresponding area of visible sky (see Table 1).

TABLE 1. DISTRIBUTION OF METEORS WITH RESPECT TO α

α	0°		10°		20°		30°		40°		50°		60°		70°		80°		90°		100°		110°		120°		130°
No.		3		4		5		5		13		11		15		13		10		13		1		6		2	

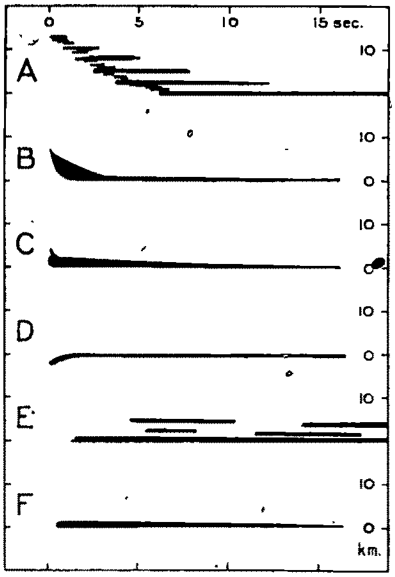
The corresponding echoes were divided into six empirical types, based on their appearance as photographed on the range–time display. The general form of each type has been sketched in the accompanying diagram. The average characteristics of the echo types have been listed in Table 2.

TABLE 2. MEAN CHARACTERISTICS OF RADAR METEOR ECHOES

Type	No. of meteors	Elongation from radiant (α in deg.)	Apparent visual magnitude	Echo duration (sec.)	Range (km.)	Total change in range
A	7	47 ± 2*	0·4	35	126	13
B	15	72 ± 2	0·9	17	140	7
C	4	74 ± 3	0·6	19	132	5
D	12	94 ± 2	1·0	23	171	3
E	19	50 ± 3	− 0·4	63	150	
F	44	5 to 125	0·7	26	160	

* Probable error of the mean.

The following additional observational facts appear evident from an examination of the echo photographs. Two basic types of echo seem to be present: (1) An echo which shows a continuous change in range, either decreasing or increasing, and which appears simultaneously with the visual meteor. Velocities deduced from this type of echo average well below the Perseid velocity of 61 km./sec., and the echo is generally restricted to meteors with α between 60° and 120°.



(2) A long-enduring echo at a discrete range (for brighter meteors several of these echoes at different ranges) which appears after the visual meteor with delays ranging from 1 to 12 sec. and which is present for all the meteors considered.

The total change in range found for the first type of echo decreases as α approaches 90°. It corresponds consistently with reflexion from a meteor path-length of about 20 km. For meteors with α near 90°, there is little or no spread in range and, though both the basic types of echo may be present, it is difficult to resolve them. The overall mean height for echoes of the second type was 99 km. and the average height difference between two echoes from the same meteor was 5 km.

Radar echoes lasting less than 5 sec. were twelve times as numerous as those of longer duration; but for these short echoes there was no significant correlation with the visual meteors in time of appearance. A total of fifty-four meteors, first magnitude and brighter, gave no echo at all on the radar.

The data presented above indicate that the strong, enduring radar reflexion from meteors is not restricted to the neighbourhood of the point where the meteor is travelling perpendicular to the line of sight. Hence, an explanation other than the geometrical one proposed by Hey, Stewart, Lovell and others must be sought to explain the discrete ranges observed. It seems logical to assume two different mechanisms for the production of the effective radar targets. The theory outlined by previous investigators would, with some modifications, account for the first basic echo type. To explain the second type a reasonably satisfactory phenomenological theory can be evolved by postulating the existence of discrete layers (fine structure) in the region in which the meteors appear. These layers are more highly susceptible to ionization from some agency (for example, ultra-violet light emitted by the meteor) than are the inter-layer spaces. Delays in the growth of the layer ionization clouds can account for the principal phenomena observed in the long-enduring echoes and might, for the short echoes, explain the lack of coincidence in time with the visual meteors. The layer theory is consistent with the sharp cut-off at minimum slant range found by Appleton and Pierce for the Giacobinid meteors.

It is not feasible to attempt to compress all the experimental data or the tentative theoretical conclusions into a short letter of this nature.

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Dec. 8.

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[1] Bateman, R., McNish, A. J., and Pineo, V. C., *Science*, **104**, 434 (1946). Pierce, J. A., *Phys. Rev.*, **71**, 88 (1947). Appleton, Sir Edward, and Naismith, R., *Proc. Phys. Soc.*, **59**, 461 (1947). Hey, J. S., and Stewart, G. S., *Proc. Phys. Soc.*, **59**, 858 (1947). Papers by Prentice, J. P. M., Lovell, A. C. B., and Banwell, C. J., and by Lovell, A. C. B., Banwell, C. J., and Clegg, J. A., *Mon. Not. Roy. Astro. Soc.* (in the press).

THE results obtained by Dr. Millman and his colleagues represent an important contribution to the study of the complex radio echo phenomena which are observed on wave-lengths longer than 8 m. Recent unpublished British work has a significant bearing on some of the issues raised and a short summary may be appropriate.

Effect of Radio Wave-length. Simultaneous observations on two or more wave-lengths have been made of the transient echoes originating in the 100 km. region of the atmosphere, from which it appears that a striking change occurs as the wave-length is decreased from 8 m. to 6 m.[1]. Above 8 m. a very large number of radio echoes are observed independently of the presence of a major meteor shower of the 'visible' type. These echoes show a marked diurnal and seasonal variation[2,3], and are believed to be due to a uniform distribution of minute dust through which the earth is passing. As the radio wave-length is decreased, this high echo-rate disappears, and, on 6 m. and less, the transient echoes arise only from the meteors associated with the visible streams emanating from definite radiants.

Aspect Sensitivity and the Scattering Process. On wave-lengths less than 6 m. the main radio echo is obtained only when the meteor crosses the perpendicular from the station to the trail. This is immediately evident when observations are made with a highly beamed aerial system. Thus, near the peak of the great 1946 Giacobinid shower, a directional aerial system was turned into the radiant instead of at right-angles to it, and the echo-rate fell from 50 per minute to less than 0·1 per minute, although at that time the sky appeared to be full of meteors[4]. This aspect sensitivity, and the change in scattered power with wave-length from the same meteor trail, can be explained if the electrons are created by the meteor in the form of a long column of diameter small compared with the wave-length[5]. It has been realized, however, that this picture does not succeed in giving a satisfactory account of the much more complicated phenomena in the wave-length range greater than 8 m., and as Dr. Millman and his colleagues suggest, additional scattering processes must be invoked to explain the high echo-rate from invisible meteors, and the lack of aspect sensitivity.

It seems clear that in the present state of our knowledge the astronomy of the meteor streams can only be studied satisfactorily on wave-lengths less than 6 m., where the aspect sensitivity of the trails can be used to delineate radiant points by such methods as devised by Hey and Stewart[6], and Clegg[7], and where the observed echo-rates bear a very close relation to the visible meteor-rate.

The complex phenomena on longer wave-lengths are not yet understood, and further information of the Canadian experiments will be awaited with much interest.

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Feb. 6.

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[4] Lovell, Banwell and Clegg, *Mon. Not. Roy. Ast. Soc.*, **107** (1947) (in the press).

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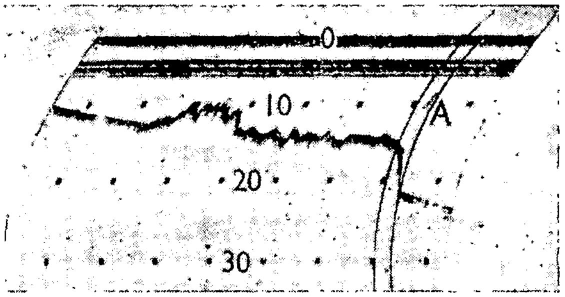
[7] Clegg (in the press).

A Submerged Ancient Cliff near Plymouth

ECHO soundings, made on the Marine Biological Association's research vessel *Sabella*, have revealed a submarine cliff, suggesting an ancient shore line, about two miles south-south-west magnetic from Plymouth Breakwater Lighthouse (see record reproduced). The height of the cliff at the section is about 33 ft., its foot rests at about 22 fathoms below the level of low water springs, while the gradient is of the order 1 in 3.



PORTION OF ECHO-SOUNDING RECORD ON COURSE S.S.W. MAGNETIC FROM PLYMOUTH BREAKWATER LIGHTHOUSE

A vertical line below the ship is represented by an arc of a circle. The distance between two dots along an arc represents ten fathoms, while the distance between two dots along a horizontal line represents the passing of 3 min. or about 650 ft. run by the ship at a quarter speed

The record of the bottom landward of the submerged cliff in 15 fathoms or less is irregular, suggesting a surface of sub-aerial denudation which has not yet been completely covered with recent deposits. Seaward of the cliff the record, with others, shows a gently sloping smooth platform suggesting a wave-cut beach possibly covered with some recent sediments. Sections across the submerged part of the Eddystone show a very rugged topography; nonetheless, there are indications at several points of the foot of a wave-cut cliff at 24 fathoms.

The formation of such a cliff would seem to need a fairly prolonged stand of the sea at a level about 22 fathoms (40 m.) lower than that of to-day, or perhaps a few fathoms lower still. If similar cliffs exist elsewhere in the English Channel, their further study may help to solve problems of sea-level during the regressions of the sea in the Pleistocene Ice Ages.

Directly above the cliff at the point marked *A* the record of a shoal of fish may be seen. The fish are reminiscent of birds soaring above a cliff in an ascending current of air. The time was within five minutes of low water at Devonport.

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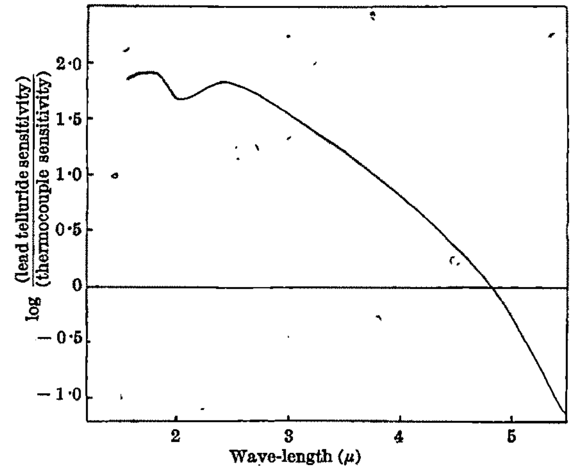
Lead Telluride Cells for Infra-Red Spectroscopy

FOLLOWING the successful development[1,2] of lead selenide photoconductive cells for the detection of infra-red radiation, we have now extended this work to lead telluride. It was known from very incomplete information that experimental cells of this material were made in Germany during the War[3] and showed some response as far as 5·8 μ, that is, considerably farther than lead selenide. However, no information was available to us on the method of preparation, nor on their performance, and it may be presumed that the absolute sensitivity was poor, in view of the widespread use in Germany of the lead sulphide cell in spite of its restriction to wave-lengths shorter than 3 μ.

As the evaporation method was used, one of the main problems was to find a window material for the base of the cell which would transmit radiation to at least 6 μ. After experimenting with various alternatives, including evaporation from small heating coils, an extremely simple solution has been found, namely, to make use of thin bubble windows similar to those used in certain ultra-violet work. It has been found that flat windows of glass approximately 20 μ thick transmit more than 90 per cent of any radiation between the visible and 8 μ, and that 'hemispherical' windows can be made which are sufficiently strong to withstand atmospheric pressure, and transmit freely to beyond 6 μ. Although some distortion of the beam occurs in passing through such a window, our results show that the effect of this on the performance of the cell is negligible.



The lead telluride cells show no photosensitivity at ordinary temperatures, and so far all the observations have been made at the temperature of liquid air. The response curve of one telluride cell to various wave-lengths is shown in the accompanying graph, in which the ordinate represents the logarithm of the ratio of the cell response to that of a Hilger–Schwarz vacuum thermocouple, the comparison being made in the same manner as for lead selenide[2]. It should be noted that at its maximum the sensitivity of the lead telluride cell is about a hundred times that of the thermocouple, that is, much the same as for the best lead sulphide cells[4]. Although the maximum of sensitivity shown by this cell lies between 2 and 3 μ, it is superior to a thermocouple up to 4·6 μ and some sensitivity is exhibited so far as 5·5 μ. As experience is gained with these cells, it may well be possible to control the position of maximum response and cause it to move to between 4 and 5 μ, as reported in the German work[3]. The time of response of these lead telluride cells is of the order of 10^{-4} sec., which is about the same as lead sulphide. It is important to note that the selenide cells which were much more rapid in response (about 10^{-5} sec.) were much less sensitive. It seems probable that there is a reciprocal relation between time of response and sensitivity for detectors of this class.

This note is primarily intended to indicate the potentialities of cells of this type for spectroscopic work, where they are clearly far superior to sulphide and selenide; full details of the method of preparation and of the properties of these cells will be published shortly.

It may be added, however, that an independent measurement of the sensitivity at 2·2 μ of a cell similar to the one used for the above tests gave a figure of 2×10^{-14} watt as the equivalent noise input (signal/R.M.S. noise) for a band width of 1 c./s. The area of the receiving surface was approximately 1 mm.^{2} and the time of response $1{\cdot}5 \times 10^{-4}$ sec.

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Laboratories,
Cambridge. Jan. 8.

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[2] Blackwell, D. E., Simpson, O., and Sutherland, G. B. B. M., *Nature*, 160, 793 (1947).

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High-Frequency Characteristics of Lead Sulphide and Lead Selenide Layers

RECENT work on the photoconductive effect in lead sulphide layers has suggested that the origin of both the high resistance and the photoconductive effect is in the intercrystalline barriers existing in such layers[1,5].

Impedance measurements have been made on lead sulphide and lead selenide photoconductive cells at frequencies high enough to ensure the substantial short-circuiting of these barriers. In all cases so far investigated, it has been found that as the frequency of measurement is increased the shunt resistance component of the cell impedance decreases until at about 60 Mc./s. a steady value is reached equal to a fraction of the D.C. value at room temperature. If the cell is cooled to the temperature of solid carbon dioxide (194·5° K.) or liquid oxygen (90° K.), the D.C. resistance increases exponentially in the usual manner found for semi-conductors, while the high-frequency resistance is only slightly affected. Either a small positive or a small negative temperature coefficient of high-frequency resistance is obtained, and the high-frequency behaviour is essentially semi-metallic.

For all the layers studied, the photoconductive effect decreased with increasing frequency, finally disappearing at frequencies high enough for the cell resistance to have reached a constant value.

These effects are illustrated in Figs. 1 and 2 for a lead sulphide cell which had been manufactured by a vacuum evaporation process.

Fig. 1 illustrates the variation of cell resistance with frequency at two temperatures, measurements being made with the cell illuminated and unilluminated.

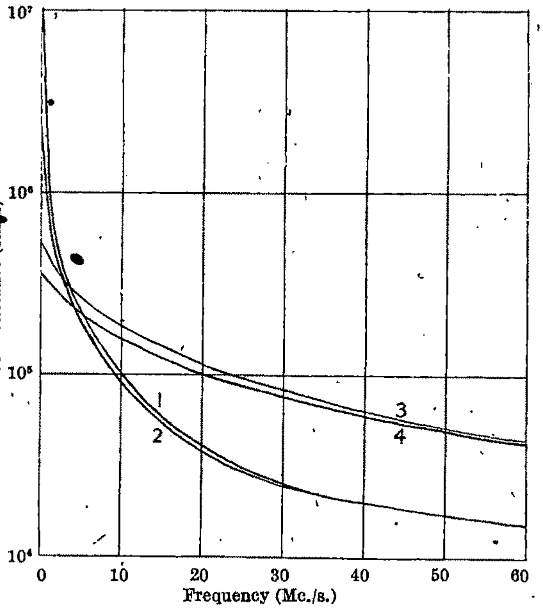


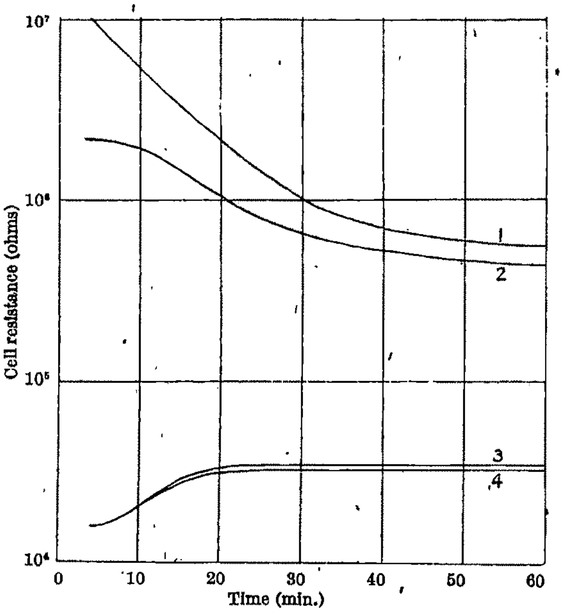
Fig. 1. Curves 1 and 2 ; 194·5° K., cell in darkness (1), illuminated (2).
„ 3 „ 4 ; 297° K., „ „ „ (3), „ (4).

Fig. 2 gives an indication of the variation of cell resistance with temperature at low- and high-frequencies. The direct variation of cell resistance with temperature has not yet been determined at the high frequency, so it is hoped to make this the subject of a future experiment.

On the basis of the above results it would seem reasonable to draw the following conclusions :

(*a*) The presence of the photoconductive effect is associated with the intercrystalline barriers, as it disappears when these are short-circuited.

(*b*) The microcrystals constituting the photoconductive surface the impedance characteristics of which are measured at high frequencies are themselves semi-metallic in nature, thus indicating a high impurity content, resulting in energy-levels near the conduction band ; this fits in well with the measurements made by Dunaer[2] and Bauer[3] on single crystals.



CELL WARMING FROM 194·5° K. TO ROOM TEMPERATURE (297° K.)

Fig. 2. Curves 1 and 2 ; 1590 cycles, cell in darkness (1), illuminated (2).
„ 3 „ 4 ; 50 megacycles, „ „ (3), „ (4).

One apparent anomaly should be mentioned. Approximate values for the layer dimensions are length = 1 cm. ; width = 1 mm. ; thickness = 3×10^{-4} cm. Taking a high-frequency value for the resistance of 3×10^4 ohms, we find for the conductivity of the microcrystals a value of 0·01 ohm^{-1} cm.$^{-1}$ approximately.

This is of the order of a thousand times less than the usual values for impure semi-metallic single crystals[4]. Some explanation for this may perhaps lie in the fact that owing to the random size and shape of the microcrystals, the effective contact area of the crystals is considerably smaller than the size of the crystals themselves.

The above work was carried out in the laboratories of the Telecommunications Research Establishment (Ministry of Supply), and thanks are due to Mr. P. Handley (University of Oxford) and Mr. J. Newton (University of Cambridge), who assisted with the measurements described during their summer vacation.

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Nov. 20.

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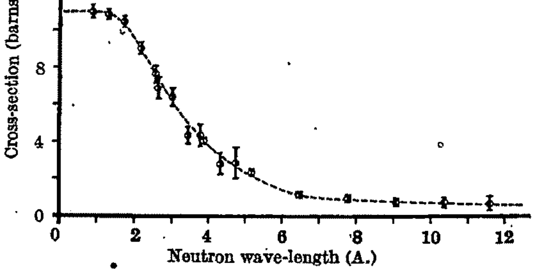
Scattering of Neutrons by Lead

THE University of Cambridge cyclotron and neutron velocity selector have been used for studying the scattering of neutrons by lead. The scattering cross-section as a function of the neutron energy was determined by measuring the number of neutrons scattered out of a collimated beam into a boron trifluoride counter placed near a cast lead scatterer. Neutrons scattered through angles between 30° and 150° (approximately) were counted.

The results show that the scattering cross-section, which is assumed to be 11 barns (1 barn = 10^{-24} cm.^{2}) at short neutron wave-lengths, drops to a value of 0·6 ± 0·3 barn at wave-lengths greater than about 6 A., owing to the microcrystalline structure of the lead.

No scattering should occur at long wave-lengths from an ideal lattice composed of identical coherent scattering centres. The observed residual scattering is the sum of contributions arising from thermal



vibrations, crystal defects, the presence of isotopes, and the different orientations of the nuclear spin. The experiment, therefore, fixes an upper limit to the residual scattering caused by the presence of several isotopes in lead:

$$s_{is} \leqslant 0{\cdot}6 \pm 0{\cdot}3 \text{ barn},$$

which does not disagree with the upper limits of 1·6 and 2·5 barns set by transmission measurements[1,2].

If we use the scattering length a as defined by Fermi[3], the normal random scattering cross-section is given by

$$\sigma = 4\pi \sum_r p_r a_r^2,$$

and the coherent scattering cross-section relevant in single crystal diffraction is

$$\mathbf{s} = 4\pi\Big(\sum_r p_r a_r\Big)^2.$$

The three cross-sections are related by the simple equation:

$$s_{is} = \sigma - \mathbf{s} = 4\pi(\overline{a^2} - a^2).$$

Since s_{is} is so small, it is evident that the minimum value of $\mathbf{s}$ is about 10 barns, and so the scattering lengths of all the major lead isotopes must be nearly equal. This is reasonable, since the small capture cross-section shows the absence of nearby resonances.

This result is in disagreement with the tentative value for $\mathbf{s}$ of 2·9 barns deduced by Fermi and Marshall[3] from measurements on a lead sulphide crystal. Substitution in their results of form factors modified in accordance with $\mathbf{s} = 10$ barns certainly gives an uneven decrease of intensity with order of reflexion, and it is not clear at present how this arises.

R. LATHAM
J. M. CASSELS

Cavendish Laboratory,
Cambridge. Nov. 14.

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Production of Nitrogen Atoms in the Upper Atmosphere

EVIDENCE has accumulated in recent years that nitrogen is at least partially dissociated in the upper atmosphere. However, thus far the precise process causing the dissociation of nitrogen has not been established, except that it has been suggested that only the extremely short ultra-violet beyond 500 A. could produce it[1].

Recently, R. Herman[2], under certain conditions of discharge, found a breaking off above the level $v' = 6$ in the Lyman–Birge–Hopfield ($a-X$) bands of nitrogen. We have confirmed this breaking off in nitrogen excited at low pressure in a high-frequency electrodeless discharge. The appearance of our spectra leaves no doubt that we have here a predissociation of the N_2 molecule. The predissociation limit is between the levels $v' = 6$ and 7 of the $a\ {}^1\Pi_g$ state at an energy of approximately 9·8 eV., which agrees closely with the energy necessary to dissociate N_2 into $N({}^4S)$ and $N({}^2D)$, assuming $D(N_2) = 7{\cdot}38$ eV. The $a-X$ bands are the only absorption bands of N_2 above 1150 A. (see Birge and Hopfield[3]). The absorption is comparatively weak, since the bands represent a forbidden transition (see G. Herzberg[4]).

The $v'' = 0$ progression has been observed in absorption from the 0—0 to the 9—0 band. The 7—0, 8—0 and 9—0 bands have the wave-lengths 1249·3, 1226·6 and 1205·3 A. respectively. Absorption of solar radiation of these wave-lengths will lead to the production of nitrogen atoms in the upper atmosphere, since the molecules in the upper levels will undergo predissociation. The observation that in the laboratory the predissociation becomes noticeable only at low pressures indicates that the predissociation is a forbidden one. Nevertheless, in the upper atmosphere, a considerable fraction of the excited molecules will predissociate rather than return to the ground-state with emission of fluorescence.

On account of the comparatively low transition probability of the a—X bands, the formation of nitrogen atoms according to the above mechanism will go on over a very considerable range of heights, particularly since in the region 1150–1250 A. absorption by oxygen molecules is comparatively weak. It is thus possible to account both for the presence of nitrogen atoms at comparatively low heights and for the presence of nitrogen molecules at much greater heights (as observed in auroras).

While it is conceivable that nitrogen atoms may also be produced at much shorter wave-lengths through different mechanisms, we feel, in view of the much greater intensity of solar radiation at 1200 A. than at the shorter wave-lengths, that the mechanism here established is by far the predominant one.

The production of nitrogen atoms by predissociation in the a—X bands is independent of the correctness of the value of $D(N_2)$ assumed above. If one assumes Gaydon's value[5], the predissociation would lead to two normal atoms rather than one normal and one excited atom. However, it may be mentioned that the type of predissociation observed points strongly to the lower dissociation energy. Experiments are in preparation to settle this question definitely.

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Oct. 29.

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[1] See Wu, T. Y., *Phys. Rev.*, **66**, 65 (1944).

[2] Herman, R., *C.R. Acad. Sci. Paris*, **217**, 141 (1943); *Ann. de Phys.*, (11), **20**, 241 (1945).

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Calculation of the Piezo-electric Constants of α- and β-Quartz

α-QUARTZ possesses only two piezo-electric constants, ε_{11} and ε_{14}, given by the equations

$$\left.\begin{aligned} p_x &= \varepsilon_{11}(u_{xx} - u_{yy}) + \varepsilon_{14}u_{yz} \\ p_y &= -\varepsilon_{11}u_{xy} - \varepsilon_{14}u_{xz} \\ p_z &= 0 \end{aligned}\right\}, \qquad (1)$$

where p_x, p_y, p_z are the electric moments per unit volume developed on strain along the axes of the crystal, and u_{xx}, u_{xy}, etc., the components of strain. β-Quartz, which possesses a higher symmetry, has only one constant, ε_{14}, the other, ε_{11}, being zero. A method of deriving the above equations from the structure of the crystal, that is, the co-ordinates of the atoms in the unit cell, is not known. While the earlier work of Curie[1] (1882), Riecke[2] (1892) and Kelvin[3] (1893) is purely speculative, Gibbs[4] (1926) calculated the piezo-electric modulus δ_{11} on the basis of his structure and obtained a value which is nearly five times too high. Moreover, he did not calculate the other constant, δ_{14}, and did not show how the above equations can be obtained from his co-ordinates. We have been able to derive the above equations from the structure of Gibbs and have in this way obtained values of ε_{11} and ε_{14} which agree completely with the observed values. The piezo-electric constant ε_{14} of β-quartz and the variation of ε_{11} and ε_{14} with temperature in the case of α-quartz has also been calculated.

α-Quartz is a crystal with covalent bindings. The electric moment may therefore be supposed to arise from the displacements of the silicon and oxygen atoms in close neighbourhood. As each silicon is linked to four oxygens and each oxygen to two silicons, six Si—O bonds—there are twelve Si—O bonds in the unit cell—will correspond to a charge k_1e on each atom and the remaining six to a charge k_2e. In β-quartz, k_1 is equal to k_2, since all the bonds are equivalent.

It can be shown that in a general elastic deformation, the changes in the length of a line after strain, and the changes in the angles between two lines after strain, are completely given in terms of the strain components u_{xx}, u_{xy}, etc., and are independent of the rotation components ω_x, ω_y, ω_z (*vide* Love[5]). Any change Δr in the length of an Si—O bond would produce a moment $ke\Delta r$ in that direction, but the direction cosines of the line after strain are not known, since they involve the rotation components ω_x, ω_y, ω_z. We therefore take three points P, Q, R, such that P and R are silicon atoms and Q an oxygen atom, or *vice versa*, and resolve the electric moments due to the displacement of atoms in the plane of the Si—O bonds, PQR and perpendicular to this plane.

Since the components of strain u_{xx}, etc., are very small quantities, it is easy to show that the moments in the plane PQR may be regarded as produced by a change in the bond directions before strain, and the moment normal to the plane may be taken as half the value of the moment normal to the plane when the displacements of the atoms P, Q, R are entirely normal to the plane. This would be justifiable, since in an elastic deformation of the unit cell, the moments due to 36 O—Si—O planes and 6 Si—O—Si planes have to be considered.

If l, m, n are the direction cosines of Si—O bonds, and p, q, r of the normals to the various planes, we get in summing over all these planes:

$$p_x = \frac{e}{v}\left[\overset{\text{12 Si—O bonds}}{\Sigma}\, k\,.\,\Delta r\,.\,l\right] +$$

$$\frac{e}{8v}\left[\overset{\text{18 O—Si—O planes and 6 Si—O—Si planes}}{\Sigma}\left\{\frac{k_1+k_2}{2}\,(\Delta r_1 - \Delta r_2)\cot\alpha\; + \right.\right.$$

$$\left.\left.\frac{k_1-k_2}{2}\;\frac{r_3\,\Delta r_3 - r(\Delta r_1+\Delta r_2)\,(1-\cos.2\alpha)}{r\sin 2\alpha}\right\}p\right];$$

with similar expressions for p_y and p_z; here $PR = r_3$; Δr_1, Δr_2, Δr_3 are the variations of PQ, QR and PR; $r = PQ = QR$; $\angle PQR = 2\alpha$; $v =$ the volume of the unit cell.

These expressions resolve into equations (1) by giving p, q, r suitable signs. The calculation shows that the moments in the plane of the Si—O bonds (the first part of the above expression) make no contribution to the transverse coefficient ε_{14}. Assuming that the moments normal to the plane of the bonds give no contribution to the longitudinal coefficient ε_{11}, we find that if $\varepsilon_{11} = 5{\cdot}1 \times 10^4$ we get $k_1 = 0{\cdot}752$, $k_2 = 0{\cdot}695$, and $\varepsilon_{14} = 1{\cdot}23 \times 10^4$, in complete agreement of the observed values.

A similar calculation when applied to β-quartz gives $\varepsilon_{11} = 0$, and $\varepsilon_{14} = 1{\cdot}07 \times 10^4$ for a non-ionic crystal ($k = 0{\cdot}724$) and $1{\cdot}47 \times 10^4$ for an ionic crystal ($k = 1$). If the moments perpendicular to the plane of the bonds are supposed to give no contribution to the longitudinal coefficient, we find $k_1 = k_2$, which is the case in β-quartz. The assumption is therefore justified.

The variation of ε_{11} with temperature in α-quartz can be completely explained on the basis of change of co-ordinates with temperature. It is found that at 558° C. the silicon atoms in α-quartz occupy the same positions as they do in β-quartz. As the transition temperature is reached, the longitudinal coefficient in α-quartz drops to zero, but the transverse coefficient changes only by 12 per cent.

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Max Planck

IN a broadcast talk on Max Planck, in which whole-hearted tribute was paid to his great work, I used the words, "If I hesitate to put Planck on a level with Newton and Einstein it must be partly on the ground that he did not seem to know quite what he had done when he did it . . . Planck seems to have been reluctant to realize the range of his innovation." I was, of course, basing my opinion upon his published work. I have just received a letter from Frau Planck, his widow, who has read the talk as printed in the *Listener* of November 6, 1947, p. 811, in which she says, "You have done justice to the scientist and to the man in every respect. I should only like to make one small exception. You think that he did not realize the scope of his discovery. Yet he did do so—though of course not in all its consequences. He said to our son with whom he had gone through a book on Galileo, Newton and Kepler, 'Look, my boy, I shall one day be in a book like this'. And to our other son he spoke as Sommerfeld has set it down." The reference is to an article of Prof. Sommerfeld's (*Die Neue Zeitung*, November 6, 1947), which I have received both from her and from Sommerfeld, where the following passage occurs: "Planck realized the scope of his discovery from the beginning. This is clear from an anecdote which Professor Bavinck, who died recently, repeated to me on the occasion of his lecture at Munich this year: he had it from his friend Erwin Planck, the son of the great man. The father said to the son in 1900, on the occasion of a walk in the Grünewald, 'Today I have made a discovery which is as important as Newton's discovery'."

Naturally both these conversations were unknown to me and do not affect the point that there is nothing in his writings to indicate this early realization of the importance of his discovery. They seem to be of sufficient general interest for the historian of science to warrant me laying them before the readers of *Nature*.

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STONYHURST COLLEGE OBSERVATORY

THE closing of Stonyhurst Observatory on December 31, 1947, brings to an end more than a century of scientific work. Founded in 1838, the Observatory has been staffed and maintained by the Society of Jesus. Its first work was purely meteorological, and this has been continued throughout its existence. The Royal Society Commission, which in 1867 replaced the Board of Trade in the organisation of meteorological observations in Britain, selected Stonyhurst as one of the seven principal stations, each of which it supplied with standardized equipment and continuously recording instruments. For many years these stations formed the mainstay of British meteorology.

Stonyhurst Observatory was, however, early in its existence, to extend its activities to geophysics and astronomy. At the instance of Sir Edward Sabine, regular magnetic measurements were started by Perry in 1861, and continuous magnetic recordings a few years later. During the years 1868–70, Perry and Sidgreaves carried out an extensive magnetic survey of France and Belgium. In more recent years, seismology has also been included in the regular programme.

Astronomical work had already engaged the attention of Stonyhurst when the Observatory gave refuge to Secchi during the Italian troubles of 1848. Perry's interest in solar physics defined the direction which this work was to take. In 1881 he commenced the series of daily solar drawings, which were included in the routine of the Observatory for sixty years. To these drawings Sidgreaves and Cortie added the spectroscopic study of sunspots. In their pioneer research on the *B*—*D* region, which supplemented the work of Lockyer and Smart, they were among the first to detect molecular bands, and to identify the numerous vanadium and titanium lines. In addition, Cortie found time to use the material provided by the simultaneous solar and magnetic observations for an independent analysis of the interrelation of solar and geophysical phenomena.

During the years 1870–1914, the Stonyhurst astronomers played leading parts in a number of scientific expeditions, including both the transits of Venus (1874 and 1882), and seven solar eclipses. Astronomers will remember in particular the Royal Astronomical Society's eclipse expedition to French Guiana in 1889, which Father Perry led to a successful conclusion only at the cost of his life.

The considerable programme of solar and geophysical work and the relatively modest equipment of the Observatory made a continuous programme of stellar work impracticable. The occasional researches, mainly on the spectra of novæ, carried on within these limitations, were not for that reason desultory or ephemeral, but showed at times an eye for experimental technique of which a larger institution would not have felt ashamed. Stonyhurst was one of the few observatories to secure photographic spectra of Nova Aurigæ in 1892, the first nova to be so photographed. For this purpose Sidgreaves and Cortie used a slitless spectrograph with a collimated beam, instead of the objective prisms used at Harvard and at South Kensington. In this they anticipated Wadsworth's suggestion by a decade, and its common adoption by a still longer time. A similar ingenuity stamped the attempt to apply Orbinsky's length-of-spectrum method to the measurement, from objective-prism spectra, of the radial velocity of the expanding shell of Nova Aquilæ (1918). The astronomical work of Stonyhurst will always be associated with the name of Perry, but scarcely less credit is due to the originality of Sidgreaves, and the effective collaboration of O'Connor. While not so great an astronomer, Cortie contributed much to the spread of astronomical knowledge among a wider public.

The growing disparity between modern observational needs and the limited equipment of a private observatory has caused Stonyhurst in more recent times to return to the geophysical and meteorological work for which it was originally founded. This selfless task has been performed for many years by Father J. P. Rowland, the retiring director, whose advancing years and failing health have precipitated an inevitable though regretful decision. He will have the satisfaction of having completed a century of recording, and will terminate, temporarily at least, a line of priest-scientists whose solid achievement in their self-imposed task will be most readily admitted by their fellow physicists and astronomers.

P. J. TREANOR

THE ASSAYING OF PENICILLIN

THE first joint meeting of the Biological Methods and the Physical Methods Groups of the Society of Public Analysts and other Analytical Chemists, held on January 29 in the Barnes Hall of the Royal Society of Medicine, was devoted to methods of penicillin assay—their purpose, scope and validity. The plenitude of highly ingenious assay techniques in the chemical and physical and in the biological fields respectively were briefly surveyed by the opening speakers of the two sessions, Dr. E. Lester Smith and Dr. N. G. Heatley. A dozen or so specialized physical instruments have been pressed into service, several for more than one method, as have many more distinct chemical reactions and physical and microbiological techniques not involving instruments.

There were really two distinct problems under discussion, namely, the assay of *total* penicillin, and the assay of *individual* penicillins, at least five of which are now recognized as liable to be present in appreciable proportions in commercial penicillin supplies. It is perhaps clearer to adopt this division of the papers and discussions, rather than into non-biological and biological methods, as was done at the meeting.

Total penicillin may be assayed non-biologically with the aid of the polarograph, polarimeter, colorimeter (three methods), fluorimeter, ultra-violet spectrophotometer or Warburg manometer. Nevertheless, most of the people who do daily routine assays have simpler tastes and appear to favour the burette. Many of the other methods are now only of historical interest; the trouble with some of them is that they require more labour to carry them out than the biological methods they seek to replace, without offering adequate advantages by way of compensation. It is only fair to add that the biological methods have themselves been streamlined to cut down manipulation and improve accuracy, since some of these tests were invented in the early days of penicillin manufacture.

Two titration methods are available, each with minor variants. The first, the subject of a paper read by Miss S. J. Patterson, commends itself by extreme simplicity, being virtually a determination of saponification value. Dilute alkali quantitatively opens the β-lactam ring of penicillin in an hour or so at room temperature, whereupon the unused excess alkali is back-titrated to the cresol red end-point. The other, the iodometric method, involves somewhat more manipulation but is perhaps rather more specific; also, being much more sensitive, it is applicable, for example, to the assay of lozenges and other pharmaceutical products. It depends on the fact that the product of alkaline hydrolysis, penicilloic acid, is vigorously oxidized by iodine, consuming about eight atoms per molecule, whereas penicillin itself is not attacked: thus a blank determination, omitting only the hydrolysis step, corrects for oxidizable impurities.

The avowed object of the meeting was to discuss the "purpose, scope and validity" of the methods, and the speakers at the earlier session took this very seriously. Indeed, so frankly did they point out the limitations of their methods, that during the tea interval biologists could be heard proclaiming that their own methods remained virtually unchallenged. This, however, would be an unfair conclusion; despite the unavoidable uncertainty as to the proper factor for conversion to biological units, when assaying mixtures of penicillins, these non-biological methods have their place in routine control. They offer the advantages of speed and moderately high accuracy with a minimum of labour.

The biological methods have their shortcomings too, as we learned later; for example, when one speaker gave as an advantage of the turbidimetric over the plate diffusion methods, that it was less liable to break down completely and invalidate a whole day's assays. There are fundamentally three methods with innumerable variants. The earliest, the serial dilution method, appeared to engender depression among its devotees from the fact that the result is given by only one tube out of the six or more that must be set up for each test. Accordingly two speakers, Dr. C. G. Pope and Mr. C. R. Bond, described turbidimetric methods that appear to give greater æsthetic satisfaction as well as greater accuracy, from the fact that several tubes of the series are measured. The third group of methods, most widely used for routine control, are those depending on diffusion of penicillin from a hole in, or a cup, spot or disk of blotter upon, a sheet of agar seeded with a suitable organism, usually *B. subtilis* or *S. aureus*. A curious point was made by Dr. N. G. Heatley that merits some explanation: in the hole or cup techniques, the diameter of the ring of inhibition is controlled by the *concentration* of penicillin and not the total amount used, whereas in the spot or blotter-spot techniques, it is the *total amount* that matters irrespective of concentration. The Japanese, perhaps from a shortage of Petri dishes, apparently prefer vertical diffusion techniques, using test-tubes of seeded agar overlaid with the penicillin solution.

The biologists have the field almost entirely to themselves when it comes to assaying penicillin in body fluids. Some other methods will deal with penicillin solutions as dilute as these, but scarcely in the presence of so much interfering material, which indeed can cause errors in the biological methods too. The diffusion methods are not usually sensitive enough, unless an organism hypersensitive to penicillin is employed. Serial dilution methods are generally used, with micro tubes, capillaries or even single drops on microscopic slides.

Turning now to the determination of individual penicillins, this may be tackled by X-ray crystallography, or better by infra-red or ultra-violet spectrophotometry, as described by Dr. G. H. Twigg. The infra-red method, employing alanine or cystine as internal standard, exploits characteristic absorption bands for each penicillin species. At present it is limited to the examination of sodium salts in crystalline form, and accuracy is conditioned by the difficulty of preparing a uniform suspension of sample and standard in liquid paraffin. The other methods also have their snags and are mostly adapted to determine only one of the penicillins, usually benzylpenicillin (penicillin G or II). The few purely chemical methods have the same defect and were dismissed as of low accuracy. Much more satisfactory are the physical methods described by Dr. W. R. Boon, involving partition between buffer solutions and organic solvents, preferably ether. The very limited value of separating funnels may be enhanced by the counter-current apparatus of Craig. Complete separation of all the penicillins, however, demands chromatography on buffered silica columns or strips of filter paper, techniques developed by Dr. Boon's colleagues. He spoke of the difficulty of securing completely satisfactory separations on the silica columns (except of penicillin K), criticizing some American publications on the subject: another disadvantage is the destruction of 25 per cent or so of the input penicillin. The paper-strip method, on the other hand, can effect even the most difficult separations quantitatively under suitable conditions.

An interesting application of this technique is in checking the purity of penicillin standards. The International Standard, for example, was found to contain a few per cent of penicillins other than benzylpenicillin (G). Another application is in checking the specificity of a chemical method that has been adopted officially in the United States. It depends upon the precipitation of the crystalline salt of penicillin G with N-ethyl piperidine on adding this base to an amyl acetate extract of the penicillin, in presence of acetone. Dr. Boon stated that other penicillins are also precipitated from mixtures and that penicillin G is not obtained pure even on putting the precipitate through the process a second time. This lack of specificity was confirmed by Dr. Smith during the discussion: he had also found, using the same technique, that part of the penicillin G appears in the filtrate.

It was now the turn of the biologists to be discomfited, for their differential assay methods (using two organisms) came in for some pointed comments on account of their continued application to complex mixtures of penicillins, as well as to the binary mixtures for which they were designed. They retaliated by attempting to claim from the physicists the paper-strip microchromatographic method, on the ground that the penicillin zones are rendered visible by biological means (as zones of inhibition on seeded agar). It was, indeed, remarkable how unanimous the speakers were in praise of this method, although one wondered if this was not due more to despair of the other methods, and admiration for its originality and extreme elegance, than to any proof presented as to its accuracy. Its originators themselves admit that it is still in need of refinements and of a more precise check on its accuracy, using known mixtures of pure penicillins. Nevertheless it remains the only method capable of measuring all the penicillins simultaneously, yet simple enough for routine use.

Dr. Pope recorded the observation that nearly equal *weights* of penicillins G and K are adsorbed by suitable amounts of a washed charcoal; since the biological activities of these penicillins against *S. aureus* differ considerably, the amounts adsorbed *in units* also differ sufficiently to form the basis of an assay method. Like the differential assay methods, it is not applicable to more complex mixtures.

In vivo tests have been suggested for determination of heptylpenicillin (K) in mixtures, based on the observation that the protective value of this penicillin against experimental infections is much smaller than that of all the other common ones, namely, Δ^2 pentenylpenicillin (F or I), amylpenicillin (dihydro F), benzylpenicillin (G or II), and *p*-hydroxybenzylpenicillin (X or III). Such a test is naturally slow and expensive and of low accuracy. Its main value lies clearly in establishing the relative therapeutic efficacy of the penicillins rather than for assay of mixtures. Such work has recently produced some evidence for enhancing effects of one penicillin upon another, and also of two or three substances present in some crude penicillin supplies upon pure penicillins of all types.

Sir Alexander Fleming, opening the discussion after the second session, expressed his admiration for, and astonishment at, the galaxy of physical and chemical methods; but pointed out that the biological methods, though now more refined, were fundamentally those originally used in the discovery of the antibacterial activity of penicillin. Finally, Dr. A. A. Miles, director of biological standards at the National Institute for Medical Research, drew together and sorted the tangled threads of the discussion in a speech as witty as it was concise.

The full papers and discussion will be published in due course in the *Analyst* and also in booklet form.

LONG-DISTANCE CORRELATION OF BOULDER CLAYS

By D. F. W. BADEN-POWELL
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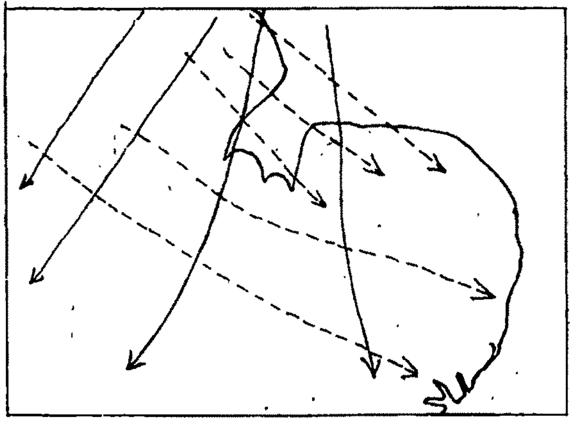
RESEARCH work on the glacial deposits of East Anglia during the last few decades has been directed mainly towards: (1) the establishment of a sequence of deposits; and (2) the discovery of the direction or directions in which the ice has travelled, as shown by the contents of the various beds. In order to combine these two lines of approach, I have recently undertaken a fresh examination of the glacial deposits, especially the boulder clays, and having determined some of the changes in ice-direction, have found that certain long-distance correlations which have been made, especially by Prof. P. G. H. Boswell, are strongly confirmed.

Knowledge of the glacial succession in East Anglia has accumulated very gradually, and the contributions of a number of geologists culminated in the sequence published in 1931 by Boswell[1]. Few alterations or additions have been made since that date, except in nomenclature, and the present state of our knowledge on the subject seems to be:

Youngest
  Hessle Boulder Clay (Brown Boulder Clay at Hunstanton).
  March Gravels (and probably the Brundon Gravels).
  Upper Chalky Boulder Clay (Solomon's 'Little Eastern')[2].
  Hoxne Interglacial.
  Lower Chalky Boulder Clay (Solomon's 'Great Eastern').
  Corton Beds (Wood's 'Middle Glacial')[3].
  Cromer Tills (included in 'North Sea Drift').
Oldest

Of the three boulder clays observed by Paterson[4] in the Breckland, the Upper Boulder Clay of that area is Boswell's Upper Chalky Boulder Clay, and the Middle and Lower Boulder Clays described by Paterson may be the equivalents of the Lower Chalky Boulder Clay and one of the Cromer Tills respectively, but further evidence is needed on this point.

Comparatively little work has been done on the direction of ice-movement as shown by the contents of the various boulder clays, although Harmer[5] showed that some of the material in the 'North Sea Drift' had come from a general northerly direction, whereas much of the content of the 'Great Chalky Boulder Clay' was obviously derived from the north-west, including Jurassic rocks from the Fenland. Harmer suggested that the ice-sheet responsible for that boulder clay fanned out from Fenland in several directions, eastward across Norfolk and Suffolk, southward towards London and westward up the valleys of the Great Ouse, Nene and Trent. The drifts carried during this fanning-out process are shown by symbols on the well-known map which accompanied his paper; but a detailed examination of this map shows that there are many contradictions to the 'fanning-out' theory, and in any case the exact date in Boswell's sequence at which this process took place is unknown.



DIRECTIONS OF ICE-MOVEMENT IN EASTERN ENGLAND. UPPER CHALKY BOULDER CLAY, →; LOWER CHALKY BOULDER CLAY, - - →

A fresh examination has therefore been made, especially of the chalky boulder clays of Suffolk, the results of which are now sufficiently advanced to prove that the Lower Chalky Boulder Clay of that area is the darker-coloured clay containing much Jurassic material, whereas the Upper Chalky Boulder Clay is paler, and contains more chalk and igneous rocks, and has come from a more northerly direction, and to the eastward of the Lincolnshire Wolds. It is therefore the Lower Chalky Boulder Clay which Harmer described as bringing Jurassic material across the Fenland from west of the Lincolnshire Wolds. The directions of these two independent ice-sheets are indicated on the accompanying sketch. These conclusions are based on the assumption that the Upper Chalky has picked up more chalk than the Lower Chalky, because its direction of movement nearly coincided with the strike of the chalk, whereas that of the Lower Chalky corresponded more nearly with the dip of that formation, and therefore crossed a smaller area of its outcrop. The foregoing observation refers to the strike of the chalk in Norfolk and Suffolk, with a direction approximately from north to south between Hunstanton and Mildenhall, and continuing south-west by Newmarket towards Royston.

The intensely chalky boulder clay of the Cromer district[3], on the other hand, can belong to the Lower Chalky glaciation, because ice from the north-west in northern Norfolk would have passed along the strike of the Lincolnshire chalk.

Apart from the matrix of the boulder clays, these ice-directions are confirmed by such erratics as have been collected *in situ* in the boulder clays. The Lower Chalky at Claydon, near Ipswich, contained flint, hard chalk, Neocomian sandstone, Red 'Chalk' (very rare, and doubtfully *in situ*), Septaria, Kimmeridge Shale, Oolite (probably from Lincolnshire), *Gryphæa* cf. *incurva*, Bunter quartzites, blue limestones (? Carboniferous or Jurassic), ? Millstone Grit and non-porphyritic basalts (which may be from Derbyshire). At Bawsey, east of King's Lynn, collection included flint, hard chalk, Neocomian Sandstone, *Terebratula* cf. *rosenkranzi* and *Pavlovia* cf. *worthensis* (Portlandian), and possibly Bunter pebbles. The same boulder clay at Pakefield, near Lowestoft, yielded similar Cretaceous and Jurassic rocks, including *Ostrea dilatata, Ostrea delta* and *Pachyteuthis abbreviata*. The Lower Lias is probably represented by *Lima hermanni*. The Lowestoft boulder clay also contains Bunter quartzites, blue limestone (? Carboniferous), basalt and a small rounded pebble of schist. This last erratic is probably derived from the underlying Corton Beds. If the long list of Jurassic fossils from Ormsby St. Margaret, published in the Geological Survey Memoir (Yarmouth), is taken into account, the Lower Chalky Boulder Clay is seen to consist of Cretaceous, Jurassic, Trias and probably Carboniferous pebbles in a matrix of various Jurassic clays. No other igneous or metamorphic erratics were found *in situ*. This boulder clay appears to be the product of Pennine Ice, which has travelled south-east across mainly Jurassic outcrops.

The Upper Chalky Boulder Clay is consistently different. Cretaceous material is much more common than Jurassic. Red 'Chalk' is abundant, especially at Claydon and Bolton's pits near Ipswich, also blue-and-white flint with the so-called 'basket-work' patina, which is not known to occur in the Lower Chalky. The Upper Chalky also contains Bunter pebbles, porphyrites of supposed Old Red Sandstone type, ? volcanic tuff, various felspathic grits and a sandstone with abundant tourmaline (at Hoxne). An erratic of rhomb-porphyry was found some years ago by Miss Tomlinson close to Upper Chalky Boulder Clay in Bolton's pit, Ipswich. Such Jurassic fossils as occur rarely could be derived from the Lower Chalky Boulder Clay. The Upper Chalky is therefore a deposit containing much flint, and erratics from apparent Scottish Old Red Sandstone, with others which could be derived from one of the Cromer Tills, in a matrix of sand and soft chalk. It appears to represent Scottish Ice, which has entered west Norfolk and Suffolk from a northerly direction off the existing Lincolnshire coast.

These two boulder clays are not often seen in direct superposition, but they are exposed together in the pit at Claydon, and have been seen in former sections at Hoxne and Derby Road brickworks at Ipswich (where the Upper Chalky is decalcified), at Bolton's pit, and probably elsewhere. Most of the Acheulean and associated implements of the Ipswich district come from interglacial deposits between these two boulder clays.

The marine March Gravels of the Fenland have been described as resting on a chalky boulder clay[6], and it is obviously not possible that the chalky boulder clay at Peterborough, for example, was laid down by ice crossing the oolitic rocks from the north-west. The chalky boulder clay of Fenland contains Cretaceous material from Lincolnshire, local Jurassic septaria, felspathic grit, and schists, and gneisses which could be derived from Cromer Till, in a matrix of local Jurassic clays. This assemblage, especially in southern and western Fenland, points to ice-movement from the north across the Lincolnshire Wolds. This direction is parallel to that of the Upper Chalky of West Suffolk, and the Fenland boulder clay is most easily accounted for as having been brought by the Upper Chalky Ice. It should be emphasized that it is different in many ways from the Hessle Boulder Clay of the Fens, which in any case overlies the March Gravels.

If this explanation of the chalky boulder clays is correct, correlation becomes possible between East Anglia and a large area of the East Midlands. Deeley[7], Boswell[1] and Hollingworth[8] have shown that the early Pennine Boulder Clay of the East Midlands underlies later chalky boulder clay from the north-east, and many of the relevant memoirs of the Geological Survey admit a similar sequence. The simplest explanation of these facts is that the older Pennine Ice from Derbyshire to the Fens was the same as that which deposited the Lower Chalky Boulder Clay of East Anglia: and that the younger ice which brought Cretaceous and other material from the north-east to the districts round the Trent, the Stratford Avon and the neighbourhood of Buckingham, was contemporaneous with that which deposited the Upper Chalky Boulder Clay of Suffolk. This hypothesis fits the facts better than Harmer's conception of a single ice-sheet with its fanning-out and cross-currents.

It is hoped to publish the full evidence on which this work is based as soon as possible. The boulder clay samples are still being worked out in detail. I would like to thank Dr. W. J. Arkell for identifying many of the Jurassic fossils.

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AMALGAMATION OF SOME ALLOYS OF GOLD, SILVER AND COPPER

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THE surface of amalgamated metals is greasy to touch, and lustrous in appearance like liquid mercury. In a previous publication[1] the extreme tenuity ($2 \cdot 7 \times 10^{-4}$ cm.) of the film necessary to confer these properties on a pure silver surface was noted. This observation has been confirmed for gold-rich alloys of the legalized carat compositions used for jewellery, for some silver alloys, and for bronzes. By the nature of the problem, exactly reproducible results could scarcely be expected, but, in fact, surprisingly concordant values have been obtained. The problem is of interest in the amalgamation of coarse gold concentrates from the corduroy table on the Rand[2].

Gold-rich alloys. Values of the equivalent film thickness in the hard-rolled state are too erratic to be compared, since in this condition the alloys crumble on mere contact with liquid mercury. This is the phenomenon of 'season cracking' attributed to intercrystalline penetration of the strained metal by liquid mercury.

In the rolled state (half-hard, with 'close' surface texture), the equivalent thickness of mercury is a little more than 1×10^{-4} cm. On fully annealing the gold alloys in hydrogen, giving a surface with 'open' texture, this thickness rises somewhat, attaining a value less than 2×10^{-4} cm.

After polishing the half-hard alloys to a 000 emery finish, the equivalent thickness is reduced to about a third. In annealed alloys similarly polished the equivalent thickness is very slightly less. The polishing appears to activate the surface and renders it very able to take up the mercury; a similar procedure may be adopted to bring annealed metals into a state of standard strain for electrode potential determinations.

Comparison tests on a few commercial golds showed a wide variation in the thickness of the equivalent layer, namely, $0{\cdot}45$–$2{\cdot}7 \times 10^{-4}$ cm. This is attributed to wide differences in the surface texture, polish, roughness and hardness. (A smooth surface may have an 'open' texture[3].) In all cases burnished surfaces yielded thin films. 18-ct. 'white gold' was particularly difficult to amalgamate. 'Rolled' gold gave the low value of $0{\cdot}22 \times 10^{-4}$.

Silver alloys. In silver alloys the effect of surface roughness is shown by the equivalent thickness of more than 3×10^{-4} cm. on the plated pure silver surface of a new shilling, compared with $2{\cdot}7 \times 10^{-4}$ cm. for pure silver and $0{\cdot}6 \times 10^{-4}$ cm. for the underlying basis metal containing only 50 per cent silver, when polished to a 000 emery finish. A similarly prepared surface on sterling silver (92·5 per cent) gave $0{\cdot}6 \times 10^{-4}$ cm.

On standing for a few hours, the lustrous surface becomes mat. This is not due, as might be suggested, to diffusion of mercury atoms into the silver crystals, and subsequent fixation as a result of synthesis[4] of Ag_3Hg_4. This process is much slower, and may take weeks, whereas the lustre of the mat surface can be restored by gentle rubbing. Probably it is due to thixotropic setting within the surface layer of mercury[5].

Copper alloys. Most gold and silver alloys amalgamate readily on mere contact with mercury, and the wetted area extends quickly on gentle rubbing. But copper and its alloys are difficult to amalgamate by contact, even when surface cleanliness is not in question. Prolonged rubbing is necessary, and it is not surprising that resulting films are much thicker, as much as 14×10^{-4} cm. having been observed. However, they do not seem to differ in behaviour from amalgamated alloys of gold and silver. This difficulty in wetting is quite consistent with immediate formation in air of a thin invisible oxide film on newly polished copper surfaces, which has been deduced from electron diffraction and surface reflectivity measurements. Chemical amalgamation yields much thinner films; about $1{\cdot}4 \times 10^{-4}$ cm. by displacement in mercurous nitrate solution, and about half that thickness in a mixture of mercury and nitric acid. This also is consistent with the shielding effect of an oxide layer.

Phosphor bronze, and copper alloyed with a little beryllium (so-called *beryllium bronze*) closely resembling it in physical properties, both gave surprisingly low thickness for contact amalgamation of surfaces polished to a 000 emery finish, respectively 0·07 and $0{\cdot}1 \times 10^{-4}$ cm. Values obtained by chemical amalgamation, while still small at $0{\cdot}12$–$0{\cdot}19 \times 10^{-4}$ cm. and $0{\cdot}35$–$1{\cdot}6 \times 10^{-4}$ cm., much exceeded the contact values. It is clear that surface conditions are very important in the amalgamation of copper alloys.

Grateful acknowledgment is made to the Carnegie Trust, which supplied the precious metals, and particularly to its secretary, Dr. Peddie.

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[1] Hudson, D. R., *Metallurgia*, **29**, 299 (1944).
[2] Year Book of the Union of South Africa (1940).
[3] Rayleigh, Lord, *Proc. Roy. Soc.*, A, **144**, 266 (1934).
[4] Hudson, D. R., *J. Phys. Chem.*, **49**, 483 (1945).
[5] Hudson, D. R., *Nature*, **153**, 562 (1944).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, February 23

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Corrosion in Electrical Apparatus" (to be opened by Brigadier F. H. Maclennan).

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. L. A. Oliver: "Machinery and Layout in German Rubber Plants".

Tuesday, February 24

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. Daryll Forde: "Anthropological Analysis of Social Change".*

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Discussion "That Artificial Lighting is an Adequate Substitute for Natural Lighting".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Dr. H. W. Thompson, F.R.S.: "Infra-Red Methods of Analysis and Control".

TEXTILE INSTITUTE (joint meeting with the MANCHESTER GEOGRAPHICAL SOCIETY, in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. F. Shuttleworth: "Some Strange Native Customs and Ways of Using Textile Materials".

CHEMICAL SOCIETY, SOCIETY OF CHEMICAL INDUSTRY, and ROYAL INSTITUTE OF CHEMISTRY, EDINBURGH AND EAST OF SCOTLAND SECTIONS (joint meeting with the EDINBURGH UNIVERSITY CHEMICAL SOCIETY, in the Biochemistry Lecture Theatre, Teviot Place, Edinburgh), at 7 p.m.—Prof. W. F. K. Wynne Jones: "Proton Transfer and Analogous Reactions".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. P. Good: "The General Aspects of Standardization" (Presidential Address).

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at St. Enoch Hotel, Glasgow), at 7 p.m.—Mr. E. Marney: "All-over Pigment Coloration of Textiles".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Cherry Tree, Welwyn Garden City), at 8 p.m.—Prof. D. H. Hey: "Reactions of Benzoyl Peroxide".

Wednesday, February 25

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. C. Butement: "Three-Dimensional Photography".

ROYAL MICROSCOPICAL SOCIETY, SECTION OF INDUSTRIAL MICROSCOPY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Miss M. Dempsey: "The Structure of the Skin and Leather Manufacture".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Growing Points in Science", 2. (To be opened by Prof. A. A. Hall and Prof. C. H. Waddington, F.R.S.)

Thursday, February 26

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Wallace Akers: "The Research Laboratories of the Imperial Chemical Industries, Ltd.".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Exhibition Meeting (Exhibits of botanical and zoological interest, with brief comments by the Exhibitors).

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Prof. R. L. Lockley: "The Evolution of the Design of an Aeroplane".

Royal Statistical Society, Sheffield Group of the Industrial Applications Section (at the Royal Victoria Hotel, Sheffield), at 6.30 p.m.—Miss B. Pickersgill: "Graphical Methods for the Demonstration of Simple Statistical Relations".

Royal Institute of Chemistry, Manchester and District Section (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. J. H. Carrington: "Rubber".

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Annual General Meeting, followed by a Film Show.

Society of Dyers and Colourists, West Riding Section (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. A. H. Gordon: "The Composition of Wool".

Friday, February 27

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Recent Work on the Earth's Main Magnetic Field". (Fellows of the Geological Society are invited to attend.)

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Discussion on "The Future of Fuel and Power" (to be opened by Dr. F. Rogers).

British Institution of Radio Engineers, Midland Section (at the Technical College, The Butts, Coventry), at 6.30 p.m.—Mr. G. F. N. Knewstub: "The Design of Electronic Calculating Machines".

Institution of Electrical Engineers (at the Central Hall, Westminster, London, S.W.1), at 6.30 p.m.—Dr. P. Dunsheath: "Electricity and Everyman" (Faraday Lecture).*

British Glaciological Society (at the Electrical Laboratory, Oxford), at 8.15 p.m.—Mr. Gerald Seligman: "Some Aspects of Snow and Glaciers".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Linus C. Pauling: "The Nature of Forces between Large Molecules of Biological Interest".

Universities Federation for Animal Welfare, Cambridge University Branch (at St. John's College, Cambridge).—Symposium on "Pain" (to be opened by Prof. E. D. Adrian, O.M., F.R.S., and Sir Frederic Bartlett, F.R.S.).*

Saturday, February 28

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Redcliffe N. Salaman, F.R.S.: "The Potato Came to Europe".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Plant Pathologist to investigate an unexplained disease of coconuts, in Jamaica—The Under-Secretary of State, Colonial Office (Research Department), Palace Chambers, Bridge Street, London, S.W.1 (February 28).

Laboratory Steward at the College, Swindon—The Borough Education Officer, Civic Offices, Swindon (February 28).

Chemists (men and women), Scientific Officer Class and Experimental Officer Class, in the Chemical Inspection Department of the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F78/48A (February 28).

George William Britt Studentship in Physics, and the Arthur Jubber Studentship for advanced study or research in any subject, preferably in the field of Chemistry, Botany, Mathematics, Ancient, Modern or Natural History—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 1).

Graduate Assistant (with zoology degree and good field knowledge of birds)—The Director, Edward Grey Institute, 91 Banbury Road, Oxford (March 5).

Senior Assistant in the Electrical Engineering Department—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1 (March 6).

Principal Scientific Officer at the Post Office Engineering Research Station, Dollis Hill, London, N.W.2, to advise and undertake research work on physiological problems—The Director General, Personnel Department (C.C.B.), Headquarters Building, General Post Office, London, E.C.1 (March 8).

Science Master at Longerenong Agricultural College under the Victoria Department of Agriculture—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (March 8).

Geologists (about 10) and Senior Geologists (1 or 2) at the Geological Survey and Museum—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2117 (March 15).

Professor of Psychiatry—The Registrar, The University, Leeds 2 (March 22).

Senior Lecturer and Lecturers (2) in Physiology—The Secretary of University Court, The University, Glasgow (March 31).

Principal Scientific Officer for work on the Commonwealth Potato Collection, Cambridge—The Secretary, Commonwealth Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (April 1).

Assistant in Astronomy—The Director, University of London Observatory, Mill Hill Park, London, N.W.7 (April 1).

Ramsay Memorial Fellowships for Chemical Research—The Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College London, Gower Street, London, W.C.1 (April 17).

Principal Meteorologist, a Senior Meteorologist, a Meteorologist and a Junior Meteorologist; a Principal Technical Assistant, a Senior Technical Assistant, and a Technical Assistant (Grade I), in the Meteorological Services, Department of Transport, under the Government of the Union of South Africa—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, W.C.2 (April 30).

Chair of Pharmacology—The Registrar, The University, Sydney, N.S.W., Australia (June 30).

Lecturer in the Chemistry Department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Laboratory Assistant (girl or woman)—The Principal, Furzedown Training College, Welham Road, London, S.W.17.

Laboratory Assistant (woman) at Dalston County Secondary School, Shacklewell Lane, London, E.8—The Education Officer (Estab./2), County Hall, London, S.E.1.

Laboratory Steward (Grade C)—The House Governor and Secretary, Gordon Hospital, Vauxhall Bridge Road, London, S.W.1.

Organizing Secretary of the proposed Institute of Education—The Registrar, University College, Leicester.

Science Graduate (Senior Scientific Officer grade) with an interest in economics and statistics to carry out operational research in the iron and steel industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Street, London, W.1.

Demonstrator for the Department of Aerodynamics—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

Assistant Technical Librarian—The Secretary, British Internal Combustion Engine Research Association, 111–112 Buckingham Avenue, Slough, Bucks.

Histological Technician (Grade B) in the Department of Anatomy—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

Government Chemist in Mauritius—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 2, No. 18: The Geology of the Highland Border—Stonehaven to Arran. By Dr. J. G. C. Anderson. Pp. 479–516 + 1 plate. (Edinburgh and London: Oliver and Boyd, 1947.) 12*s*. [225

Chelsea Polytechnic. 51st Annual Report, Session 1945–46. Pp. 18. (London: Chelsea Polytechnic, 1947.) [225

Board of Trade. Working Party Reports—Linoleum and Felt Base. Pp. viii + 50 + 2 plates. (London: H.M. Stationery Office, 1947.) 1*s*. 6*d*. net. [225

Ministry of Education. Education for Management: Management Subjects in Technical and Commercial Colleges. Report of a Special Committee appointed by the Minister of Education. Pp. 32. (London: H.M. Stationery Office, 1947.) 6*d*. net. [225

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board, with the Report of the Director of Water Pollution Research, 1st July 1939 to 31st December 1945. Pp. iv + 78. (London: H.M. Stationery Office, 1947.) 1*s*. 3*d*. net. [225

Report of the Rugby School Natural History Society for the Year 1946. (80th Issue.) Pp. 82. (Rugby: George Over, Ltd., 1947.) [225

Survey of Sickness, October 1943 to December 1945. By Patrick Slater. A Report on a Series of Surveys on the State of Health of the Civilian Population between these dates, made for the Ministry of Health. Pp. 76. (London: Social Survey, 1946.) Not for sale. [225

Other Countries

What is Missing. By Dr. B. A. Sokolow. (Kosmopolit-Akademia, Postumae N.1.) Pp. 32. (Helsinki: Mrs. M. Ronseval, Box 184, n.d.) [125

American Institute of Crop Ecology. International Agro-Climatological Series. Study No. 1: Ecological Crop Geography of the Ukraine and the Ukrainian Agro-Climatological Analogues in North America. By M. Y. Nuttonson. Pp. 24. Study No. 2: Agricultural Climatology of Poland and its Agro-Climatic Analogues in North America. By M. Y. Nuttonson. Pp. 12. Study No. 3: Agricultural Climatology of Czechoslovakia and its Agro-Climatic Analogues in North America. By M. Y. Nuttonson. Pp. 12. (Washington, D.C.: American Institute of Crop Ecology, 1947.) [125

International Astronomical Union. 43rd Name-List of Variable Stars. Pp. 78. (Moscow: Academy of Sciences of the U.S.S.R., 1947.) [125

American Philosophical Society. Year Book 1946, January 1, 1946–December 31, 1946. Pp. 459. (Philadelphia: American Philosophical Society, 1947.) [155

Nigeria. Annual Report on the Forest Administration of Nigeria for the Year 1945–46. Pp. 44. (Lagos: Government Printer; London: Crown Agents for the Colonies, 1947.) 9*d*. [155

RCA Technical Papers (1919–1945). Index, Vol. 1. Pp. vi + 143. RCA Technical Papers (1946). Index, Vol. 2a. Pp. vi + 21. (Princeton, N.J.: Radio Corporation of America, 1947.) Free. [155

South African Council for Scientific and Industrial Research. First Annual Report, 1945–46. Pp. 27. (Pretoria: South African Council for Scientific and Industrial Research, 1947.) [155

Bulletin of the Bingham Oceanographic Collection. Vol. 8, Art. 1: A Review of the Types of Polychaetous Annelids at the Peabody Museum of Natural History, Yale University. By Olga Hartman. Pp. 98. (New Haven, Conn.: Peabody Museum of Natural History, 1942.) 1.50 dollars. [225

Indian Forest Records. Vol. 6, No. 2: The Stomates and Early Growth of some Timber Trees of the Malabar Coast. By Dr. A. L. Griffith. Pp. 62–92 + 21 plates. (Delhi: Manager of Publications, 1946.) 2.12 rupees; 4*s*. 9*d*. [225

NATURE

No. 4087 SATURDAY, FEBRUARY 28, 1948 Vol. 161

CONTENTS

Page
International Control of Atomic Energy 291
Controlling the Staff of Life. By A. L. Bacharach 293
Servo-Mechanism Fundamentals 294
The Laurentian Hormone Conference. By Prof. S. Zuckerman, C.B., F.R.S. 295
Practical British Forestry. By Prof. E. P. Stebbing 295
Earthquakes and Volcanoes. By Lt.-Col. Ernest Tillotson . . 296
Cross-Linking in Polymeric Systems. By Dr. G. F. Bloomfield . 298
Salmon and Animal Migration. By Dr. A. G. Huntsman . . . 300
Submicroscopic Structure of the Bacterial Cell, as Shown by the Electron Microscope. By Dr. Stuart Mudd 302
Obituary :
  Dr. Henri Deslandres, For.Mem.R.S. 303
News and Views 304
Letters to the Editors :
  Formation of Derivatives of Thyroxine from Derivatives of Diiodotyrosine.—Rosalind Pitt Rivers 308
  Condensation of 2 : 4 : 5-Triamino-6-hydroxypyrimidine with Glucose and Fructose.—H. S. Forrest and Dr. James Walker . 308
  Configuration of Synthetic Œstrogens.—H. P. Koch . . . 309
  A Polysaccharide from Hydatid Cyst Fluid.—Gwen M. Macnab . 310
  Gas Discharges at Centimetre Wave-lengths.—W. A. Prowse and R. Cooper 310
  Refraction Effects in Electron Diffraction and in Electron Microscopy.—Dr. H. Raether 311
  Triple Magneto Ionic Splitting of Rays Reflected from the F_2 Region.—Gordon Newstead 312
  Variable Source of Radio Frequency Radiation in the Constellation of Cygnus.—J. G. Bolton and G. J. Stanley 312
  Particle-size Measurement.—Gervase L. Mills 313
  Surface Radiography with Alpha Rays.—C. Jech 314
  A Suggested New Force Field for Molecular Vibrations.—D. F. Heath and Dr. J. W. Linnett 314
  Band Spectrum of Aluminium Bromide.—Carl Gustav Jennergren 315
  Comparison of Metallographic and X-Ray Measurements of Retained Austenite.—William J. Harris, jun. 315
  Rh Genes Allelomorphic to *C*.—Dr. R. R. Race, Dr. Ruth Sanger and Mrs. Sylvia D. Lawler 316
  Cytology of Staphylococci Before and After Treatment with Penicillin.—Prof. R. Tulasne and Dr. R. Vendrely . . . 316
  Subtilin *C* : an Antibiotic Concentrate from *Bacillus subtilis*.—C. H. Hassall 317
  Serological Position of *Streptococcus bovis*.—Dr. P. M. F. Shattock 318
  Intravenous Methylene Blue : a New Method for Studying the Nervous System.—W. H. Feindel, D. C. Sinclair and Dr. G. Weddell 318
  Influence of Low Bicarbonate Concentrations on the Growth of a Green Alga.—Sven Österlind 319
  A *Chaetomium*-like Thermophile Fungus.—C. J. La Touche . 320
  Treatment of Apple Canker Lesions with Plant-growth Substances.—S. H. Crowdy 320
  A New Dry Test for Gold.—R. C. Mehrotra 321
  Demonstration of the Heart Beat.—Dr. Alan J. Hird ; Dr. C. A. Beevers 321
International Meeting on Animal Production. By I. L. Mason . . 322
Insulating Materials and Methods for Use at Low Temperatures. By Dr. Ezer Griffiths, F.R.S. 323
Some New Anisotropic Time Effects in Rheology. By S. M. Freeman and K. Weissenberg 324
Dielectric Constant and Piezo-electric Resonance of Barium Titanate Crystals. By Bernd T. Matthias 325
Exploration of the Lloyd George Mountains in the Northern Canadian Rockies. By Dr. N. E. Odell 327
Cambridge Archæological Expedition to Cyrenaica. By C. B. M. McBurney, R. W. Hey and W. Watson 327
The Common Cold. By Dr. G. Lapage 328
British Rocket Weapons Research. By R. H. Macmillan . . . 329
Photo-elasticity in Mechanical Engineering. By Dr. E. K. Frankl . 329
Recent Scientific and Technical Books . . . . . . Supp. ii

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INTERNATIONAL CONTROL OF ATOMIC ENERGY

THE sober, and somewhat sombre, review of the proposals for the international control of atomic energy, and the appraisal of the present position, which Dr. J. R. Oppenheimer, chairman of the Advisory Committee of the Atomic Energy Commission of the United States, contributes to the current issue of *Foreign Affairs*, appeared appropriately just when President Truman's Air Policy Commission had warned the United States that within five years foreign countries would almost certainly possess atomic weapons in quantity and would probably also have in mass production effective long-range guided missiles. Dr. Oppenheimer's review should receive close study, not merely by those directly interested, but also by scientific workers generally, on its own intrinsic merits. Apart from Dr. Oppenheimer's authority, it is a most valuable indication of the trend of opinion which has led to the specific recommendations of the Air Policy Commission, and as such assists materially in appraising their significance.

Dr. Oppenheimer attempts to present, briefly but objectively, some of the sources of United States policy, and the formulation of that policy in the context of contemporary events. His article is also useful in assisting those outside the United States to estimate not merely the sound and durable elements in that policy, but also the reasons for its present lack of success. He does not enter deeply into political considerations, though they are not ignored; but the scientific and technical aspects are presented in balance with the political aspects in a way that should facilitate realistic discussion.

Early in this article, Dr. Oppenheimer makes the important point that the advantages which could come from the exploitation of atomic energy do not appear to be of such a character that they are likely to make a short-term contribution to the economic or technical well-being of mankind. It was clear two years ago that, although the generation of useful power from atomic sources was possible and that decisive progress in favourable circumstances was probable within a decade, the question of the utility of this power, the scale on which it could be made available, and the costs and general economic values would take a long time to answer. Intensive development and exploration are required; no evaluation, in Dr. Oppenheimer's view, could justify regarding atomic power as likely to provide immediate economic aid on a world-wide scale, or give its development the urgency of the control of atomic armaments. Similarly, he reminds us that the other form of application, involving the use of tracer materials, radioactive species, and radiations for science, the practical arts, technology and medicine, depends in the first instance upon the skilful development of chemical, physical and biological techniques—a development which under the best conditions is a gradual and continuing one.

It follows from this that the development of atomic energy for such peaceful purposes cannot present a direct appeal to the weary, hungry, almost desperate peoples of a war-ravaged world. Despite its challenge to the interests of technical men, and also to the vision of the statesmen concerned with long-term projects for human welfare, honesty compels us to regard such development as falling within the category of long-term projects, the development and exploration of which may have to be deferred until immediate needs have been met. That view lends some support to proposals which have already been advanced elsewhere, for example, by Mr. Lewis Mumford in "Programme for Survival", that we should forgo the use of atomic power until the world is better prepared for it.

Even if it is clear that mankind would lose little in the next few decades by such renunciation, it still remains to be seen whether it is practicable, even if it is wise, to postpone consideration of the control of large-scale power production. Here it should be noted, as Dr. Oppenheimer reminds us, that the development of atomic power cannot be separated from the technological development essential and largely sufficient for the manufacture of atomic weapons; and again, neither the development of power nor the effective and widespread use of the new tools of research and technology can prosper fully without a degree of freedom in regard to the technical realities difficult to reconcile with the traditional requirements of military security about the development of weapons of war.

These views have been overshadowed in most discussions by preoccupation with the control of atomic energy to the extent required to prevent its use for destructive purposes, and more especially with those considerations which derive from the nature of atomic armament. The main concern of the latter part of Dr. Oppenheimer's paper is to redress the balance, and to give to those arguments derived from the political climate of the post-war world the preponderance in determining policy which he considers they should have. Indeed, he contends that our excessive concern with the arguments based on the nature of atomic armament are the main cause of estrangement and misunderstanding with the U.S.S.R., and that relegation of problems of atomic energy to discussions with the United Nations has prejudiced the chances of any genuine international intellectual co-operation.

Dr. Oppenheimer recognizes fairly enough that during the Second World War the fabric of civilized life was worn so thin in Europe that there is the gravest danger that it will not hold. He admits, too, that the question of the future of atomic energy presents itself in one main constructive context: What can be done with this development to make it an instrument for the preservation of peace and for bringing about those altered relations between the sovereign nations, on the basis of which there is some reason to hope that peace can be preserved? He argues, however, that although this may have been the question in principle, a far more concrete and immediate problem faces the world, namely, whether the co-operative control and development of atomic energy might not play a unique and decisive part in establishing co-operation between the U.S.S.R. and the United States.

For all its frustrations and disappointments, the Atomic Energy Commission of the United Nations, notwithstanding the limitations under which it has worked, has proved the vitality of the basic idea of security through international co-operation. Dr. Oppenheimer does not examine the question whether the United States, Great Britain, Canada, and those other nations that are prepared to accept the necessary sacrifice of national sovereignty involved in a control system with its essential international inspectorate, should go ahead and demonstrate in a limited field the feasibility of such a scheme. He rightly observes that collaboration in the field of atomic energy cannot be entirely separated from collaboration in other fields; and although he does not suggest that it would necessarily have succeeded, he argues that an attempt should have been made to influence the U.S.S.R. at a higher level and to make the heads of the Soviet Union, in part at least, party to the effort at control.

That effort has not been made, and only the historian can pronounce upon the probability of its success. Meanwhile, we have to face the fact that the most unexceptional formulation of principles set forth in the report "International Control of Atomic Energy: Growth of a Policy" (Washington: Department of State Publications, 2702; 1947) confronts the evasion of the very bases for co-operation between the United States and the Soviet Union. Episode after episode in the last two years has emphasized their deep conflicts of interest, the apparently mutual repugnance of their ways of life, the non-co-operativeness of the Soviet Union and its apparent conviction of the inevitability both of the decay of American democracy and of conflict.

In such an atmosphere there can be little hope that measures of international control less radical than those already proposed by the United States will be either adequate or acceptable. Even in a situation less tense, there would have been considerable difficulties in reconciling particular national security, custom and advantage with an overall international scheme for security. In the present juncture, formal renunciation of atomic armament and some concession with regard to access to atomic facilities on the part of international inspectors is no more likely to commend itself as adequate to Great Britain and other nations than to the United States or Canada. Dr. Oppenheimer himself sees little hope except in a profound change in the whole orientation of Soviet policy, and a corresponding reorientation of American policy, even in matters far from atomic energy; though he urges that those who work for the establishment of peace and who wish to see atomic energy contribute whatever is possible to that end should maintain all that is sound in the early hopes and work for their eventual realization.

One road to peace may be through a limited scheme of control applying to the Western democracies. This may give time for the creation by writers, artists, scientific workers, teachers, and travellers of a widening field in which there is a common human bond and understanding between the diverse peoples of the world.

In this connexion the discussions now proceeding on an international declaration on human rights may be of significance. The British delegation, for example, is in favour of a covenant containing legally enforceable obligations, and in the Foreign Office draft Bill of Human Rights the obligations deemed acceptable are limited to those guaranteeing the existing common law rights of Englishmen. The accompanying memorandum argues that the right of all persons to work, to education, to social security and similar social and economic rights cannot "by their nature" be defined in the form of legal obligations for States. It is, however, precisely these obligations which the Slav bloc might conceivably accept as, in its view the indispensable guarantees of true political freedom. Without suggesting that the cause of peace will be furthered by any slackening of the effort to spread Western ideals of political freedom, it may well be, as Mr. Bryan King suggests in *The Economist*, that an international treaty is not the right medium for their propagation; such an instrument should afford rather the opportunity to establish or affirm common aims which will help to dispel mistrust and open the way to better understanding. Whatever views may be held as to the practicability or value of an international affirmation of faith in fundamental human rights and in the dignity and value of the human person, there can be no question as to the importance of not allowing either an idealistic or a legalistic point of view to accentuate differences and place fresh obstacles in the way of international understanding.

In this context it may be recalled that the Atomic Scientists' Association, although limiting its full membership to scientific workers with specialist knowledge of atomic energy, seeks to enrol the support of a large body of associate members, both scientific and lay, to broaden the activities and to increase the effectiveness of the Association. Such support is clearly invaluable and indeed essential for the expansion of the publicity activities of the Association. It should also counteract any tendency to approach the problems of atomic energy from too narrow an angle, and help to bring those intimately concerned with atomic physics into closer touch with other men of science, and the ordinary citizens alive to the larger issues at stake.

The report of the Air Policy Commission of President Truman provides a first-rate example of how much depends on the existence of an informed body of responsible opinion. The specific recommendations of the report are indeed less important than the affirmation by this body of distinguished private citizens of their belief that "the United States will be secure in an absolute sense only if the institution of war itself is abolished under a regime of law. World peace and the security of the United States are now the same thing." Even the most optimistic view of the record of the United Nations affords no assurance that that Organisation will develop in time the necessary authority to prevent another war.

It will be noted that this blunt report and the hardening of opinion which it tokens has something in common with Dr. Oppenheimer's conclusions and with the trend of thought elsewhere. There can now be little to hope from another examination of the current Russian proposals, and the Atomic Energy Commission has held only one ineffective meeting since its second report was made to the Security Council in September. The question of atomic energy and its control and development is now merging into the larger issues of which it forms a part; and when the Air Policy Commission expresses its belief that a strong America will be a force for peace, it is giving expression to views which are widely held and responsibly endorsed among the Western democracies. But the nations joining in any limited scheme of collective security, including the control of atomic energy as one essential element, must make clear what they regard as essential interests and make known resolutely and unambiguously where they will make a stand; and at the same time, they must use every means available to promote understanding and good will, and to demonstrate afresh the inherent greatness and resilience of Western civilization and its tradition and heritage of human individuality and freedom. Demonstration of the moral, spiritual and economic strength of Western Europe may in due course prepare the way for the adherence of the U.S.S.R. to a system of collective security the practicability and soundness of which has been made evident.

CONTROLLING THE STAFF OF LIFE

Modern Cereal Chemistry

By Dr. D. W. Kent-Jones and Dr. A. J. Amos. Fourth edition. Pp. vii + 651. (Liverpool: Northern Publishing Co., Ltd., 1947.) 50*s*. net.

IT were a work of sheer supererogation to recommend "Kent-Jones and Amos" to cereal chemists or to any of those concerned with the technical side of the milling and baking industries. They will all have this new (fourth) edition, if not on their shelves then certainly on order—or on loan! Indeed, there is much to be said for the definition of cereal chemist as "a graduate in chemistry whose work makes it essential for him to possess Kent-Jones and Amos and to consult it at least once a day!" To avoid gilding the lily or piling Pelion on Ossa or whatever may be the appropriate metaphor, I propose as a non-cereal chemist to consider in this review how far "Modern Cereal Chemistry" may be of value as a permanent companion of chemists practising in other branches of the food and allied industries. To do this it will be simplest to take a look at each chapter or group of chapters separately.

We begin, then, by considering the "Composition of Wheat and Products of Milling", which contains photographs of two delightful pieces of Egyptian statuary, dated 3300 B.C. The authors' subject has indeed a history. Not only have we in this chapter a detailed discussion of the proximate analysis of wheat and its milling fractions, but the chemistry of the carbohydrate, protein and fat constituents is also exhaustively expounded. A chapter like this should be of value and interest to any chemist who has ever to handle wheat or its milling products, even if only as a direct consumer of the grain or an indirect consumer of its milling products by way of the domestic hen's eggs. It is worth noting that neither in this chapter nor in any part of this book do the authors for a moment connive at that distressing term 'wheat berry', which has somehow crept into scientific jargon and is curiously difficult to exorcise. The wheat grain, as they point out on page 1, is a seed.

Chapter 2, on "Principal Wheats of the World", has an obvious interest for botanist and geneticist; it is also aimed at the pestologist, for it contains descriptions of all the leading wheat diseases due to infection or infestation and to methods of getting rid of them. Chapter 3, on "Barley", includes consideration of malt, but maintains a discreet silence on the main technological problem connected with the use of malted barley, for reasons, no doubt, of space rather than of personal predilection. Brewing has, in any event, many excellent text-books of its own already. Chapter 4 gives in admirably condensed form summarized data about four more cereals—rye, oats, maize and rice—as well as about two non-cereal sources of carbohydrate of world-wide importance—soya and the potato. Chapters 3 and 4 must obviously be immediately accessible to any chemist who has frequently or regularly to handle any of these food plants or their products, whether they be destined for human consumption, for stock-feeding or for industrial exploitation.

The next three chapters bring us directly into the field of milling technology and deal respectively with "Some Physico-Chemical Aspects of Flour", "Flour Strength" and "Conditioning and the Effect of Heat on Wheat and Flour". They may well be considered along with certain later chapters—"The Technique and the Chemistry of the Baking Process" (9), "Bleaching and Flour Improvers" (10) and perhaps also "Dough Testing Apparatus" (11). It is interesting to those who maintain the impossibility of separating 'pure' and 'applied' science to note how many problems in fundamental biochemistry crop up during the discussion of such mundane matters as the baking qualities of flour, which leads to a condensed but admirable general exposition of *p*H and *r*H, with incidental references to the electronic theory of atomic structure. The intensity of research effort that has gone into many of the basic phenomena underlying industrial practice is well exemplified by a passage in Chapter 10 where the authors, discussing the action of flour improvers, refer to the work of Jørgensen on the use of potassium bromate. On this extremely specialized problem the Danish worker has produced a volume of 434 pages—with a bibliography of no less than 10 pages and 218 references[*]. Kent-Jones and Amos write of this book that the author "has certainly put up a good case for his theory and has replied to a number of his critics". It would ill become a non-expert to add to this masterly comment.

Chapter 8, on the "Composition of Milled Products", is a logical extension of Chapter 1. It is packed with tabular matter and carries with it the conviction that nothing known about the chemical make-up of commercial wheat products has passed through the authors' fine-meshed bibliographic bolting-cloth. Many of the data included are based on their own work, which the bibliography (42 pages at the end of the book) shows to go back at least to 1924. "Use of Wheat and Flour for Special Purposes" (Chapter 12) covers such subjects as self-raising flour and baking powder, biscuit manufacture, confectionery, macaroni, dog biscuits and alcohol production.

Two of the longest chapters, as is only right, are those concerned with "Nutritive Value of Cereals" (12) and "Cereal and Balanced Rations for Livestock" (13). For certain obvious reasons I will not comment on these, except to say that the authors, though convinced supporters of a 'white bread' policy, preferably with enrichment, state the case of their opponents who favour the use of long-extraction flour with a fairness and objectivity that might well be an example to some of those opponents. These two chapters, depending as they do for their validity on accurate knowledge about the nutrient analysis of cereals and their products, extend the earlier chapters (1 and 8), and justify the meticulous details of the final two chapters on methods of analysis. These are "General Analytical Procedure for Cereals" (17) and "Assay of Vitamin Content of Cereals and Cereal Products". Here, surely, is the last word (at January 1947) on how to measure the individual compounds present in the most important of all man's foods.

There remains space only to mention the titles of Chapters 15 and 16, "The Microbiology of Cereals" and "Moisture in Cereals and Cereal Products", and thirty pages of tabular appendixes, giving figures on such diverse subjects as the atomic weights of the elements, relative humidities and compositions of ingredients used in common feeding stuffs. Could not future editions include a table of the manifold, and often mysterious, measures used in the milling and baking industries?

Finally there is, of course, a thoroughly adequate index (31 pages) to end a book for which, and for the knowledge, energy and enthusiasm that have gone to the writing and rewriting of it, there is only one word—prodigious! A. L. BACHARACH

SERVO-MECHANISM FUNDAMENTALS

Servo-mechanism Fundamentals

By Henri Lauer, Robert Lesnick and Leslie E. Matson. Pp. xi + 277. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 17*s*. 6*d*.

THE use of the word 'fundamentals' in the title of this book is fully justified. A careful and detailed analysis of the physical principles underlying the operation of servo-mechanisms is made, with relation, in particular, to mechanisms for position control. The mathematical treatment is, in the main, on the transient basis—that is to say, the application of a 'step velocity' input—and deals in separate chapters with systems employing viscous output damping, error-rate damping, integral control and the various combinations of these features used in practice. It is noteworthy that the mathematical analysis is by straightforward classical methods very fully detailed, no recourse being made to operational methods or other specialized techniques. This is a valuable feature, for the presentation is, in consequence, well suited to the student with no greater mathematical background than that of the regular undergraduate course in science or engineering.

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[*] Studies on the Nature of the Bromate Effect. By Dr. Holger Jørgensen. Pp. 435. (Copenhagen: Einar Munksgaard; London: Oxford University Press, 1945.) 40 Danish crowns; 40*s*.

While emphasis is placed rather on the characteristics and performance of systems of generalized type, attention is also given to the nature and behaviour of the various elements in the mechanism. Error-detecting devices are considered in a chapter devoted to 'follow-up links', and a further separate section deals with typical electrical networks employed in connexion with error-rate stabilization. Only brief attention is given, mainly in the final chapter, to the amplifier controller.

Along with the detailed solutions of the differential equations for step velocity input, which constitute the main body of the theory, is given a brief development of the solutions for sinusoidal input. This is extended in a chapter dealing with the transfer function analysis of servo-mechanisms. The correspondence with feed-back amplifier theory is demonstrated, and the application of the stability criterion to servo systems is briefly considered.

A particularly valuable feature of the book is the number of worked numerical examples incorporated in the text.

A very effective effort has been made by means of detailed descriptions and the use of mechanical analogies towards providing a clear physical picture of the main phenomena of servo systems. Rather less successful has been the attempt made in Chapter 3 to provide, in the same volume, a condensed account of the basic mechanics and electricity required for the study of servo systems. The space occupied by this restatement of the elements of mechanical and electrical theory might have been more usefully employed in dealing a little more fully with the amplifier-controller element of the servo-mechanism and introducing the fundamental concepts of the effects of 'noise' in amplifying systems.

This book provides, however, a most satisfactory introduction to the principles of servo-mechanisms.

THE LAURENTIAN HORMONE CONFERENCE

Recent Progress in Hormone Research

Proceedings of the Laurentian Hormone Conference. Vol. 1. Edited by Gregory Pincus. Pp. v+399. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 7.50 dollars.

THE Laurentian Hormone Conference had its origin at the 1943 meeting of the American Association for the Advancement of Science. The proceedings of the endocrinological section were so successful that the Montreal Physiological Society invited its participants to regather in Canada in 1944. A profitable reunion was held in the Laurentians, and the Laurentian Hormone Conference is now established as an annual event.

The present volume is a report of the 1945 meeting, and consists of four main sections, the first on neurohumoral relationships, the second on the chemistry and physiology of adrenal hormones, the third on the role of hormones in metabolic processes, and the fourth on aspects of clinical endocrinology. Each section comprises from two to four general papers, followed by a record of the subsequent discussions.

It is difficult to single out, from what is a collection of well-chosen and well-presented papers, any particular contribution for detailed mention. Beach's paper on "The Hormones and Mating Behaviour in Vertebrates" is undoubtedly the best review that has yet appeared on the subject. The conclusions he draws from the available information are: (1) that some hormones affect sexual behaviour by virtue of their control of general metabolic processes, (2) that some types of sexual behaviour are independent of hormonal control, (3) that other patterns of sexual behaviour are specifically affected by hormonal stimulation, and (4) that where hormones affect sexual behaviour patterns, they do so by increasing or decreasing the sensitivity to external stimulation of cortical nervous circuits.

Another paper which is of particular importance, in so far as it presents a novel survey of newer knowledge, is Kochakian's review of the role of hydrolytic enzymes in some of the metabolic activities of steroid hormones. This paper shows that the metabolic effects of the steroids affecting protein anabolism work partly through the kidney, while those affecting protein catabolism function primarily through the liver.

A third most valuable review is Albright's on the effect of hormones on osteogenesis in man. This is a brilliant summary of the available knowledge on bone growth and of the effects of various types of endocrine stimulation on the process.

It is almost invidious to mention these three particular reviews. All the contributions to the volume are of the greatest importance, and it is to be hoped that future Laurentian conferences will be as well reported. Those who cannot attend the meetings will be even better pleased if the interval between conferences and the appearance of their Proceedings can be reduced. In the present instance, the date of publication is 1947, while the meeting took place in 1945.

S. ZUCKERMAN

PRACTICAL BRITISH FORESTRY

Practical British Forestry

By C. P. Ackers. Second edition. Pp. xviii + 394. (London: Oxford University Press, 1947.) 20*s*. net.

THE first edition of this book was reviewed in *Nature* of October 8, 1938; for the new edition, the chapters on nursery work and the future have been rewritten.

In the chapter on the future, the author discusses the changes brought about by the Second World War. He considers that the fully trained forester will be essential in the future, though in short supply, and that private forest owners will not be able to compete with Government for trained men. These statements are not quite in accordance with the existing position. There must be well over a couple of hundred men training at the present moment at the four universities, Oxford, Edinburgh, Aberdeen and Bangor, for the forestry degree. There are well over a hundred at Edinburgh alone. Out of this number it should be quite possible to provide good men for private forestry. The onus of taking this step does not lie with the educational centres, but with the private owners themselves. As has been advocated for a number of years now, if a few adjacent private owners of forest land would join together, they could easily afford to pay for the services of a man who has taken full training in forestry and done well at his examinations. In any event, wherever a man goes, to whatever Government service, he will have to learn the ropes during his first year or more before he can become fully efficient in carrying out the work of the department in question. This holds equally good for the young fully trained man appointed to private forestry; but the bogy that they will be carrying a 'dud' for three to five years is entirely without reason: and to sit and wait, as some owners of private estates have been doing for the last forty years in some cases, until they can pick up a fully trained man with full experience—obtained, it may be well asked, from where?—is not, it may be suggested, the way in which Mr. Ackers' aspirations will be fulfilled. That such trained men are fully as necessary to the management of large areas of private forests as to the large areas under the Forestry Commission is so obvious that it does not need discussion.

In the chapter on the nursery the following topics are dealt with: temporary nurseries; choice of a nursery site; shelter; cleanliness; soils, of course, and then seed and its extraction; period of sowing; depths of sowing and covering, and sowing distances; the collection of seed, and the dangers to which both seed and young plants are subject from birds, mice, moles, damping off and frost; the size of the plants to be put out in the forest; transplanting in the nursery from the seed beds; use of manures and rotation of areas in the nursery; season of planting; transport troubles and the use of sets and cuttings; packing and unpacking, and heeling the plants on arrival at their new position, previous to planting them out.

As in the former edition, the present one contains a number of good illustrations. The author may be congratulated on his presentation of the subject.

E. P. Stebbing

EARTHQUAKES AND VOLCANOES

Séismes et Volcans

Par Prof. J.-P. Rothé. (Que sais-je ?, No. 217.) Pp. 136. (Paris: Presses universitaires de France, 1946.)

THIS small book, with approximately the size and format of a British Penguin book, is believed to be the first written by Prof. J.-P. Rothé, of Strasbourg, the seismologist and son of the late Prof. E. Rothé, the distinguished French geophysicist. It is a worthy beginning. The book is accurate though semi-popular.

The five chapters concern the study of the visible effects of severe earthquakes, instrumental seismology and an earth model, earthquake geography, the supposed causes of earthquakes, and there is one chapter on volcanoes. The selection of material for the book has evidently been carried out with considerable care. Three earthquakes especially mentioned are the Provence earthquake of June 11, 1909, the Chilian earthquake of January 25, 1939, and the Roumanian earthquake of November 10, 1940. In a book of this sort it is a definite benefit to have large earthquakes mentioned which have occurred recently, even though there have been greater ones well described in such books as those by Dr. Charles Davison. The Chilian earthquake was undoubtedly one of the greatest earthquakes of the world and was so figured in *Nature* at the time. The macroseismic study of earthquakes still demands attention, for although it may be possible for an earthquake to start in a volume approaching a point, yet the mechanics of plane faulting figure largely both in the immediate cause and effect of earthquakes. Hidden faults have been mapped by instrumentally determined earthquake foci.

The chapter on seismic waves states clearly the elementary ideas underlying earthquake-recording instruments and the records obtained from these, and points out named waves on the records. The paths of these waves are shown on an earth model. There are no mathematics in the chapter, and seismic prospecting is confined to two pages. Seismologists and seismic prospectors will look forward to the promised book by the Rothés which is now being prepared.

The general outline of earthquake geography including deep-focus earthquakes as proved by Scrase is well described, and the regional earthquake geography of two well-explored regions, California by numerous American seismologists and the European Alps by J.-P. Rothé, is ably summarized. I myself feel that more modern attention to such subjects as are dealt with in "La Géologie Séismologique" by Montessus de Ballore would amply repay the time spent.

The 'causes' of earthquakes is a thorny subject, especially where it links up with isostatic theory. Epeirogenic and orogenic movements are considered and emphasis is placed on structure. The convection hypothesis, which incidentally assumes finite viscosity at moderate depths in the earth, is dealt with in conjunction with the gravity axis of Vening Meinesz near the Dutch East Indies. The theory of Wegener concerning moving continents is also mentioned.

Any theory of the origin of earthquakes must be capable of explaining the known facts of earthquake geography, such as the circum-Pacific belt and the South European–Asiatic belt, together with the limited distribution of deep-focus earthquakes and the gradual deepening of foci as we go from Spain via the Pamirs to Java. Seismology as an independent science is still young and has made great strides during the past forty years. That there are more problems to answer is a spur to those working on the subject. That the science is growing quickly is seen by the fact that the latest use of microseismic movement as a storm-centre locator at sea, and thus the use of the seismograph as a meteorological instrument, is not mentioned in Rothé's book.

Volcanoes are associated with earthquakes in the minds of people probably because both are catastrophic and unpredictable, and because both often occur in the same countries. Apart from both being associated with 'young' mountains, they have little else in common. This is made clear in a very concise terminal chapter in this admirable little book.

The books in this series "Que sais-je ?", published by the Presses universitaires de France, together form a popular modern encyclopædia on most branches of human thought. Sixty-eight volumes on pure science are mentioned on the cover. The general idea is commended to publishers of British Penguin and other low-priced books. Ernest Tillotson

X-Ray the City!

The Density Diagram: Basis for Urban Planning. By Dr. Ernest Fooks. Pp. 108. (Melbourne: Ruskin Press, 1946.) 12*s*.

IN this essay on the general principles of town-planning, Dr. Fooks, emphasizing that population density should form the starting point for urban planning, reviews the methods already suggested for measuring the density of population in urban areas and then suggests a new method which would enable a comparable analysis of different cities to be made, free from the confusion of arbitrary administrative boundaries which constitute the major defect in density figures in relation to a whole urban or metropolitan area when considered as a basis for urban development or rehabilitation. To overcome this defect, Dr. Fooks proposes to introduce clearly defined notions for expressing the environmental factor of urban living conditions and for measuring population distribution, and to illustrate the distribution of the population within urban areas by means of the diagram of population density in its various forms, based on the distance grid. He would then replace the vague overall density figures by distance-density figures and distance-density factors; and superimposing on a city plan a circular distance grid, and calculating the densities for individual segments of each concentric ring, he obtains a rational area density diagram which can be used effectively, if not universally, to implement the sociological approach to planning of which Lewis Mumford, F. J. Osborn, T. Sharp and Ebenezer Howard have been such eloquent exponents.

The various functions and facilities of a town can also be analysed on this grid basis, and quite apart from the international adoption of the method for which Dr. Fooks pleads, its interest and bearing on the various proposals for new and satellite towns in Great Britain need scarcely be stressed further.

The book is well produced and illustrated, and an excellent bibliography also enhances its general appeal, apart from its value as a scientific tool.

R. BRIGHTMAN

Alternating Current Electrical Engineering

By Philip Kemp. Seventh edition. Pp. ix+660. (London: Macmillan and Co., Ltd., 1947.) 25*s*. net.

THIS is essentially a students' text-book. It has already served, in six editions, many generations of students and should in the new edition continue to enjoy a well-merited popularity. A good deal of new material has been introduced and considerable sections of the text have been re-written.

In its scope and treatment this book is particularly suitable for use in connexion with National and Higher National Certificate courses, and it should also serve as an introductory text-book for engineering degree courses.

The difficult task of selecting the subject-matter has, in general, been well done; the exclusion, for example, of electronic phenomena and apparatus except in relation to mercury arc rectifiers. It is, however, questionable whether, having regard to present practice, the twenty-five pages devoted to rotary converters are justified.

In a book covering so wide a range of material the treatment of many topics is necessarily somewhat superficial, but in general the essentials are emphasized and a satisfactory picture presented. There are, however, occasional cases of lack of clarity of expression, as, for example, where it is stated on page 281 that "The advantages of hydrogen as a cooling medium are reduced windage and ventilation losses, due to the density of the gas". The treatment of fundamental matters is in the main thorough and satisfactory, but it is regrettable that such an important question as the sign convention which determines the 120° phase displacement of three-phase currents or voltages receives rather scant attention.

J. G.

Die hormonalen Aspekte des Fortpflanzungsprozesses

Von Dr. Jules Samuels. Pp. v+152. (Amsterdam: Holdert und Co., N.V., 1946.) n.p.

Die Hormonversorgung des Fœtus

Von Dr. Jules Samuels. Pp. vii+320. (Leiden: E. J. Brill, 1947.) n.p.

DR. SAMUELS is a gynæcologist and clinical endocrinologist of Amsterdam, and believes that the development of the fertilized ovum is under the direct control of the gonadotrophic hormones of the pituitary and chorion. He also believes that the thyrotrophic factor of the pituitary is identical with the luteinizing factor, and that both the sperm and the ovum contain a store of gonadotrophic substances. These views are a series of speculative and somewhat obscure conclusions derived from a general review of the literature. They are at variance with the more usually accepted conclusion, derived from experimental study, that the gonadotrophic substances exert an influence only on the pre-fertilization phases of development of the gametes. The burden of proof of Dr. Samuels' theses rests upon his shoulders, and until he can provide experimental support for his views they are scarcely likely to command more than occasional interest.

The Gemmologists' Compendium

By Robert Webster. Second edition. Pp. 241+20 plates. (London: N.A.G., Ltd., 1947.) 15*s*.

IT is ten years since this Compendium first appeared. Much additional matter has been incorporated in the new edition. The extensive glossary which constitutes Part 1 includes not only definitions of precious and semi-precious stones, and the trade names by which they are sometimes known, but also explanations of the various technical names used in connexion with the scientific study of gem stones. It has been enlarged, and now occupies one half of the book. Part 2 also has been extended, and deals very thoroughly with the optical, physical and chemical properties and characteristics of precious stones, and the technical methods by which these properties can be determined. Numerous tables of optical and physical constants are included, and there is also a section on artificial gem stones and the methods by which they can be recognized. Among the illustrations are twenty excellent plates, nine of which are coloured. Irrelevant matter of the type often found in books on gem stones, relating to their history and æsthetic value, has been completely omitted; but the book contains a vast amount of accurate and useful technical information arranged in a compact and convenient form. It is primarily intended as a *vade mecum* for jewellers and traders in precious stones, to whom it should prove invaluable; but it also forms a very useful ready-reference work for all in any way interested in gem stones, whether in a professional or amateur capacity.

CROSS-LINKING IN POLYMERIC SYSTEMS

By Dr. G. F. BLOOMFIELD

THE mechanical properties of a natural or synthetic polymer are profoundly affected when the van der Waals' intermolecular forces are supplemented by stable chemical linkages (cross-linkages) between the polymer molecules. In synthetic polymers, cross-linking may generally be brought about either as an essential part of the polymerization reaction, or by chemical modification of the polymer subsequent to polymerization; but cross-linking in natural rubber can only be accomplished by the latter method. Although cross-linkages in synthetic rubbers could be introduced during polymerization if desired, they are, in fact, excluded so far as possible; hence, as with natural rubber, it is necessary to carry out the cross-linking reactions on the polymer itself. In a recent series of lectures at the Royal Institution, London, various types of cross-linking mechanisms and their effect on the properties of polymers were discussed. Dr. H. P. Staudinger dealt with the cross-linking of vinyl polymers, the present writer discussed the structural modification of high polymers by vulcanization, with particular reference to rubber, and Dr. L. R. G. Treloar described the relation of mechanical properties to the degree of cross-linking in rubbers. Phenol-formaldehyde resins, in which the role of cross-linking reactions is rather less clear, were surveyed by Mr. E. G. K. Pritchett. My thanks are due to the board of the British Rubber Producers' Research Association for permission to contribute to this series of lectures and to prepare the following summary of them.

Permanent cross-linkages prevent irreversible flow and so contribute essentially to the reversible character of a deformation. Resistance to plastic flow, to thermal deformation and to solvents is thereby increased. A low degree of cross-linking, that is, less than one cross-linkage per polymer molecule, is insufficient to impart any real resistance to deformation, since the interlinked molecules still behave essentially as a linear, although highly branched, molecule; but as soon as two or more cross-links per molecule are introduced, there results a network in which flow is impeded. A high degree of cross-linking, on the other hand, leads to a highly rigid structure.

In order that rubber-like elasticity may be realized, some compromise is necessary between flow and rigidity, excessive cross-linking leading to a complete loss of rubbery characteristics.

Vinyl polymerization provides a useful means of studying the effect of cross-linking on the physical properties of polymers, particularly the flow properties, if the second-order transition temperature, *Tm*, can be taken to indicate the onset of viscous flow. A close relation between *Tm* and the average number of vinyl monomer molecules between cross-link junctions can be established. Cross-linking may be accomplished either by co-polymerizing bi- and tetra-functional monomers (for example, styrene with divinyl benzene, methyl methacrylate with allyl methacrylate), or by chemical reaction of a linear polymer containing reactive substituent groups with a substance of low molecular weight (for example, a copolymer of methyl acrylate and maleic anhydride is treated with ethylene glycol). In the first category the properties of the product may range from solubility and fusibility to complete insolubility and infusibility, depending on the relative amount and on the nature of the cross-linking agent in the co-polymer. Although in its initial stages the process of cross-linking with tetra-functional monomers can be interpreted by the kinetics of co-polymerization as applied to bifunctional monomers, where the relative amounts of the monomers and the relative reactivity of their double bonds are the determining factors, a full kinetic interpretation becomes extremely difficult, once inter- and intra-molecular reactions between polymer chains occur as part of the growth process in addition to the four growth reactions which are possible between polymer radicals and monomers. Fundamental differences in the polymerization mechanism arise when the degree of cross-linking is sufficient to give a gel due to a three-dimensionally interlinked network structure, for although the polymerization-rates are not significantly changed when the concentration of the cross-linking reagent is low, there is a marked increase in rate, coinciding with the appearance of the gel, when more of the cross-linking component is used.

Considering that termination is a bi-molecular reaction with respect to polymer radicals, the high viscosity of the medium—which is infinite once gel formation has occurred—will restrict diffusion of, and reduce collision between, polymer radicals, thus reducing the termination-rate; while propagation, involving diffusion of, and collision with, monomer, is little affected.

In order to exercise some measure of control over cross-linking by copolymerization, it is desirable to select types of double bond of widely different reactivities within the cross-linking molecule, the ideal being to produce a linear molecule by polymerizing the vinyl bonds, and then to promote a cross-linking reaction involving the less reactive bonds by a rather more drastic treatment. In practice, polymerization is first conducted to a point short of gelation, and the resulting syrup is used for casting or impregnation. An outstanding advantage of the new technique is that it requires no high-pressure equipment, and is accordingly very suitable for the fabrication of structures of considerable size.

A particularly undesirable form of cross-linking in vinyl polymerization is that responsible for 'popcorn' formation, in which small particles resembling popcorn grow rapidly with considerable volume expansion. 'Popcorn' formation is determined mainly by temperature and the proportion of cross-linking agent, consequently control involves both of these two factors. 'Popcorn' can itself initiate fresh 'popcorn' growth in virtue of its hydroperoxide content, or as a result of electronically stabilized radicals becoming reactive.

In cross-linking by chemical modification subsequent to polymerization, it is necessary that the polymer should contain functional groups (for example, ethylenic linkages) or reactive substituents (for example, halogen, hydroxyl, carboxyl).

An important aspect of cross-linking by chemical reaction is that comprising the whole field of rubber vulcanization; in fact, any reagent which is capable of providing intermolecular linkages between two or more polymer molecules is capable of vulcanizing rubber. The properties of the resulting vulcanizate, however, depend not only on the nature and number of the cross-linkages, but also on the possibility of side reactions and on the treatment necessary to promote reaction, and consequently they vary widely.

Rubber vulcanizing agents fall into two classes: those giving rise to radical reactions leading to carbon-carbon cross-linkages, and those which affect bridging through the agency of a bifunctional atom or molecule which itself forms the cross-linkage. The simplest example of carbon-carbon linking is provided by photogelling; cross-linking reactions of benzoyl peroxide, diazoaminobenzene and other reagents which decompose thermally to give free radicals are believed to follow a similar course. Bifunctional reagents include dinitroso compounds, azodicarboxylates, hydrogen sulphide, dithiols, sulphur chloride, and, most important in technical rubber practice, sulphur. The essential cross-linking reaction of sulphur consists in the establishment of a polysulphide bridge between two of the originally unsaturated molecules, with loss of one of the original double bonds and a displacement of the other. A necessary prerequisite of a cross-linking agent is that it shall react intermolecularly. The 1 : 5 diene system in rubber is, however, particularly prone to form intramolecular cyclic linkages when the reagent contains only one or two atoms between its reactive ends, and sulphur is no exception. The formation of tetrahydrothiopyrans has been demonstrated in the reaction of sulphur with small polyisoprenic molecules, and the low efficiency of sulphur as a cross-linking agent for rubber is undoubtedly to be attributed, at least in part, to its participation in cyclic linkages of the tetrahydrothiopyran type. A contributory cause of the low efficiency of sulphur is its participation in polysulphide rather than monosulphide cross-linkages. Rubber vulcanization is consequently very susceptible to small amounts of auxiliary substances capable of promoting intermolecular rather than intramolecular linkage, or capable of promoting monosulphide rather than polysulphide cross-linkages. Certain accelerated vulcanizates accordingly exhibit a much higher efficiency of cross-linking, although they still fall short of the theoretical maximum of one cross-linkage for each sulphur atom incorporated.

From the theoretical point of view, a vulcanized rubber is visualized as a three-dimensional network of molecules, the mechanical properties of which may be calculated by the methods of statistical thermodynamics. The physical basis of this approach is the assumption that the individual chains (or portions of molecules between successive junction points) are in a state of random thermal fluctuation of form, by virtue of the relative freedom of rotation about single bonds in the chain. This kinetic basis provides a reasonably satisfactory quantitative background for such physical properties as the form of the stress-strain relations in any type of strain, the effect of progressive vulcanization on tensile strength, the optical double refraction due to strain, and the principal phenomena of swelling in diverse liquids. By the use of certain simplifying assumptions it is possible to derive the following force-extension curve for a vulcanized rubber:

$$F = (\rho RT/M_c)\,(\alpha - 1/\alpha^2), \qquad (1)$$

where F is the tensile force, referred to the original cross-section, α is the ratio of the stretched to the unstretched length, ρ the density and M_c the 'molecular weight' of the chains between successive points of cross-linkage. Two interesting features of this equation are worth noting: first, the form of the stress-strain curve is determined by $(\alpha - 1/\alpha^2)$, and should therefore be the same for all rubbers, whatever their chemical constitution; and secondly, the modulus $(\rho RT/M_c)$ should be inversely proportional to M_c, the chain-weight between points of vulcanization, or alternatively, directly proportional to the number of cross-links.

Generally speaking, these theoretical predictions have been borne out experimentally. For a series of rubber-sulphur vulcanizates Gee observed a direct proportionality between modulus and percentage of combined sulphur, while Flory, in a comprehensive investigation of a range of butyl rubbers, obtained close agreement with the slightly modified formula

$$F = \rho\,\frac{RT}{M_c}\left(1 - \frac{2M_c}{M}\right)(\alpha - 1/\alpha^2) \qquad (2)$$

(M is molecular weight before vulcanization, M_c is molecular weight between junction points), in which the effect of terminal chains connected to the network at one point only is allowed for.

The swelling of rubbers by liquids is a phenomenon closely related to the mixing of two liquids. For a good swelling agent it is found experimentally that the absorption of the solvent is accompanied by very little change of energy. It is, however, accompanied by a very large change of entropy. Equilibrium swelling is achieved when the entropy increase due to the absorption of an additional small quantity of liquid is balanced by the entropy decrease due to the expansion of the elastic molecular network. Both the entropy of mixing and the network entropy can be calculated, and in this way it is possible to predict quite accurately how the maximum swelling will depend on the degree of cross-linking. Since the modulus also is determined by the degree of cross-linking, it follows that there should be a close relation between the modulus and the maximum swelling for a series of rubbers of different degrees of cross-linking. The quantitative relation worked out by Flory indicates that the modulus should vary inversely as the five-thirds power of the maximum swelling ratio—a relation which was found to be very closely borne out by Flory's data for butyl rubbers.

A phenomenon which is at first sight rather surprising, and for which, until recently, no explanation had been given, is the rapid fall in the breaking strength of natural rubber vulcanizates which occurs when the degree of cross-linking is increased beyond the optimum value. In a recent publication by Gee, evidence is brought forward which indicates that the effect may be explained in the following way. With increasing cross-linking the modulus continuously increases, and at the same time the elongation at break tends to fall progressively. But with reduced extensibility there is reduced molecular orientation and therefore very probably a reduction in the degree of crystallization. It is this reduced crystallization which gives rise to the reduction in tensile strength, since the crystallites have the effect of introducing strong binding forces between the molecular chains.

In the field of thermosetting resins, the role of cross-linking reactions is by no means so well established as in vinyl polymers and in rubber. Although the conception of cross-linking by methylene groups at the *p*-positions of the benzene rings is widely accepted, there are difficulties in the general application of this principle, since it is not at all certain that hydroxyl groups may not also be involved in the thermosetting reaction; and it is noteworthy in this respect that *p*-cresol resins show some thermosetting properties. Models indicate that methylene-linked structures are extremely rigid, since rotation of the benzene rings is very restricted sterically ; thermosetting linkages may possibly involve only a few of the benzene rings, so giving a plausible explanation of the low tensile strength of phenolic resins. An entirely new conception proposed by E. G. K. Pritchett envisages a mechanically interlinked rather than a chemically cross-linked structure, the extreme rigidity rendering the substance insoluble and infusible.

SALMON AND ANIMAL MIGRATION

By Dr. A. G. HUNTSMAN

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MORE than two thousand years ago, Aristotle wrote that all the actions of animals are for breeding, for feeding and to avoid extremes[1]. Clearly such motivations of migration satisfy those who ask why animals migrate ; but have they been verified and are they verifiable ? Are they still accepted as explanations of migration, the only problem being to discover how the animal can accomplish wonderful feats ? Has such an attitude been successful in elucidating migration ? The statements that for birds "this question has been extolled as a mystery of mysteries"[2] and that for the salmon migration is accomplished by "an instinct which man cannot comprehend"[3] are not reassuring.

If the matter is not yet clear, it may be because the proper approach has not been used. Perhaps migration should be considered merely as wandering, as was the original meaning. Facts against the prevalent ideas have long been known[4]; but no attempt seems to have been made to develop theories to include them, except as divorced from 'true migration', which has the idea of purpose either of the animal or of 'Nature'. It is not clear how we can verify the animal's purpose, and, as to Nature's purpose, it may be a mistake to assume that the animal's behaviour should be useful for survival, rather than merely not incompatible with survival of some of the race somewhere. If migration is merely wandering, that is, changing the place of abode, the problem is when and whither will an animal wander in view of its nature and of the conditions to which it is exposed. There has been a growing tendency to treat the matter thus objectively, which may permit accurate prediction.

For more than a decade, the Fisheries Research Board of Canada has been intensively studying the salmon (*Salmo salar*) as a somewhat representative fish. This study has provided the main facts with which we are attempting to develop a true science of fish migration.

No simple method of salmon behaviour will permit accurate prediction, since they behave most variously, as the following examples show. They may or may not spawn as parr before moving from the locality where they were spawned. On metamorphosing into smolts in the spring, they fail to spawn in that year and may or may not spawn in subsequent years up to the fifth. Usually, parr remain in streams, smolts and kelts (adults after spawning) descend, and near-spawning adults ascend ; but salmon may or may not descend to or ascend from the sea as parr[5], as smolts, as near-spawning adults and as kelts[6]. Clearly, the idea that their migrations are between breeding grounds in rivers and feeding grounds in the sea is inadequate. Some differences in behaviour have been ascribed to differences in original nature (sub-species or races) ; but for none of these has the original nature of the individuals been shown to be different, while correlations with environmental differences are evident and experiments fail to show that offspring of those behaving differently will behave differently under the same conditions, for example, for descent to the sea, that is, "migratory and non-migratory races"[7] or for time of return to streams, that is, "early and late running races"[8].

One theory that fits the facts, but that can be only part of the complex whole, is quite simple. It is that in the rapid water of a stream the fish is carried down (as it must be more or less) in its descending, and swims actively up (as it must) in its ascending migration, these being the only directions in which stream fishes can migrate. The well-known upstream orientation of fishes, or rheotaxis, which may or may not be elicited by the flowing water, depending upon the conditions, and the more or less active swimming of the fish are all that the theory requires. Underyearling salmon have been found to vary sufficiently to separate into two groups when placed in a rather strong shallow current—those that ascend and those that descend—but they all head upstream. Similarly, when with a strong freshet in the rivers the salmon in the sea left the east coast of Sutherland near Brora for the rivers, 'droppers', that is, salmon that had ascended the rivers and remained there for some time, but had dropped down again, appeared in coastal nets[9].

When entering the smolt stage, for which descent is typical, salmon behave most variously. With higher, that is, swifter water, more descend[10,8]. Some descend quickly, some very slowly, and some fail to descend ; yet they would all leave the stream in a few hours if they merely kept up from the bottom and headed downstream. Smolts marked as they left Forest Glen Brook for the large North-East Margaree River, Nova Scotia, in the spring of 1938, arrived at a trap fifteen miles down that river in from 1 to 28 days or more. It is judged that they all could, if headed right, have descended in 12 hours. In swift water they descend tail first swimming vigorously upstream, and they sometimes ascend rapids, as may be seen when they near a trap placed in swift water. That in slow water descending fish all head downstream into a trap may mean nothing more than that all the others, if swimming faster than the water flows, are certain to be moving upstream, since the narrowness of the stream prevents movement any distance in directions other than up and down. In a lake, roaming near the surface would be apt to take them near enough to the outlet for the current to act.

In September and October of 1945, smolts were still to be found above beaver dams in Holmes Brook near Moncton, New Brunswick, in spite of freshets that were thought to have brought them down. This finds explanations in observations by Mr. C. W. Andrews in trapping smolts on the neighbouring Pollett River. With quite low water in 1944, smolts known to be in the pool above the trap failed to descend during the forty-three subsequent days of operation of the trap and no rise in water. In late evening he saw them to have descended to the brink of a shallow rapid, and they moved back up to the pool by morning. Clearly, when near the surface and down to this rapid in the evening, strong rheotactic reaction due to their nearness to the bottom[11] caused them to swim upstream more rapidly than the current carried them down. With deeper water, they would face less stimulus when at the surface and the current would be stronger. He showed experimentally in 1946 that increase in water-depth at the rapid from four to twelve inches or more resulted in descent of smolts into the trap. In work in progress, underyearling salmon in round rearing pools are seen to migrate downstream, swimming with the current, in a zone of weak current up from the bottom, when in poor condition and at unfavourably high temperature. On these and other facts is based the conclusion that salmon descend when they both wander about and fail to react strongly enough in current to remain upstream. Evidence fails of salmon at any stage heading downstream in response to strong current.

Upstream migration is more easily understood, since fishes react to current by heading upstream. Salmon may ascend from the sea a year before spawning. Even when congregated at the river mouth, they frequently fail to ascend when ascent is easy with low, slowly flowing water, but ascend quickly in spite of the greater energy required with the increasing flow of a freshet (even artificial), unless the flow is quite strong[12]. Also, they ascend at times at least a short distance when the river water is so warm that they are killed by heat stroke[13]. On these and other facts is based the conclusion that salmon ascend when they both wander about and are sufficiently stimulated to swim upstream in rapids. The stimulus may come from increase in stream flow, from wandering of the salmon into more rapid waters or in other ways.

Even a stream in heavy flood has relatively quiet water at intervals where salmon will remain if resting on the bottom. It will depend upon how they move and how the water moves as to whether or not they migrate when active. Rheotaxis is the reaction of stream fishes that permits them to continue living in streams when they move about, their swimming upstream counterbalancing the current which would otherwise carry them out. This orientation is effected through relation with the bottom, even to frequent contact[11], which relation diminishes and disappears with increase in distance of the fish from the bottom.

A one-way current and a variable counter-current reaction by the fish form a proper basis for Meek's[14] denatant-contranatant theory of migration. Salmon are clearly to some extent both denatant (going with the current) and contranatant (going against the current) at all stages, so that the theory is applicable to them in one-way freshwater streams of sufficient strength and shallowness, as observation readily shows. In pools with deep, very slowly moving water, evidence for it fails and other factors must operate. Meek's theory has been used to explain migration of sea fishes, but proper evidence seems to be lacking, even for its action in estuaries. The facts given us as to the movement of salmon in estuaries, even shallow ones, are that they move inwards with flooding tide, that is, with, not against, the current. We have failed to get evidence of contranatant migration in the sea of either herring or salmon except in restricted tidal rapids with the fish not far from the bottom.

In general, movements of the salmon in the sea seem to be in all horizontal directions and more or less to and fro, as shown by the facts of their capture and of recapture of tagged fish. Their movements are clearly determined by the conditions they meet. They become inactive with the near zero (° C.) temperature of winter. Feeding actively as the water warms in the spring, they apparently do not roam and are not caught until they are ceasing to feed, which happens as early as May for large fish in eastern Canadian waters, but not until August for post-smolts, which corresponds with their relative fatness. They tend to hold position in rapids, which results in their collecting in channels and at river mouths. With steep salinity gradients, they tend to keep in water of low salinity, as the facts of their capture and of recapture of tagged fish show, which results in their reaching rivers. Also they tend to keep in water like that of the home stream[15], which is apt to take them sooner or later to the home stream, if far from it.

With such behaviour, they collect in the river outflow as the season progresses, but do not necessarily ascend. Some stimulus seems to be required for them to do more than swim sufficiently to hold position at the river mouth. A freshet may start their ascent, which is directed by rheotaxis. Underyearling salmon in a trough ascend quickly when stimulated by a local rapid increase in flow from lowering of the surface level downstream, although ascent then requires more effort. Adult salmon, when stimulated by the increased flow of a freshet, will for the most part not ascend when the current is strongest at the height of the freshet, but only as the current weakens. When sharp, stimulating, artificial freshets were made in the Moser River, Nova Scotia, in the dry season of 1942, more than twice as many salmon entered as were to be expected from counts of smolts and adults for the preceding three years[11], with the water generally so low that the fish could be readily caught in the evening on the rapids by poachers who made rough traps or mazes of stones for the purpose. With such freshets in the somewhat wet season of 1943 and with the native grilse having been marked the previous year as smolts, from one quarter to more than one half of the entering grilse were unmarked and presumably foreign fish[16], the proportion rising with advance in the season and particularly with heavy floods that doubtless brought in fish that were farther out to sea. Even through the spawning period, with continued absence of freshets from summer to the December freeze-up in 1946, salmon did not appear in traps operated on Holmes Brook, North River and Bennett Brook above the main Petitcodiac River, as they had done in previous years in going to spawning grounds, even though some were in the main river from midsummer[17]. If salmon must be stimulated to go upstream to spawn, should they be used as the chief example among fishes for true migration, defined[18] as "a racial custom, enregistered in the animal's constitution"?

With pressure of a dense population, planted salmon spread more widely, as planting experiments have shown. The facts indicate that the brook trout (*Salvelinus fontinalis*) shows this factor by failing to migrate down to the sea when heavy fishing lessens population pressure. The room required to stop migration changes with increase in size of fish, so that large fish are generally found in lower, larger waters. Planting of tagged kelts above Shubenacadie Lake has just shown extent of descent to large lakes or the sea to be correlated with the size of the fish.

I am deeply grateful to many colleagues who, with other ideas, have kindly responded to appeals for criticism, greatly aiding this presentation of the matter.

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SUBMICROSCOPIC STRUCTURE OF THE BACTERIAL CELL, AS SHOWN BY THE ELECTRON MICROSCOPE*

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THE wall of the bacterial cell is solid. The cell-wall may maintain its approximate shape after cytolysis; on breaking it may present a jagged line of fracture[1]. Within the cell-wall, and normally doubtless closely applied to it, is the cytoplasmic membrane enveloping a fluid or potentially fluid protoplasm. In electron micrographs the protoplasm often is appreciably separated from the cell-wall[2]. This is doubtless a shrinkage artefact due to desiccation in the electron microscope, which operates in a high vacuum. The protoplast and in particular the cytoplasmic membrane are stained and visible, the cell-wall unstained and not seen, in routine bacteriological preparations. Flagella, if present, arise from the protoplast and pass through the cell-wall, at least in vibrios. They are of uniform diameter somewhat characteristic of the bacterial species. They are not artefacts or mucous threads[3]. Capsules, as in the case of the pneumococcus, are extracellular gels surrounding the cell-wall[4].

Combination of bacterial antigens with antibodies may be directly observed with the electron microscope. Specific antibodies combine with somatic and flagellar antigens of non-capsulated bacteria to form surface deposits, respectively, on the cell-wall and flagella[5]. Non-specific components of serum (complement) may be adsorbed secondarily on the antigen-antibody complex[2]. Antiserum permeates the capsular gel of the pneumococcus; antibody combines with homologous capsular antigen and non-specific serum components are adsorbed; the swollen gel resulting is opaque to electrons[6].

Study of the internal structure of the bacterial protoplast has been retarded by the 'opacity' to electrons (diffuse scattering of electrons) of the protoplast, in particular of Gram-positive species, and by insufficient contrast of structures within the protoplast. In the special case of the sporulation and spore germination of an aerobic bacillus (*Bacillus mycoides*), Knaysi, Baker and Hillier[7] have revealed much additional detail by the use of a research model electron microscope operating at higher than ordinary voltage (150 kv.).

Knaysi and Baker[8] have also discovered an elegant method of making internal structure more apparent. *Bacillus mycoides* is grown in a nitrogen-free glucose-containing medium, buffered with sodium acetate. Under these conditions the electron-scattering ribonucleic acid of the cytoplasmic membrane and protoplast is reduced to a minimum, and two types of internal structures are revealed. The first are opaque bodies 0·22 by 0·29 μ to 0·43 by 0·50 μ in diameter; one to six of these are found in each cell; these bodies are present in all stages of development; they divide; they are included in the forespore when sporulation occurs; they take nuclear stains. They are interpreted as nuclei.

The second type of bodies are thin, each with circular or elliptical outline; they are 0·08 to 0·17 μ in diameter; a few to about forty are present per cell. "They are part of the cytoplasmic membrane and, except when they appear homogeneous, they cannot be structurally differentiated from the rest of that membrane. Both seem to consist chiefly of a net-work of beaded threads and granules, probably representing complex molecules." Electron micrographs of *Bacteroides funduliformis* by W. E. Smith, Mudd and Hillier also show a finely reticulated structure of the bacterial protoplasm[9].

The structure thus far made manifest in the bacterial cell, even with the aid of the electron microscope, is much simpler than the remarkable synthetic capacities of bacteria would seem to require. Cells of many kinds of bacteria, furnished only with water, salts, glucose and simple sources of carbon and nitrogen, can synthesize proteins, complex carbohydrates, lipids, ribose and desoxyribose nucleic acids, growth accessories and enzymes, all organised into characteristic and reproducible protoplasmic systems. The cell can reproduce itself and divide within half an hour at body temperature. These feats of chemical synthesis and organisation, which cannot be duplicated by the finest chemical laboratories in existence, are accomplished within a cell a few microns in length and less than a micron in diameter. The plain facts would seem fantastic if they were not so familiar.

W. Seifriz, K. H. Meyer and others[10] have pointed out that the elastic and thixotropic properties of protoplasm imply a three-dimensional lattice of elastic and solvated protein molecules or micelles. The width and thickness of extended molecules of ordinary proteins (about 10 A. by 4·5 A.) are at, or just beyond, the present limit of resolution of the electron microscope, when full resolution is taken advantage of by use of the techniques of shadow-casting[11], or of surface replica[12]. Globular protein molecules[13] and fibres composed of a small number of aggregated, extended protein molecules are detectable under favourable conditions with the electron microscope. The electron micrographs of bacteria cited above and those of Porter, Claude and Fullam[14] of the hyaloplasm of fibroblasts are compatible with the reticular protein framework which has been postulated as necessary to explain the physical properties of protoplasm.

It may be useful to proceed in imagination beyond the present visual evidence of fine structure. The interstices of the reticulum may be supposed to be filled with an aqueous phase. The simultaneous occurrence of complex reactions, involving energy utilization, synthesis, and organisation of the materials elaborated, implies means of keeping the reactions in proper temporal and spatial relation to each other, and implies organisation equivalent to an efficient system of transport and logistics. Substrates and enzymes must be brought together, the structural units of proteins must be synthesized and brought to the 'templates' at the surfaces of which further syntheses may be supposed to be determined; completed molecules must be added in their appropriate places to cell-wall, cytoplasmic membrane, nucleus, or even capsule or flagella, all in orderly, rapid and reproducible sequence.

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* From a Symposium on Electron Microscopy at the Nobel Institute of Physics, Stockholm, Sweden, July 16, 1947, in connexion with the Sixth International Congress for Experimental Cytology.

Necessary segregation of reacting systems may be effected in part by the internal organisation of the submicroscopic particles present in protoplasm[10]. Some of the requirements of segregation and of transport may be supposed to be met by films of lipid or of lipoprotein across the interstices of the fine reticulum of the protoplasm. Lipid-aqueous phase interfaces tend to adsorb polar–non-polar molecules and particles and to transport them along the interface from regions of low to regions of higher interfacial tension[15]. The effects of oriented molecules in such interfaces on the orientation and distribution of molecules in the adjacent phases may be supposed to be additional factors in organisation[16].

Such considerations furnish only an imaginative sketch, in vague and general outline, of some of the features of the fine structure of bacterial protoplasm. Are there reasonable grounds for hope that electron microscopy may throw light on the actual fine structure of protoplasm? There are such grounds. The micellar and macromolecular fine structure of protoplasm is within the powers of *resolution* of even present-day electron microscopes. Analysis of the ultra-structure of nerve axoplasm[17] and of various fibrous structures[18] has indeed made significant progress. The problem of preparing specimens sufficiently thin so that fine structure is not overlaid and obscured, and with sufficient contrast so that fine structure is detectable, without essential alteration of the natural structure, has thus far only been partially achieved in a few favourable instances. Techniques of increasing contrast by selective combination with chemicals containing atoms of high atomic number[18,19] have been explored to the point of showing them to be feasible; but their exploitation has only begun. It is challenging at least to realize that study of submicroscopic fine structure with the electron microscope is limited by technical difficulties rather than by the inherent nature of image formation, as is the case with the light microscope.

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OBITUARIES

Dr. Henri Deslandres, For.Mem.R.S.

By the death on January 15 of Henri Deslandres, born in Paris on July 24, 1853, the Paris Academy of Sciences has lost its senior member, and astronomy and spectroscopy have lost one whose active researches go back more than sixty years. Destined for an army career, he resigned in 1881 when a captain in the Engineers and devoted himself to spectroscopy and astronomy. His earliest papers on band spectra date from 1885, and he continued his work until last year, publishing his last paper in the *Comptes rendus* within a week of his ninety-fourth birthday. Even at that age he suggested taking up fresh work as soon as sufficiently accurate material was available. Laws connecting the wave numbers of separate lines in the same band and of the heads of different bands are associated with his name.

In 1889 Deslandres was appointed an assistant at the Paris Observatory and placed in charge of the spectroscopic investigations. He at once began work on radial velocities of stars, on planetary rotations, on cometary spectra, and on solar physics. In his work on the photography of prominences and features on the sun's disk in monochromatic light, he developed the spectroheliograph independently of Hale, to whom, however, priority of invention was awarded; but he also designed the *spectro-enregistreur des vitesses*, which showed the sight-line motions of the gases giving the features in the monochromatic pictures. Instead of a very narrow second slit and continuous motion, he used in this instrument a wider second slit and obtained a series of stationary photographs of successive narrow sections of the sun's disk. How good his technique was, and what beautiful results he could obtain with both types of instruments, were amply shown after he became director of the Meudon Observatory on the death of Janssen in 1907. His work gave an insight into the circulation taking place in the solar atmosphere in disturbed regions, and laid the foundation for the excellent studies now continued by his colleague and successor, Dr. L. d'Azambuja. In particular, he examined the differences between the layers of the solar atmosphere photographed in different narrow sections of the lines $H\alpha$ and K. His work on sunspots and connected solar phenomena led to a study of the connexion with terrestrial magnetic storms, and of the nature of the charged particles emitted by the sun.

Deslandres was appointed director of the Paris Observatory in 1927 and retired in 1929. He was elected an associate of the Royal Astronomical Society in 1904, received its Gold Medal in 1913 and became a foreign member of the Royal Society in 1921. He received the Bruce Medal of the Astronomical Society of the Pacific and was a foreign member of many national academies. He remained mentally alert to the end of his long life, and died of pneumonia after several months of growing physical weakness.

We regret to announce the following deaths:

Prof. Selig Hecht, professor of biophysics in Columbia University, on September 18, aged fifty-five.

Sir Arthur Huddleston, C.M.G., O.B.E., director of the Royal Technical College, Glasgow, since 1933, and previously a member of the Sudan Political Service, on February 11, aged sixty-seven.

NEWS and VIEWS

Importation of Books into Britain

Lord Balfour of Inchrye, speaking in the House of Lords on February 19, directed attention to the effects of the present restrictions on the import of books into Britain. He said that we cannot afford to fall behind in the application of modern scientific developments, and due to the difficulty in publishing books there is danger that Britain will be cut off from the exchange of ideas and knowledge. He suggested the imposition of a maximum time-limit for dealing with applications for import licences, that the permissible quantities of book imports be increased, and that there should be blanket licences of specified amounts for universities, libraries and approved scientific bodies. Lord Chorley, Lord in Waiting, in reply, said that the President of the Board of Trade is discussing with representatives of the learned institutions their difficulties in obtaining books, particularly from the United States. As a result of those discussions, an increase in the quota may be granted, though he would not hold out a promise that it would be up to the 200 per cent of the pre-war amount which had been suggested.

Conscription and Industry

An article by D. R. O. Thomas (*J. Inst. Personnel Management*, 29, No. 293; September–October 1947) directs attention to the possible effect on industrial efficiency of the withdrawal of large numbers of young men for national service requirements. Under the Act, which becomes operative on January 1, 1949, men between the ages of eighteen and twenty-six years are to be called up for national service for a period of twelve months, the actual call-up age being eighteen, and thereafter each man will serve 5½ years with the reserve, during which he is required to do sixty days training. This, and the new developments under the 1944 Education Act in respect of the raising of the school age to sixteen years and the establishment of county colleges, will mean that industrial organisations will be faced with the prospect of starting youths in employment at sixteen years and afterwards releasing them for one day in five, up to eighteen years, when they will disappear altogether for twelve months. On return to employment, the young man will be required to do two weeks Service training per year for 5½ years, which, together with his annual holiday, may mean his being absent from industrial employment for one month in every twelve until he is about twenty-five years of age.

Remembering, too, that the effects of the lower birth-rate will be strongly felt within the next decade, these national service requirements are bound to cause difficult problems for management in industry. It is essential, therefore, as Mr. Thomas points out, that the national service period should be used as efficiently as possible and should fit carefully into a scheme of training and experience, from school-leaving age to twenty-one or so, which will provide a useful apprenticeship to the responsibilities of work and citizenship. To offset the loss of industrial time, industry itself must make the best possible use of the time available in providing young people with specific training for their jobs. The rest of the article makes cogent suggestions for training schemes for various types of recruits and indicates how the difficulties of deferment for apprentices and students can be overcome.

U.N.E.S.C.O.: New Appointments

The following new appointments in U.N.E.S.C.O. have recently been announced:

Dr. Clarence E. Beeby, director of education in the New Zealand Government, to be assistant director-general, concerned chiefly with the co-ordination of educational activities. Dr. Beeby, head of the New Zealand Delegation to the Second Session of the General Conference in Mexico City (November–December, 1947), was also chairman of the Programme and Budget Commission and thus is already well familiar with the aims and the activities of the Organisation.

Prof. Emile Auger, member of the French Atomic Energy Commission, to be head of the Natural Sciences Section. Prof. Auger was a member of the French Delegation to the General Conference of U.N.E.S.C.O. and has for the past year been a member of the Executive Board of the Organisation. He will replace Dr. Joseph Needham in that post. Dr. Needham, after nearly two years service with U.N.E.S.C.O., is returning to his post at the University of Cambridge.

Prof. Pedro Bosch Gimpera, to be director of the philosophy and humanistic studies section. Prof. Gimpera was formerly Dean of the Philosophy Department of the University of Barcelona. He has lately been professor in the University of Mexico.

Mr. Gordon Menzies (Australia), to be director of administrative services.

War-time Work of the American Academies

"The Ethnogeographic Board", by Wendell C. Bennett (*Smithsonian Misc. Coll.*, 107, No. 1; 1947), is a history by one of its members of an organisation for harnessing the academic institutions of the United States to the war machine. It was set up by the National Research Council, the American Council of Learned Societies, the Social Science Research Council and the Smithsonian Institution in June 1942 and continued until the end of 1945. It was not an official body and it was financed and supported by the organisations which founded it, particularly the Smithsonian; but it was very largely used by the Armed Forces and Government departments, and is described as a "clearinghouse for Government needs and Academic knowledge". It consisted of a directorate, situated in the Smithsonian, which was the Washington office of the Board and did most of the work, and the Board proper, which was advisory. It produced reports on various areas, and lists of people with knowledge of foreign parts, and it undertook special projects, of which a booklet called "Survival on Land and Sea" was one of the most valuable and was widely circulated to the Armed Forces in the Pacific theatre. It had no equivalent in Great Britain, where the type of information supplied was collected by Service departments, such as the naval and military intelligence organisations and the Inter-Services Topographical Department.

Dr. Bennett gives a straight account of the Board and its activities, pointing out its strength and its weaknesses, and makes suggestions as to how such a body should be organised if needed again. (One of these is that it might have a better name!) Some points are of general interest, particularly the first paragraph on war-time Washington, beginning "Fo[illegible] the millions who milled around Washington in t[illegible] first half of 1942, no statement about the fabu[illegible] confusion could ever be adequate . . .", and [illegible] following statement about the search for peopl[illegible] could compile special reports: "The Board found that those who were still in their academic settings managed to find time for something within their competence which was directly concerned with the war. Once a scholar was in Washington it was hard to get much out of him, and once he got into uniform, however sedentary the assignment, it was almost impossible."

Science and Society in Ancient China

In his Conway Memorial Lecture, "Science and Society in Ancient China", delivered on May 12, 1947, Dr. Joseph Needham attempts to sketch a pattern of the organisation of Chinese feudal society and its relation to Western European society (London: Watts and Co., Ltd. 2*s*. net). While the Taoist hermits who withdrew from human society to contemplate Nature had no scientific method, they tried to understand Nature in an intuitive and observational way, and the earliest chemistry and astronomy in Asia had Taoist connexions. In ancient China, although Taoist empirical mysticism favoured the development of science, Confucian ethical rationalism was antagonistic, and it could not be claimed that all through history rationalism had been the chief progressive force in society. While inventions and technological discoveries such as gunpowder, paper, printing, the magnetic compass and efficient animal harness, which changed the course of civilization, were made in China, modern science and technology did not develop them. Dr. Needham points out that the status of military technology may deeply affect the crystallization of social philosophy, and that a moral question such as slavery may be closely connected with technical factors. Philosophical and ethical thought, he believes, can never be dissociated from their material basis, and he thinks that Chinese civilization was basically inhibited from giving rise to modern science and technology, because the society which grew up in China after the feudal period was unsuitable for these developments. Dr. Needham concludes by commending a closer study of the great classics of Chinese philosophy and of the parallel course of technology in China.

Interchange of Technical Publications in Sheffield

A report on the progress made during the last year by the Organisation for the Interchange of Technical Publications in Sheffield was presented to the fifteenth annual general meeting held in the Central Library, Sheffield, on December 2. This Organisation controls a system of co-operative borrowing of books, periodicals and other records, between the numerous special libraries in the Sheffield area. Recent activities of the Organisation have been directed to other ways of assisting research and development now that the effective pooling of technical publications and information has been operating for many years. The annual report shows that 1,459 publications were borrowed last year. A survey of the location of foreign patents in British libraries was undertaken; through the Association of Special Libraries and Information Bureaux, the Patents Office was asked to close the gap in indexes and abridgments to British patent specifications left during the War; and an inquiry made as to the mount of assistance obtainable from the Neder- ndsch Instituut voor Documentatie en Registratuur foreign patent searches. At the annual general ting, it was decided to ask the Board of Trade ave the mass of documents relating to war-time German industry held by the Technical Information and Documents Unit of the Board abstracted and indexed on similar lines to the work done in the United States by the Air Technical Intelligence and to have the more important items translated on the advice of technical experts. It was also recommended that files of the microfilms taken by the Board of machine drawings selected from this collection should be deposited with the leading technical libraries of Britain. Twenty-four firms and seven societies and institutions now belong to the Organisation.

Textile Laboratories at Leeds

The International Wool Secretariat has for the past ten years given increasing support to the University of Leeds for research on wool; it has now made a gift of £10,000 for the purchase of equipment for the new Textile Laboratories, all the apparatus to be utilized for the benefit of the wool industry. At present, five men hold Secretariat fellowships in the Department, and in addition, a grant of £1,600 a year has been made during the past two years in support of research in textile engineering. The number of workers engaged on these and other wool research projects is now so great that a severe strain has been thrown on the laboratory accommodation. In 1946, however, the Worshipful Company of Clothworkers of London made a grant of £20,000 towards the building of new wool research laboratories, and a start on the work was made in December 1947. The ground floor of the new building will be used to extend the Cloth Finishing Section of the Department, while the first floor will contain several laboratories for wool research workers. The second floor will take the form of one large laboratory, which will be used to give undergraduates practical experience of the applications of chemistry at all stages of the manufacture of wool textile materials. The grant of £10,000 from the International Wool Secretariat is for the equipment of the new building and will be used to purchase the most modern types of machinery for the Finishing Section, as well as the special apparatus which will be needed by research workers and undergraduates.

Old Scientific and Natural History Books

The following catalogues have been issued by Messrs. Bernard Quaritch, Ltd., of 11 Grafton Street, London, W.: No. 644, Books and Periodicals relating to Mathematics, Physics and Allied Sciences including two small collections on Accountancy and Mining; No. 650, Books and Periodicals on all Branches of Zoology, Geology, Palæontology and Botany; and a Catalogue of Books and Manuscripts issued to commemorate the One Hundredth Anniversary of the firm of Bernard Quaritch: 1847–1947. Noteworthy among these is Messrs. Quaritch's centenary catalogue. This is of especial interest to booklovers on account of the introductory matter, in which is related the growth of the firm from small beginnings in October 1847, in a shop in Castle Street, Leicester Square, London, to its present status as a business of world-wide repute. There is also a portrait of the founder, who died in 1899, and a brief sketch of his life, prepared by his daughter, Mrs. Charlotte Quaritch Wrentmore. As might have been anticipated, this catalogue is worthy of the occasion. It is a lavishly illustrated production, containing six coloured and some forty black-and-white plates. Among more than two hundred books listed for sale there is a number of items of scientific interest, including the *editio princeps* of Pliny's "Historia naturalis", printed at Venice in 1469; a first edition of Newton's "Principia" (another copy is offered in Catalogue 644); an exceptionally fine copy of Hooke's "Micrographia"; and the first illustrated edition of the "Hortus Sanitatis", printed at Mainz in 1491. Many interesting works are listed in Catalogues 644 and 650, which contain 423 and 1,926 items, respectively.

Another catalogue of interest is that of Dr. E. Weil, c/o National Provincial Bank, 9 Market Place, London, N.W.11. This is No. 10, "From Alchemy to Chemistry and Pharmacology", and it includes also a section with sixty-nine works relating to the early history and development of photography. Among several works by or relating to Robert Boyle listed in this catalogue is Johann Seger von Weidenfeld's alchemical work "De Secretis Adeptorum" (London, 1684), in which the author made use of an unprinted manuscript by Boyle. Dr. Weil suggests that this manuscript, entitled "De Magisterio sive de investigatione secreti occulti Lullii", may be one of the Boyle manuscripts burned in 1688, of which, hitherto, no titles were known. This work, dedicated to Robert Boyle, will, it is stated, be described in Dr. J. F. Fulton's next addenda to his bibliography of Boyle.

Food Calories

THE Food and Agriculture Organisation of the United Nations has issued an interesting brochure entitled "Energy-Yielding Components of Food and Computation of Calorie Values" (from the Organisation, Washington, D.C.). This is the report of a Committee on Calorie Conversion Factors and Food Composition Tables, and contains much useful information. An appendix deals with organic acids as sources of available calories, and this includes a useful bibliography. The Committee considered the main causes of difference between estimates of energy-yielding components and of energy values, and concluded that the ideal procedure is separate determination of all the substances contained in food which contribute energy, combined with accurate assessment of their individual physiological values and their interrelationships. The question of the protein value of nitrogenous constituents is not completely resolved. Discussing carbohydrate values of foods, the Committee considers that at present the use of 'carbohydrate by difference' is justified, provided that its limitations are understood and appropriate procedures are used for deriving energy values. The value of the report cannot, however, be appreciated unless it is read.

Earthquakes during the Last Quarter of 1947

THE last quarter of 1947 opened with an earthquake on October 3 which was felt most strongly at Santarem, caused some alarm in the working-class districts of Lisbon, and damaged many buildings in Lisbon, Cascaes and Estoril. There were about ten other strong earthquakes in October in various parts of the world, including the one felt strongly at Coroni in southern Greece on October 6, and another felt strongly and causing some property damage 40 miles south-west of Fairbanks in Alaska on October 16. The latter had an aftershock on October 20. During this month, thirty-eight small earthquakes and earth tremors were felt in New Zealand, the greatest being on October 13 from an epicentre at lat. 44·2° S., long. 169·0° E., felt over most of the South Island. November opened with an intense earthquake on November 1, 150 miles north-east of Lima in Peru. This caused considerable property damage and also was responsible for the deaths of at least fifty-three people. Strong aftershocks of the earthquake occurred on November 7 and 25. Of the fourteen other strong earthquakes during the month, that on November 23 in south-west Montana was felt in Montana and Idaho. In December, some thirteen strong shocks occurred, the European ones being felt on December 13 in the Pyrenees, on December 20 in the Tirol and on December 25 at Lago d'Iseo in Italy. Seismological reports have been received from Beograd (Yugoslavia), Durham, Kew, United States Coast and Geodetic Survey and Jesuit Seismological Association, Strasbourg, Stuttgart, Wellington (New Zealand) and Zurich and the Swiss observatories.

International Conference on Sleeping Sickness

AT a conference convened jointly by the French, Belgian and British Colonial authorities and recently held at Brazzaville, French Congo, to which the Governments of Portuguese territories in Africa, of Southern Rhodesia and the Union of South Africa also sent delegates, arrangements were made for the uniform mapping of the whole of Africa south of the Sahara to show the incidence of trypanosomiasis in man and domestic animals and of the various species of tsetse fly which transmit it. It was also agreed to establish, at Brazzaville and Leopoldville, a joint bureau for the rapid exchange of information on methods of controlling the disease, and to set up in Europe a scientific committee on an international basis to supervise the organisation of research. These conclusions will now be forwarded to the Governments of all the African territories as recommendations for a concerted effort to control the disease and to work towards its gradual elimination.

Society of Chemical Industry: Annual General Meeting

THE Society of Chemical Industry will hold its annual general meeting in Edinburgh during July 12–17. This is the first annual general meeting since the War to be held outside London, and the first since 1927 to be held in Edinburgh. The president of the Society, Dr. L. H. Lampitt, chief chemist and a director of Messrs. J. Lyons and Co., Ltd., will deliver his address on July 13. On July 14 there will be a lecture by Sir John Anderson, who has been awarded the Messel Medal for 1948 of the Society. The Lister Memorial Lecture will be given on July 15. This Lecture was founded to commemorate the influence of the work of the late Lord Lister on the pharmaceutical industry in Edinburgh and was endowed in 1944 by two Edinburgh firms of drug and fine chemical manufactures, Messrs. J. F. Macfarlan and Co. and Messrs. T. and H. Smith, Ltd. The first lecturer, in 1944, was Sir Alexander Fleming. This year's Lecture will be devoted to biochemistry. A series of papers will be presented dealing with industrial chemical aspects of a number of the principal industries in the east of Scotland. They will describe some of the industrial research which has already been done in Scotland and will point to the possibilitie for the future. In many cases the lectures will b followed by visits to the factories and installations [illegible] the various industries. Lectures will be given [illegible] Prof. S. Watson, principal of the East of Scot

College of Agriculture; Dr. G. A. Reay, of the Torry Research Station, Aberdeen; Mr. E. R. H. Edge, of Messrs. Alex. Pirie and Co., Aberdeen, on paper-making; Prof. W. H. Melville, of the University of Aberdeen, on rubber; Dr. I. A. Preece, of the Heriot-Watt College, Edinburgh, on brewing; and Mr. H. Corteen, director of the British Jute Trade Research Association of Dundee, will speak on "Research Developments and Applications to Textile Industries in East Central Scotland". The meeting is being organised by the Edinburgh and East of Scotland Section of the Society, the honorary secretary of which is F. J. Bolton, 17 Wester Coates Avenue, Edinburgh 12.

International Conference on Powder Metallurgy

THE Steirmark Branch of the Association of Austrian Chemists is arranging an International Powder Metallurgy Conference to be held during July 12–16 in Graz. It is hoped, by lectures and discussions, to furnish a comprehensive picture of the position and problems of the scientific, industrial and economic aspects of powder metallurgy and allied subjects. The organising committee consists of Prof. G. Jantsch, Technische Hochschule, Graz; Dr. R. Kieffer, Metallwerk Plansee, Reutte, Tirol; Prof. O. Kratky, Universität, Graz; Prof. G. F. Hüttig, Technische Hochschule, Graz. Further information can be obtained from Dr. C. Sykes, Brown - Firth Research Laboratories, Princess Street, Sheffield; or Mr. M. Littman, Compound Electro Metals, Ltd., 42 Pall Mall, London, S.W.1.

International Sericultural Congress

THE Seventh International Sericultural Congress will be held at Alès (Gard) in the Cevennes during June 7–13, and will be followed by an International Silk Congress at Lyons. The Sericultural Congress is being organised by the French National Institute of Agronomic Research; the president is Prof. R. Delmas, professor of sericulture in the École Nationale d'Agriculture, Montpellier, and the general secretary is M. Schenk, director of the Sericulture Research Station, Alès. The programme is being arranged in a number of sections covering scientific, economic and technical aspects of the subject. The Congress, which will mark the fiftieth anniversary of the research station at Alès, will be the first of so wide a scope since the Sixth International Sericultural Congress held in Paris during September 1878. Further particulars can be obtained from the Secrétariat-Général, Station de Recherche Séricoles, 28 Quai Boissier de Sauvages, Alès (Gard), France.

Conference on Rheology and Textiles

A CONFERENCE on "Rheology in the Textile Industries" has been arranged by the British Rheologists' Club in association with the Textile Institute, the Society of Dyers and Colourists, the Leeds area local sections of the Chemical Society and the Royal Institute of Chemistry, the Yorkshire Section of the Society of Chemical Industry and the Manchester and District Branch of the Institute of Physics, and will be held during March 19–20 in the Department of Textile Industries, University of Leeds. Further particulars can be obtained from Prof. J. B. Speakman, University, Leeds 2, or the honorary secretary of the British Rheologists' Club, Dr. E. W. J. Mardles, Royal Aircraft Establishment, Farnborough, Hampshire.

Announcements

AT a recent ceremony at the Royal Netherlands Embassy, London, the Netherlands Ambassador presented the insignia of Commander in the Order of Orange-Nassau (Civilian Division) in recognition of services rendered to the Netherlands during the War to the following, among others: Sir George Beharrell, chairman of the Dunlop Rubber Co., Ltd.; Sir Jack Drummond, sometime scientific adviser to the Ministry of Food; Dr. John Hammond, reader in agricultural physiology, University of Cambridge; Sir Raymond Streat, chairman of the Cotton Board.

THE following appointments in the University of Leeds have been announced: Prof. H. S. Ruse, professor of pure mathematics, to be head of the Department of Mathematics on the retirement of Prof. S. Brodetsky at the end of the present session; Prof. T. G. Cowling, professor of mathematics at the University College of North Wales, Bangor, to be professor of applied mathematics from October 1; Dr. N. H. Hartshorne, to be lecturer in chemical microscopy.

THE following appointments in the University of Sheffield have been announced: Dr. A. J. Gould, senior lecturer in the Department of Glass Technology; Dr. J. S. D. Bacon, lecturer in biochemistry; R. E. Davies, honorary lecturer in biochemistry; A. Jordan, honorary lecturer in clinical biochemistry.

A SYMPOSIUM on "Combustion and Flame and Explosion Phenomena" will be held at the University of Wisconsin during September 7–11. Papers will be presented on fundamental and theoretical aspects of combustion, technical research, combustion problems in jet propulsion, special fuels, etc. It is hoped to publish all the papers together within a few months of the meeting. Particulars can be obtained from Prof. Joseph O. Hirschfelder, University of Wisconsin, or from Dr. Bernard Lewis, U.S. Bureau of Mines, Pittsburgh 13, Pennsylvania.

THE Faraday Society is arranging one of its General Discussions, which will be held in the Department of Physics, University College, Southampton, during March 31–April 2. The subject will be "The Interaction of Water and Porous Materials", and the papers have been divided into four groups: (1) Fundamental Aspects; (2) Botanical Aspects: Mechanism of Movement of Solutions in Plants; (3) Zoological Aspects: Water-Protecting Properties of Cuticles; and (4) Permeability to Water and Water Vapour of Textiles and other Fibrous Materials. Papers will be issued in advance of the meeting and taken as read. Further particulars can be obtained from the Faraday Society, 6 Gray's Inn Square, London, W.C.1.

THE British Iron and Steel Research Association has now obtained a licence for erecting limited accommodation of temporary construction on a site at Meadow Street in Sheffield. At the present time the Association's investigations at Sheffield are divided between the Applied Science Department of the University of Sheffield (where there is an experimental rolling mill), the works of Arthur Lee and Sons, Ltd. (where there is a prototype backpull wire drawing machine), and elsewhere. The intention is ultimately to create a permanent building in which rolling, drawing and other similar researches will be centralized.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Formation of Derivatives of Thyroxine from Derivatives of Diiodotyrosine

THE observation of von Mutzenbecher[1] that traces of thyroxine are formed on incubation of an alkaline solution of diiodotyrosine was developed by Harington and Pitt Rivers[2]. These authors showed that the course of the reaction was greatly influenced by *p*H; the largest yield of thyroxine, amounting to 2·7 per cent calculated on the diiodotyrosine not recoverable at the end of the oxidation, was obtained at *p*H 10; at this *p*H the acidic groups of diiodotyrosine are 95 per cent neutralized. In highly alkaline solution, there was little destruction of diiodotyrosine and no thyroxine formation: at lower alkalinity (*p*H 8–9) the destruction of diiodotyrosine was very extensive and the formation of thyroxine was minute. In all experiments in which diiodotyrosine was oxidatively destroyed, tarry by-products appeared and the liberation of ammonia was evident.

It seemed reasonable to suppose that protection of the amino-group of diiodotyrosine by acylation would diminish the tendency towards oxidative destruction of the amino-acid, and might then favour the oxidative intramolecular coupling which is the essential step in thyroxine formation. As a preliminary test of this hypothesis, solutions of *N*-acetyl-*l*-diiodotyrosine were incubated at 37° for fourteen days, the *p*H varying from 6·5 (60 per cent neutralization) to 8·5 (90 per cent neutralization). At the end of the incubation, the solutions were made strongly alkaline and boiled under reflux to hydrolyse the acetamino-group; butanol separation then led to the isolation of thyroxine. The amounts of thyroxine formed were small, the maximum formation occurring at *p*H 7·5.

It had been noticed that during these incubations a white crystalline salt slowly separated. In a further experiment at *p*H 7·5, this salt was collected after fourteen days. After decomposition with acid and purification of the product by the method of Ashley and Harington[3], there was obtained N-*acetyl*-l-*thyroxine*, m.p. 227–228° (decomp.), $[\alpha]_D^{21}$ 25·7° (*c* = 4 per cent in a mixture of equal volumes of alcohol and *N* sodium hydroxide). Hydrolysis of this compound by heating with a mixture of 15 parts concentrated hydrochloric acid and 25 parts of acetic acid yielded *l*-thyroxine, $[\alpha]_D^{21}$ −5·42° (*c* = 3·3 per cent in a mixture of 2 parts alcohol and 1 part *N* sodium hydroxide); found: I, 62·0 per cent; $C_{17}H_{13}O_5NI_4$ requires I, 62·0 per cent. The yield of acetylthyroxine calculated on the acetyldiiodotyrosine destroyed was 15–20 per cent.

These experiments showed clearly that the reaction of oxidative coupling of two molecules of diiodotyrosine to form a diphenyl ether is not confined to the free amino-acid, but on the contrary is favoured by acylation of the amino-group; moreover, with the acylamino-derivative the coupling occurs most readily at the *p*H of body tissues. In view of the obvious bearing of this result on the question of the formation of thyroxine in natural proteins, it was desirable to extend the experiments to a derivative of diiodotyrosine in which both amino- and carboxyl-groups were blocked. The derivative selected was *N*-acetyl-*dl*-diiodotyrosylglutamic acid.

A preliminary incubation of this compound at *p*H 7·2, followed by hydrolysis and butanol fractionation, did indeed lead to thyroxine formation; but in this case no insoluble sodium salt separated and the ultimate yield was low. The experiment was therefore repeated at the same *p*H in baryta solution; under these conditions a barium salt soon began to separate and increased in amount until a month had elapsed. At this time it was collected and decomposed with acid, and the product crystallized from aqueous methanol. The N-*acetyl*-dl-*thyroxylglutamic acid* thus obtained formed fine needles, m.p. 195–200° (decomp.); found: C, 27·8; H, 2·77; I, 52·5 per cent; $C_{17}H_{17}O_5NI_4$, H_2O requires C, 27·3; H, 2·3; I, 52·6 per cent. Hydrolysis of this compound with a mixture of acetic and hydrochloric acids yielded pure *dl*-thyroxine and glutamic acid. The yield of *N*-acetyl-*dl*-thyroxylglutamic acid was 36 per cent after allowing for recovered starting material. It is clear, therefore, that combination in peptide linkage of the carboxyl group of diiodotyrosine favours still more its conversion at biological *p*H into thyroxine.

In the experiments just described, the final reaction mixture is relatively free from tarry by-products; it is therefore hoped that it may be possible to isolate an acylamino-compound corresponding to the side-chain lost from one of the molecules of diiodotyrosine participating in thyroxine formation; attempts in this direction are now in progress.

A full account of the work described above will be published elsewhere.

ROSALIND PITT RIVERS
National Institute for Medical Research,
London, N.W.3.
Dec. 3.

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[1] von Mutzenbecher, P., *Z. Physiol. Chem.*, 261, 253 (1939).

[2] Harington, C. R., and Pitt Rivers, R. V., *Biochem. J*, 39, 157 (1945).

[3] Ashley, J. N., and Harington, C. R., *Biochem. J.*, 23, 1178 (1929).

Condensation of 2:4:5-Triamino-6-hydroxypyrimidine with Glucose and Fructose

WE have been engaged for some time on a study of the condensation of 2:4:5-triamino-6-hydroxypyrimidine (I) with glucose and with fructose. As Ohle and Hielscher[1] have carefully established the optimal conditions for the condensation of *o*-phenylenediamine with glucose and with fructose in the preparation of tetrahydroxybutylquinoxaline, we have, from the outset, applied these conditions to (I). Glucose afforded a product (II) having $[\alpha]_D^{20°}$ approximately − 81·5° in *N* hydrochloric acid or in *N*/10 sodium hydroxide solution, while fructose afforded a substance (III) with a slightly higher specific rotation, $[\alpha]_D^{20°}$ approximately − 86·6°, under the same conditions. At this point, a paper by Karrer, Schwyzer, Erden and Siegwart[2] appeared describing the condensation of (I) with a variety of simple sugars using less elaborate conditions than ours. Their product from glucose had $[\alpha]_D^{20°}$ − 68·93°, and their product from fructose had $[\alpha]_D^{20°}$ − 46·0°, respectively, in *N*/10 sodium hydroxide solution; these figures are significantly different from ours, particularly in the case of the product from fructose. Although final conclusions were not reached, Karrer and his collaborators considered their products from glucose and fructose to be respectively (IV, or V ?) and (V, or IV ?), the constitution of their product from glucose being indicated as (IV) with some degree of certainty.

A Polysaccharide from Hydatid Cyst Fluid

A SEROLOGICALLY active polysaccharide has been isolated from hydatid cyst fluid from an infested sheep. A positive precipitin reaction was obtained with the serum from a patient suffering from pulmonary hydatid disease, when dilute solutions of this polysaccharide were used as an antigen. Serum giving positive and negative Wassermann results showed no precipitin reaction with this same antigen.

It is considered that this polysaccharide fraction of the hydatid cyst fluid is probably the specific antigenic factor.

A detailed report of the preparation of this fraction together with its properties will be submitted for publication at a later date.

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Nov. 1.

Gas Discharges at Centimetre Wave-lengths

EXPERIMENTS have recently been described[1] showing that at frequencies of 2,800 Mc./sec. and 9,800 Mc./sec. the breakdown of air takes place at stresses some 30 per cent lower than the breakdown values for steady voltages, for gaps of a few millimetres. In order to extend the observations to longer gaps, experiments are in progress on discharges in cavity resonators, where the necessary stress can be built up over longer gaps. Power is obtained from a magnetron excited by 1 microsecond pulses applied either individually or at the rate of 400 per second.

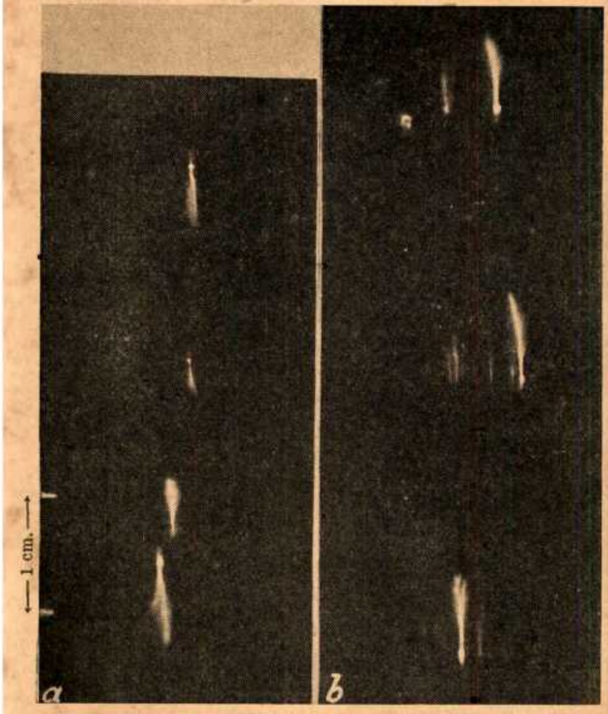

Fig. 1. PHOTOGRAPHS OF DISCHARGES IN A RESONATOR (*a*) WITHOUT IRRADIATION; (*b*) ONE ELECTRODE IRRADIATED WITH ULTRA-VIOLET LIGHT

The film was moved between successive discharges. Note that in (*b*) the discharge always starts from the same electrode and that subsidiary streamers are present. Electrode separation 1·44 cm.

The form of discharge obtained at atmospheric pressure is shown in Fig. 1, where it will be seen that the chief component consists of a bright spot on the electrode, together with a less intense tail across part of the gap. With repetitive operation, the gap is filled with a faintly luminous haze in addition. Occasional mid-gap streamers are observed for both individual and repeated pulses. Spectrographic observations show that the tail emits a nitrogen band spectrum, while the spot emits lines characteristic of the electrode material.

With 400-cycle pulses, as the pulse voltage is lowered, the time-interval between bursts of discharge increases and it is possible to determine graphically the pulse voltage V_0 for which the probability of starting the discharge becomes zero. For any pulse voltage greater than V_0, it is found that if sufficient *individual* pulses are applied a discharge eventually occurs, so that the breakdown voltage of the gap is the same for individual and for repeated pulses. Once, however, a discharge has occurred, the probability of breakdown within 1/400 sec. is increased, so that the 400-cycle pulses produce bursts of discharge, and a direct comparison of the ratio (No. of discharges)/(No. of pulses) for repeated and for individual pulses cannot be made.

Initial experiments, in which ultra-violet light from an auxiliary spark was applied immediately before the beginning of the high-frequency pulse, showed that ultra-violet light has marked effects on the appearance of the discharge, and on the sparking probability, for single pulses. A comparison between the sparking probabilities, with and without irradiation, can be made directly. In agreement with earlier work[1], in which a radium source was employed, it is found that the voltage at which the sparking probability just becomes zero—the true breakdown voltage—is unaffected by irradiation: at higher voltages irradiation increases the sparking probability.

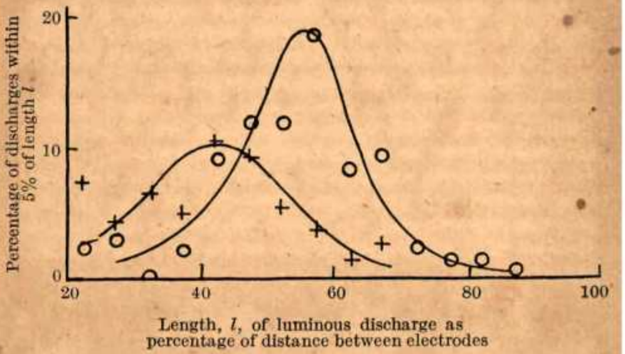

Fig. 2. DISTRIBUTION OF LENGTH OF DISCHARGES
○, one electrode illuminated with ultra-violet light; +, no irradiation

When the electrode surface is irradiated, the length of the luminous tails is increased, and shows less variation from pulse to pulse (Fig. 2). When, however, the ultra-violet light is concentrated in the gas (air) between the electrodes, numbers of mid-gap streamers are observed at each pulse, even when the typical spot and tail discharge does not occur—clearly a consequence of photo-ionization in the gas.

The observations are being extended to include an examination of the effect of changes in the duration of the pulse, the nature of the gas and the gas pressure on the discharge phenomena. It is hoped also to make cloud-chamber studies of the conditions preceding breakdown.

Grateful acknowledgment is made to the Council of the Durham Colleges for granting one of us (W. A. P.) a year's leave to pursue this work, and to the British Electrical and Allied Industries Research Association for financial support throughout the investigation.

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Nov. 11.

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[1] Cooper, R., *J. Inst. Elect. Eng.*, **94**, Pt. 3, 315 (Sept. 1947).

Refraction Effects in Electron Diffraction and in Electron Microscopy

RECENTLY, Cowley and Rees[1] reported some interesting work on the fine structure of electron diffraction patterns of crystals of magnesium oxide, cadmium oxide, etc. (multiple rings or spots) by application of high-resolution electron diffraction cameras. They confirmed the view of Sturkey and Frevel, who suggested that this fine structure arises from refraction at the faces of the regularly shaped crystal cubes. If the normals of the faces by which the beam of electrons enters and leaves the crystal lie in the same plane with the beam and the normal of the net plane[2], one can derive an expression relating the angular displacement of the beam ε to the angles φ_1 and φ_2 (angle between face normal and incident and refracted electrons respectively):

$$\varepsilon = \theta - \theta_0 = \varepsilon_1 + \varepsilon_2 = V/2E(\pm \tan\varphi_1 \pm \tan\varphi_2)$$
$$\theta < \varphi < \pi/2 - \theta \qquad (1)$$

(V is inner potential, E is accelerating potential, θ_0 Bragg angle for $V = 0$). This deviation having values of 10^{-4} radians ($V = 10$ volts, $E = 50{,}000$ volts, $\varphi = 45°$) or 3×10^{-3} cm. at a specimen-plate distance of 30 cm., high resolution will be necessary to detect it.

This explanation is intimately connected with that given for the results obtained with electrolytically polished surfaces (Jacquet procedure) by electron diffraction and the electron microscope[3]. These surfaces are slightly waved so that the angle between the limiting face and the net planes (δ) has only a value of some degrees, whereas in the case considered above the faces are steeply inclined to the net planes. Therefore ε becomes greater and the same refraction effect will be observed by normal resolution.

Thus $\varepsilon = (\tan\delta + \theta_0)\left[\overset{+}{(-)}\sqrt{1 - \dfrac{V}{E(\tan\delta + \theta_0)^2}} - 1\right]$

($\sin\theta \sim \theta$, $\sin\theta_0 \sim \theta_0$). Generally, one can put $V/E < (\tan\delta + \theta_0)^2$ also for electrolytically polished surfaces. Thus it follows

$\theta = \theta_0\,(1 - V/2E\theta_0^2\,(1 + \tan\delta/\theta_0))$ [4] or

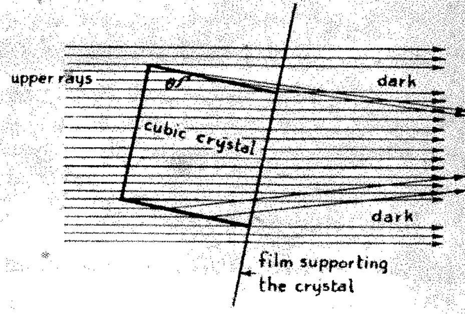
$$\varepsilon = -V/2E(\tan\delta + \theta_0). \qquad (2)$$

With $\delta \sim 5 \times 10^{-2}$ (3°) and $\theta_0 \sim 2 \times 10^{-2}$, one finds $\varepsilon \sim 15 \times 10^{-4}$, or half a millimetre at a plate-specimen distance of 30 cm., which can be seen without difficulty, $\tan\delta$ being always greater than 0 in the case of reflexion (there are always elevations transmitted), ε will be less than 0, or the reflected beam is displaced to smaller reflexion angles. If δ is continuously varying between 0 and $\delta_{\max}$, the patterns are enlarged to streaks as on electrolytically polished surfaces. For transmission patterns as referred to above, one has also $\tan\delta < 0$ and therefore $\theta > \theta_0$.

Between the angles φ, θ and δ exists the relation $\delta = \pi/2 - (\varphi + \theta)$. To show the transition from eq. 2 to eq. 1, one has to put $\varphi > \theta$ as supposed for the derivation of (1), and one obtains

$$\varepsilon = -(V/2E)\tan\varphi.$$

The total deviation is given by the sum of ε at entering and leaving the faces.



These considerations are also relevant to refraction effects in electron microscopy. A refraction effect may be of importance if well-shaped crystals, for example, cubic crystals, are transmitting electrons as shown in the diagram. The electrons being deflected by refraction out of their original direction, one would expect that the cube faces nearly parallel to the beam would appear as dark lines (a dark frame if the crystals are also somewhat tilted with their faces out of the plane of the paper). The refraction by the steeper faces is here neglected. Whether the refracted image is visible or not depends on the objective aperture and the inclination of the crystal. It seems to me that the dark bands which surround small inclined crystals of magnesium oxide[5] may be explained in such a manner. The size of these bands is given by the crystal dimensions in the primary direction and the angle of inclination.

At very small angles ($\theta \lessdot \theta_{\text{lim}} = \sqrt{V/E} = 0{\cdot}014$ at $V = 10$ volts and $E = 50{,}000$ volts) the rays, in the figure the 'upper rays', are totally reflected, which gives as above a transmitted (dark) and a totally reflected (intense) image, the latter being more deflected (2θ) than that normally refracted. Perhaps this effect would be found by a systematic study using crystals of greater dimensions, for which the bands are better resolved.

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Sept. 16.

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[1] Cowley and Rees, *Proc. Phys. Soc.*, **59**, 288 (1947). *Nature*, **158**, 550 (1946). See also Sturkey and Frevel, *Phys. Rev.*, **68**, 56 (1945) and Hillier and Baker, *Phys. Rev.*, **68**, 98 (1945).

[2] If this condition is not fulfilled one has to take a more general formula derived by Cowley and Rees (ref. 1).

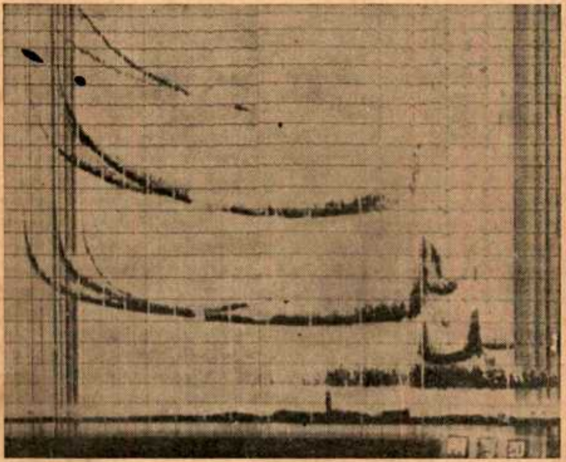
[3] Raether, H., *Métaux et Corrosion* (Jan. 1947).

[4] Kranert, W., Leise, K. H., and Raether, H., *Z. Phys.*, **122**, 248 (1944). In this paper the formula given for θ was $\theta = \theta_0\sqrt{1 - V/E\theta_0^2\,(1 + \tan\delta/\theta_0)}$, which had been derived by putting approximately $\theta + \theta_0 = 2\theta_0$: developed, it gives the exact solution 2. They are equivalent in the regions applied for the evaluation of electrolytically polished surfaces.

[5] For example, Heidenreich, R. D., and Sturkey, *J. App. Phys.*, **16**, 97 (1945), Fig. 1. Kinder, E., *Naturwiss*, **31**, 149 (1943). This effect must not be confused with the parallel strips of strongly inclined crystals the origin of which explains the dynamical theory, nor with the Fresnel diffraction strings in the out-of-focus image of a crystal edge.

Triple Magneto Ionic Splitting of Rays Reflected from the F_2 Region

A RECORD for 1700 hr. local time on November 9, 1946, from the Hobart $P'f$ recorder operating in the frequency range 1·5–13 Mc./s. is reproduced below.



The record shows the ordinary and extraordinary rays usually present from F_2 with critical frequencies of 7·6 and 8·5 Mc./s. respectively, as well as a third ray the critical frequency of which is 7·0 Mc./s. The critical frequencies of these rays correspond approximately to the Appleton–Hartree[1] reflexion condition $\mu = 0$ except that, neglecting collision, one would expect the third ray to have a critical frequency of 6·7 Mc./s. Discrepancies of about this magnitude and sign which are not ascribable to experimental error occur in all the 'triple split' measurements taken and may perhaps be accounted for if collision effects were included in the calculations. The possible existence of triple magneto ionic splitting in a layer where the variation of electron density with height is very rapid was first discussed by Mary Taylor[2], and the phenomenon has been observed by Toshniwal[3] and Liev Harang[4]; but the record shown is one of the best examples of it that we have seen.

Thirty-nine definite examples of this triple splitting have been observed in some 50,000 records spaced at regular intervals over a period of a year. Other records possibly showing this effect (quadruple and even higher multiple forking) have been discounted as examples of multiple magneto ionic splitting because of indications of stratification in F_2 or very spread echoes. The triple split records are generally accompanied by sporadic E ionization and seem more likely to occur under disturbed conditions. Triple splits have been observed at nearly every hour of the day, but they occur most frequently between the hours of 1700 and 2000. Occasionally they appear on the records over a period of several hours, starting or finishing as multiple forked records in the stratified layer. There appears on the Hobart data to be no evidence for the seasonal variation noticed by Harang. The figures for the number of occasions present (they may be either single occurrences or last for several hours) over twelve months are: 1946, September 2, October 4, November 3, December 0; 1947, January 0, February 3, March 5, April 1, May 0, June 2, July 5 and August 4. Further data on the occurrence of the phenomena will be analysed as they become available.

The records from the Hobart $P'f$ recorder are measured by the University of Tasmania for the Radio Research Board of the Council of Scientific and Industrial Research, and I would like to acknowledge the help received from that body in this and other ionosphere investigations.

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Nov. 5.

[1] Appleton, E. V., *J. Inst. Elect. Eng.*, **71**, 642 (1932).

[2] Taylor, Mary, *Proc. Phys. Soc.*, **45**, 245 (1933).

[3] Toshniwal, G. R., *Nature*, **155**, 471 (1935).

[4] Liev Harang, *Terr. Mag.*, **41**, 143 (1936).

Variable Source of Radio Frequency Radiation in the Constellation of Cygnus

COSMIC or galactic noise was discovered by Jansky[1] in 1931; but its exact origin has remained uncertain. It is generally supposed to originate from collisions in interstellar matter[2]; but there are divergencies between existing theory and experimental results, particularly at lower radio frequencies[3]. Hey, Parsons and Phillips[4] discovered variations in the intensity of galactic noise from the direction of the constellation of Cygnus, with a period of about one minute—suggesting that this particular radiation has its origin in a discrete source.

During the past three months, we have made a study of this region, mainly on 100 Mc./s., but also occasionally on 60, 85 and 200 Mc./s. The technique employed was to observe the region rising over the sea with aerials situated on a high cliff, as described by Pawsey, Payne-Scott and McCready[5]. Due to interference between the direct ray and the ray reflected from the sea, a lobe pattern is obtained which gives rise to a succession of maxima and minima. An estimate of the size of the source can be made from the relative heights of maxima and minima, and an accurate position found from the times of occurrence of minima.

Small aerial arrays were used—one or two Yagis—and considerable care was taken with receiver stabilization enabling receiver noise to be balanced out and the input signal amplified for presentation on a recording milliammeter. At 100 Mc./s. receiver fluctuations represented an input signal of less than 3×10^{-24} watts $m.^{-2}(c./s.)^{-1}$.

The general results of our investigations are:

(1) The variations from Cygnus originate in an area of less than 8′ angular width. This is an upper estimate and the source may well be effectively a point.

(2) The location of the source is R.A. 19 hr. 58 min. 47 sec. ± 10 sec. Dec. $+41° 41' \pm 7'$.

(3) The radiation consists of two components, one constant and the other showing considerable variation over short and long periods. In Fig. 1, a typical record of the source rising, the two components are separated by a dotted line. A record of the 'quiet' sun rising is shown for comparison in Fig. 2. The frequency in both cases was 100 Mc./s.; intensity scales are the same on both records.

(4) Observation on different frequencies shows that the intensity of the constant component has a shallow

It was found desirable to keep the length of the plug as short as possible, to ensure that air could readily pass through the powder when the meniscus became detached. This factor would no doubt set a lower limit to the size of particle measurable by the method, although the surface tension and density of the liquid can be adjusted to give the most favourable conditions.

The apparatus would seem to be readily applicable to other problems connected with particles; for example, the random packing of regular shaped bodies.

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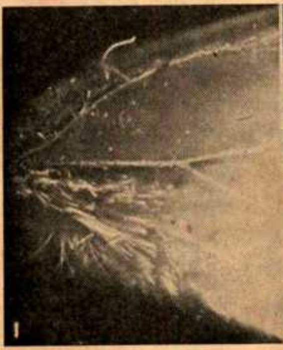
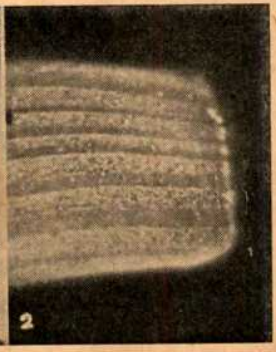
Surface Radiography with Alpha Rays

IT is well known that the short-lived atoms of radium A, B, C, and C′ are deposited on the surfaces of objects which come in contact with radon. Three of them, namely, radium A, C and C′, emit alpha rays. The emulsion of a photographic plate is blackened by these alpha particles. Their range in the emulsion is very short (maximum 50 μ). The geometric properties of the surface, for example, differences in the distance of various points of the surface of the object from the emulsion, cause a different blackening due to the alpha emission of the deposit on the surface. This enables us to develop a radiographic method which gives in a simple way a picture showing the structure of the surface.





A wing of a butterfly (*Vanessa io*) was exposed for two hours in a vessel (volume 70 c.c.) containing 1 mc. of radon. Afterwards the wing was put for 8 min. on the emulsion of a photographic plate ('Foma Repro'), and the plate then developed. Fig. 1 shows a positive copy of the original radiograph (× 3). With a microscope of low power the squamous structure of the wing can be seen in the picture. By the same method radiographs of polished surfaces of different kinds of wood were obtained; these show the fibrous structure of the wood (Fig. 2) (×3). Wood moistened before the exposure in radon gave better results.

Controls without exposure in radon gave no pictures.

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A Suggested New Force Field for Molecular Vibrations

THE molecular force field which has been most successful in accounting for molecular vibration frequencies is the 'simple valency force field'. In many cases, however, this simple field has had to be modified considerably by introducing cross-terms. Most frequently these have been introduced empirically with the sole object of obtaining a good reproduction of the observed frequencies. This procedure is unsatisfactory, because it is often impossible to be sure of selecting the correct cross-terms from those that are possible. There have been a few more valuable attempts to modify the simple valency force field, and account for the cross-terms, which have been based on a more careful consideration of the forces, other than simple valency forces, that may exist in the molecule[1]. However, recently we have found that a new force field leads to more satisfactory results. We call this the 'orbital valency force field', and it differs from the older view in its treatment of angular distortions[2]; whereas the simple valency force field considers the bending angle by angle, the orbital valency force field treats it bond by bond.

In modern valency theory, directed chemical bonds are associated with directed atomic orbitals. Take boron tribromide as an example. The three bonding orbitals of the boron atom are of the sp^2 type and are arranged symmetrically in a plane[3]. Therefore, in the equilibrium configuration, the bromine atoms are arranged symmetrically around the boron atom. When a bromine atom is displaced at right angles to the B—Br bond, the overlap of its bond-forming orbital with that of the boron atom will decrease and there will be a force tending to restore it to its original position. For the motion to be simple harmonic the restoring force must be proportional to the displacement. Because the orbitals are symmetrical about their axes, the force constant will be independent of the direction of the displacement. That is, for boron tribromide, the same orbital valency force field bending constant may be used for the in-plane and out-of-plane bending. It is this that enables us to test the new field. For boron tribromide we use a potential energy function involving three constants: k_1 is the ordinary valency force field stretching constant; k_β the orbital valency force field bending constant; and $2A$ the second differential of the potential energy function (V') for the BrBr repulsion. $\frac{1}{R} \cdot \frac{dV'}{dR}$ (where R is the BrBr distance) also enters our formulæ, but this is put equal to $\frac{1}{13}$ of d^2V'/dR^2, which is the value it would have if $V' = a/R^{12}$, that is, if the repulsion between the bromine atoms is of a van der Waals' type[4]. $\frac{1}{R} \cdot \frac{dV'}{dR}$ is much smaller than k_1, k_β and A, so that its exact value is not of great importance. With $k_1 = 2{\cdot}385 \times 10^5$ and $k_\beta/r^2 = 0{\cdot}188 \times 10^5$ dynes per cm. the calculated frequencies are those given below:

Frequencies (cm.$^{-1}$)	$\nu_1 (A_1')$	$\nu_2 (E')$	$\nu_3 (E')$	$\nu_4 (A_2'')$
Obs. freq.[5]	279	806	151	372
Calc. freq.	279	815	151	372

The frequency of the in-plane bending vibration is ν_3 and of the out-of-plane bending ν_4. It will be seen that the average percentage error for all the frequencies is only $\frac{1}{4}$. Also the orbital valency force field accounts for the relative magnitudes of the two bending vibration frequencies. The average percentage error between calculated and observed frequencies for other AB_3 planar molecules and ions is: BF_3 : 0·1; BCl_3 : 1·45; $CO_3^{=}$: 0·2; NO_3^{-} : 3·4; SO_3 : 0·55. There seems no doubt, therefore, that the orbital valency force field provides a much more satisfactory force field than the simple valency force field which requires two unrelated bending constants for planar AB_3 molecules. We have also found that the orbital valency force field is better than the simple valency force field (both being combined with repulsion between the non-bonded atoms) for 'eight-tetrahalides' like CCl_4 and 'four-ions' like $SO_4^{=}$[6]. We are proceeding to apply the orbital valency force field to other molecules.

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Dec. 19.

[1] Urey and Bradley, *Phys. Rev.*, **38**, 1969 (1931). Thompson and Linnett, *J. Chem. Soc.*, 1392 (1937). Linnett, *J. Chem. Phys.*, **8**, 95 (1940). Thorndike, Wells and Wilson, *J. Chem. Phys.*, **15**, 157 (1947). Coulson, Duchesne and Manneback, *Nature*, **160**, 794 (1947). Heath and Linnett, *Trans. Farad. Soc.*, in the press.

[2] Heath and Linnett, *Trans. Farad. Soc.* (in the press). We have recently found that a similar field was suggested by Howard and Wilson for PCl_5 type molecules, *J. Chem. Phys.*, **2**, 620 (1934).

[3] Pauling, *J. Amer. Chem. Soc.*, **53**, 1367 (1931).

[4] Lennard-Jones, *Proc. Roy. Soc.*, A, **106**, 463 (1924).

[5] Anderson, Lasettre and Yost, *J. Chem. Phys.*, **4**, 703 (1936).

[6] Heath and Linnett, *Trans. Farad. Soc.* (in the press).

Band Spectrum of Aluminium Bromide

THE $^1\Pi - {}^1\Sigma$ system of AlBr near λ 2790 has been photographed in emission with high dispersion (0·6 A./mm.). Measurements of the Q heads have verified Howell's analysis[1]. Howell was, however, not able to make any definite observations on the isotope effect of the Q heads. Some of his Q heads, therefore, refer to the molecule $AlBr^{79}$, others to the molecule $AlBr^{81}$. On account of this, a new Q head formula has been calculated. Thus the band-origins of the molecule $AlBr^{79}$ can be represented by the formula :

$$v = 35879{\cdot}5 + 297{\cdot}2\,(v' + \tfrac{1}{2}) - 6{\cdot}40\,(v' + \tfrac{1}{2})^2 - 0{\cdot}527\,(v' + \tfrac{1}{2})^3 - 378{\cdot}0\,(v'' + \tfrac{1}{2}) + 1{\cdot}28\,(v'' + \tfrac{1}{2})^2.$$

The rotational structure of the 0,1 , 1,0 , 1,1 , 1,2 , 1,3 , 2,1 , 2,2 , 2,3 and 2,4 bands has been analysed. On account of the close structure, the bands were not resolved up to the heads. The analysis gives the following values for the band-constants :

$$B'_v = 0{\cdot}1555 - 0{\cdot}00216\,(v' + \tfrac{1}{2}) - 0{\cdot}000175\,(v' + \tfrac{1}{2})^2 \text{ cm.}^{-1}$$
$$B''_v = 0{\cdot}1591 - 8{\cdot}53 \times 10^{-4}\,(v'' + \tfrac{1}{2}) + 1{\cdot}4 \times 10^{-6}\,(v'' + \tfrac{1}{2})^2 \text{ cm.}^{-1}$$
$$D'_v = -\,[1{\cdot}8 + 0{\cdot}14\,(v' + \tfrac{1}{2}) + 0{\cdot}13\,(v' + \tfrac{1}{2})^2] \times 10^{-7} \text{ cm.}^{-1}$$
$$D''_v \doteq -\,1{\cdot}09 \times 10^{-7} \text{ cm.}^{-1}$$
$$r'_e = 2{\cdot}322 \times 10^{-8} \text{ cm.} ; \; r''_e = 2{\cdot}296 \times 10^{-8} \text{ cm.}$$

The observed rotational isotope separations agree well with those calculated, but the approximate formula $\Delta\nu_r = (1 - \rho^2)\nu_r$ cannot be used.

The calculated values of the separations of R and Q heads agree well with those observed.

The frequency ω_e has been calculated from Guggenheimer's formula[2]. This gives in the case of AlBr, $\omega_e = 370{\cdot}3$, in rather good agreement with the observed value $\omega_e = 378{\cdot}0$.

A more detailed account of the analysis will be published in the *Ark. f. Mat. Astr. o. Fys.*

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Sept. 30.

[1] Howell, *Proc. Roy. Soc.*, A, **148**, 696 (1935).

[2] Guggenheimer, *Proc. Phys. Soc.*, **58**, 456 (1946).

Comparison of Metallographic and X-Ray Measurements of Retained Austenite

THE martensite reaction in steels has been studied by microscopic examination of polished and etched samples after the samples have been tempered for short periods of time. One etching reagent which has been used is a solution of 6 per cent nitric acid in alcohol, which is called 6 per cent nital. This etchant stains the martensite grey or black and leaves the austenite white.

In quantitative studies of the amount of austenite which was retained after quenching to room temperature, this etchant appeared to obscure some of the austenite when the specimens were quenched from austenitizing temperatures below 1750° F. (954° C.). In steels exhibiting temper brittleness, Cohen, Hurlich and Johnson have found that the addition of a wetting reagent called 'Zephiran Chloride' to a modified picric acid etch reveals a precipitate not shown by other etching reagents[1]. ('Zephiran Chloride' is a trade-mark of Winthrop Chemical Company, Inc., indicating its brand of a mixture of high molecular alkyl-dimethyl-benzyl-ammonium chlorides, the descriptive name of which is benzyl-trialkonium chloride, marketed as an aqueous solution containing 12·8 per cent 'Zephiran Chloride'.) Therefore, 1 per cent 'Zephiran Chloride' was added to nital in an attempt to increase the sensitivity of the nital. Although 6 per cent nital is a better etchant than 4 per cent nital for steels containing small amounts of austenite, it is necessary to reduce the amount of nitric acid in the etch containing 'Zephiran Chloride' to 4 per cent because the 'Zephiran Chloride' increased the speed of etching.

COMPARISON OF METALLOGRAPHIC AND X-RAY MEASUREMENTS OF AMOUNT OF RETAINED AUSTENITE AT ROOM TEMPERATURE (68° F., 20° C.)

Austenitizing temperature	Metallographic measurements Standard etch 6% nital	 Improved etch (4% nital and 1% 'Zephiran Chloride')	X-ray measurements
1450° F. (788° C.)	0	2·0 ± 1·0%	3·1 ± 0·2%
1550° F. (843° C.)	0	6·0 ± 1·0%	7·0 ± 0·4%
1650° F. (899° C.)	3·0 ± 3	14·0 ± 1·0%	14·0 ± 0·8%
1750° F. (954° C.)	17·0 ± 1	20·0 ± 1·0%	20·0 ± 1·0%

Critical measurements were made on a 1·1 per cent carbon, 1·4 per cent chromium steel, quenched into oil at 68° F. (20° C.) from a series of austenitizing temperatures listed in the accompanying table. X-ray measurements utilizing a new technique were made on these steels by Averbach[2]. Then the specimens were tempered for 10 sec. at 630° F., and were polished and etched. Quantitative measurements were made metallographically of the amount of retained austenite using a Hurlbut counter, described by Howard and Cohen[3]. The metallographic measurements with the improved etch were practically identical with the X-ray measurements, although the reproducibility of the X-ray results was better than that of the metallographic results, and the X-ray measurements revealed slightly more austenite than the metallographic measurements in steels containing 7 per cent or less retained austenite. It is considered that nital is improved by the addition of 'Zephiran Chloride'. However, the reason for the improvement has not been established yet.

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Oct. 27.

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Rh Genes Allelomorphic to *C*

The third allelomorph, C^w, at the C-c locus of the *Rh* chromosome was not recognized until a pure anti-C^w serum was found[1]; but its existence could have been demonstrated by testing several hundred samples of blood with a range of anti-C sera, for some of these sera are of the specificity anti-C and some, the majority, anti-$C + C^w$. It is not yet clear why the latter type of antibody may result from stimulation by the antigen C.

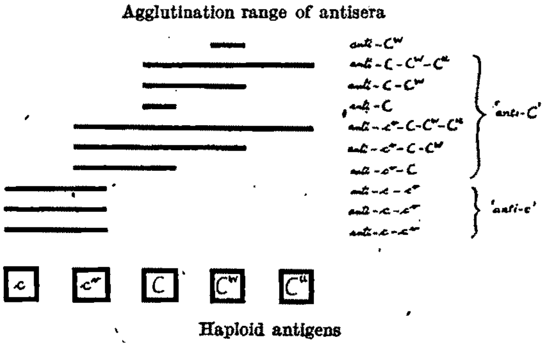
	anti	-D	-E	-e	-C^w	-c	'anti-C' -C	-C	-CC^w	-CC^w	-CC^w	-CC^w	Genotype
	Mother	+	+	+	−	+	−	−	−	−	−	−	*cDE/cde*
	Father	+	+	+	−	+	−	+	+	−	−	+	c^vDE/cde
c^v donor	1st son	+	+	+	−	+	−	+	+	−	−	+	c^vDE/cde
	2nd son	−	−	+	−	+	−	−	−	−	−	−	*cde/cde*
C^u donor		+	−	+	−	+	−	−	−	−	+	+	C^uDe/cde

In a search for further allelomorphs at this locus, 284 blood samples were tested with three anti-C sera, as well as with anti-D, -E, -e, -c and -C^w. Two bloods gave discrepant reactions with the anti-C sera; they were therefore more fully investigated and provided evidence of the existence of two more allelomorphs at this locus, which we propose to call c^v and C^u.

The agglutination reactions of the blood of the c^v donor and of his family are shown in the table. The table also shows the reactions of the C^u blood; the family of this donor was not available, and therefore the evidence for the existence of the fifth allelomorph, C^u, is somewhat incomplete.

The reactions given by the blood of the c^v donor and of his father were identical. The fortunate fact that the younger brother of the donor was *cde/cde* demonstrated clearly the exact genotype of each member of the family. The allelomorph c^v was segregating with D and E genes, and it was the partnership of these three genes on one chromosome that suggested that, in spite of the agglutination of the c^vc bloods by three out of six anti-C sera, the use of a small c was the more appropriate notation; for *cDE* is a common chromosome in England and *CDE* an extremely rare one. Strong support for this choice of notation was provided in the finding that the blood of both father and son gave a double-dose effect with the three anti-c sera available.

The anti-c^v component in the three anti-$C + c^v$ sera must have arisen in response to stimulation by the antigen C; the gene c^v is much too rare to have played a part in the three immunizations. The two components of an anti-$C + c^v$ serum have not been separated. When such a serum is absorbed by either c^vc cells or Cc cells, all agglutinin is removed. Similarly absorption of anti-$C + C^w$ sera by C^wc or by Cc cells results in the removal of both components. It is probable that in such natural mixtures the antibodies may be on the same molecule. If an artificial mixture is made by adding pure anti-C^w to pure anti-C serum, the separation of the antibodies by absorption with C^wc or Cc cells is specific.



It will be seen from the diagram that it is possible to represent the interactions of the allelomorphic antigens with the antisera in such a way that the positive reactions of the latter show as uninterrupted lines. We do not yet know whether this is a chance occurrence; if it is of significance, it seems to impose a definite linear order, in one dimension, on the allelomorphs. At least it is clear that the allelomorph c^v bridges the gap between C and c.

A more detailed account of this work will be published elsewhere.

We wish to thank Dr. J. Loutit and the members of his staff at the National Blood Transfusion Service, Sutton, for supplying us with the 284 blood samples.

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Nov. 17.

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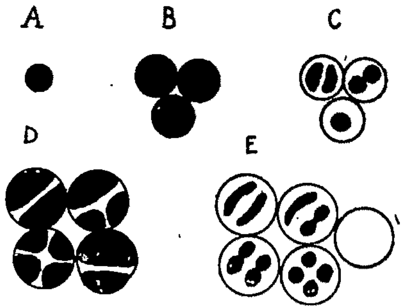
Cytology of Staphylococci Before and After Treatment with Penicillin

In a previous communication[1], we showed that, by means of enzymes, it is possible to localize both the nucleic acids of bacteria: (1) ribonucleic acid in the cytoplasm, (2) desoxyribonucleic acid in the nucleus. Thus, we have found a method, which seems to be general, of demonstrating the nuclei of bacteria. This method has enabled us to observe the nuclei, already known to exist, of the bacteria of the enteric and the anthracis-subtilis group and to discover the nuclei of bacillus diphtheria, gonococci and staphylococci. We have continued our investigations which enabled us to demonstrate the nuclei of meningococci, streptococci and pneumococci. In our first group, the staphylococcus was most difficult to investigate, and we were able to show its nucleus only by treatment with an alkali (lithium carbonate) previous to the action of ribonuclease ; but it was not very suitable because only isolated nuclei remained. We have overcome this difficulty by using higher concentrations of ribonuclease. It appears now that the method with ribonuclease, without previous alkaline treatment, has a quite general significance ; but for each micro-organism it is necessary to study optimal conditions of ribonuclease concentration and duration of enzyme contact required to eliminate the whole content of cytoplasmic ribonucleic acid, while avoiding the non-specific lixiviation effect on the desoxyribonucleic acid of the nuclei due to long exposure to hot solutions.

As part of a general programme of research, we have investigated cytological variations of a staphylococcus strain (pyogenic *Staphylococcus aureus* isolated from a human boil), the bacteria having been cultivated either (1) on ordinary agar broth medium, or (2) on agar broth medium containing a sublethal concentration of penicillin (75 units per litre of medium for this bacterium) which delays growth without stopping it.



A. NORMAL STAPHYLOCOCCUS. GENERAL BASOPHILY. *B*. NORMAL STAPHYLOCOCCUS. NORMAL SWELLING DURING THE LAG PHASE. *C*. THE SAME, AFTER RIBONUCLEASE TREATMENT: NUCLEI. *D*. STAPHYLOCOCCUS TREATED WITH PENICILLIN. DEMONSTRATION OF THE BASOPHILIC MASSES. *E*. STAPHYLOCOCCUS TREATED WITH PENICILLIN, AFTER RIBONUCLEASE TREATMENT: NUCLEI. (ON THE RIGHT, EMPTY SHELL: CYTOLIZED CELL ?) (DRAWN FROM PHOTOMICROGRAPHS)

Staphylococci cultivated on agar broth medium without penicillin. During the lag phase, the bacteria swell without multiplying, and after two or three hours they are twice as large as before. With the usual stains, they are entirely basophilic (Fig. *B*) ; but ribonuclease treatment demonstrates a nuclear apparatus (Fig. *C*). Then, there is in each coccus either a central or paracentral round nucleus, or, generally, two round or kidney-shaped nuclei showing divisions ; rarely, three or four nuclei can be seen in the bacteria. After five or six hours, the lag phase comes to an end and the cocci multiply vigorously and regain their initial size. They have generally two or one nuclei.

Staphylococci on agar broth medium with penicillin. During the very first hours, the cocci keep their normal size, then they swell very much, so that their diameter is three or four times the initial diameter. Hypertrophic cocci are no longer entirely basophilic, and after treatment with the usual stains, two, three or four chromophilic masses, separated by clear areas, may be observed (Fig. *D*). Ribonuclease treatment discloses two to four or sometimes five round or kidney-shaped nuclei showing numerous divisions (Fig. *E*). It seems that one or two nuclei form the centre of each basophilic mass which has already been mentioned. Later, most of the cocci gradually regain their usual size, and multiplication begins. But basophilic masses are found in bacteria as long as the micro-organism lives on a medium containing penicillin. When bacteria which have grown on agar medium with penicillin are transplanted on agar medium without penicillin (or agar medium with penicillin plus penicillinase) they regain their initial cytology, are entirely basophilic and have generally no more than two or one nuclei, according to the age of cultivation.

Summarizing : (1) penicillin produces, with staphylococci, during the lag phase, an exaggerated swelling ; (2) it changes the bacterial cytology and elicits differentiation of chromophilic masses separated by clear areas, an appearance which is not observed in normal bacteria even when they are old ; (3) it interferes with multiplication by inhibiting cytoplasmic rather than nucleal divisions.

We are endeavouring to find out, by chemical means, the variations of desoxyribonucleic and ribonucleic acid content in bacteria treated with penicillin. The results of these experiments will be reported later ; but we assume that the basophilic masses which can be observed under the influence of penicillin owe the most important part of this chromatophily to ribonucleic acid. After staining bacteria with neutral red, Pratt and Dufrenoy[2] have recently published drawings of staphylococci treated with penicillin which are similar to ours before ribonuclease treatment. They think that basophilic masses should be considered as vacuoles fixing the dye. So far as we are concerned, we think that these masses are perinuclear cytoplasmic areas in which ribonucleic acid has been stored, as a result of bacterial 'ill-health' due to the antibiotic.

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Subtilin C : an Antibiotic Concentrate from *Bacillus subtilis*

A CONSIDERABLE literature[1], dating back to 1897, has established the activity of *Bacillus subtilis* strains against a variety of bacteria as well as viruses. A limited amount of work has been done on the isolation of the active constituents of *B. subtilis* cultures, and although several concentrates with distinct properties have been described, no pure active compounds have yet been defined.

In recent publications[2] by members of the Northern and Western Regional Research Laboratories, United States Department of Agriculture and the University of California, extensive investigations on the production of the active antibiotic concentrate subtilin from two strains of *B. subtilis* (*A.T.C.C.* 6633, *N.R.R.L. B* 543 ; and *A.T.C.C.* 7080, *N.R.R.L.* 537) have been described, together with some of its properties. As part of this work has been duplicated here during the past eighteen months, the results of investigations to date are now recorded. A more detailed account will be given elsewhere.

Of the twenty strains of *B. subtilis* examined, the strain *A.T.C.C.* 6633 displayed greatest antibacterial activity, the metabolism solutions being adjusted to *p*H 2·5 and autoclaved at 114° C. for ten minutes. The active concentrate subtilin had been isolated from surface cultures of this strain by Jansen and Hirschmann[1]. We used quick-freeze dried cells grown in submerged culture with aerating agitation on a medium of corn-steep liquor and sucrose. It was found, after several trials with different solvents, dilute acids, and inorganic salts, that the active principle was most advantageously separated when the cells were disintegrated in alcoholic suspension with glass beads or autoclaved with 80 per cent aqueous alcohol. By the use of the latter procedure, followed by dilution of the alcoholic extract with adjustment of the *p*H to 2·3, an active concentrate, which we will term subtilin *C*, was obtained as an amorphous powder.

Subtilin *C* in high concentration (1/2,000) was inactive against the Gram-negative bacteria tested, but Gram-positive organisms were generally susceptible to high dilutions; acid-fast bacteria showed a range of sensitivity. The substance had no lytic effect on a variety of organisms. It diffused only with great difficulty.

Antibacterial activity was determined by serial dilution of solutions or fine suspensions of subtilin *C* which had been adjusted to *p*H 2·5 and autoclaved at 114° C. for 10 minutes.

	Highest dilution of subtilin *C* giving 50% inhibition of growth after 24 hr. at 37 C. in glucose broth
Sarcina lutea	1/10,000,000
Staphylococcus aureus (6 strains)	1/80,000–1/8,000,000
Corynebacterium xerosis	1/5,000,000
Lactobacillus helveticus	1/2,400,000
Micrococcus conglomeratus	1/600,000
Mycobacterium from butter	1/300,000
Mycobacterium phlei	1/60,000

Complete inhibition of growth was given by two to four times the amounts of subtilin *C* required for 50 per cent inhibition.

Subtilin *C* is stable under certain conditions. A preparation stored for five months at room temperature in a desiccator in the dark showed no loss of activity. In solution in glucose broth, *p*-aminobenzoic acid (200 μgm./ml.), nicotinic acid, pantothenic acid and riboflavin (5 μgm./ml.), aneurin and pyridoxin (2 μgm./ml.), biotin (0·1 μgm./ml.), folic acid (0·01 μgm./ml.), 2 per cent casein hydrolysate, and asparagine and tryptophane (0·1 per cent), exerted no antagonistic effect in the concentrations given. The same was true of solutions of sodium chloride (2 per cent), glucose (2 per cent) and cysteine (0·04 per cent).

Under some conditions, the antibacterial properties of subtilin *C* were impaired. Exposure to sunlight for two days reduced the activity to 10 per cent of darkened controls at various *p*H values. With serum the results were not clearly defined. Using *Staph. aureus* as test organism, no significant loss in activity was observed over short periods (24 hr.), but contact for three days reduced the activity to 25 per cent of the original. Seitz filtration of a solution of the antibiotic resulted in loss of activity. Studies on the stability of solutions at various *p*H values showed that subtilin *C* was most stable at *p*H 2·5. It is rapidly destroyed in alkaline solution.

The properties of subtilin *C* would support the view that the active principle is a polypeptide. Hydrolysis by trypsin and pepsin resulted in loss of activity. It gave a strong ninhydrin reaction for α-amino-acids and positive tests with Ehrlich's reagent for indole derivatives and the Folin–Denis reagent for phenols. No coloration developed on treatment of an alcoholic solution with ferric chloride; this differs from the results obtained by the American workers.

I am indebted to Dr. F. Bergel and Prof. A. R. Todd for helpful suggestions and a continued interest in this work; also the assistance of Dr. Klein, Dr. Moss and Miss Ward in the microbiological work is gratefully acknowledged.

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Nov. 4.

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Serological Position of *Streptococcus bovis*

Streptococcus bovis, a conspicuous streptococcus of cow dung and also occurring in human fæces, has proved difficult to classify. Biochemically it is a well-defined species (Orla Jensen), and although it has some of the characteristics of Lancefield's Group *D* streptococci, its serological identity has long been obscure because of its failure to yield a group serum. While many strains of *Str. bovis* reacted with Group *D* sera, a not inconsiderable proportion gave negative or equivocal results[1,2,3], and until group sera for *Str. bovis* could be prepared its serological placing was necessarily left in abeyance.

Using an improved method of extraction, it has now been shown that virtually all strains are precipitated with a Group *D* serum. Moreover, by further improvement in the method of preparation of suspensions for inoculation, it has been possible to produce group specific sera from *Str. bovis* itself. Reciprocal absorptions with these sera and with sera prepared from other authentic Group *D* strains confirm that *Str. bovis* now takes its place with the enterococci as a member of Group *D*.

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Intravenous Methylene Blue: a New Method for Studying the Nervous System

In 1886, Ehrlich[1] obtained striking results by the use of methylene blue as a stain for the nervous system. Of the many methods since developed for utilizing the staining properties of methylene blue perhaps the simplest and most reliable is the local injection technique of Weddell *et al.*[2]. The two main disadvantages of this method are the inevitable distortion of the tissue by the direct injection of the staining fluid and the limitation of the size of the region stained. Both objections may be overcome by continuously perfusing methylene blue into the veins of a living animal, conditions being so arranged that the animal survives for an extended period. The details of the technique are being published in full elsewhere[3], but the results obtained are so consistent that it was felt worth while to point out some of the possibilities of the method.

There appears to be no serious restriction on the number or type of tissues which can be studied in this manner, and the application of the method has already made possible detailed investigations on the pattern of innervation in striated muscle, blood-vessels (Millen[4]), and the cornea.

Fine morphological details may also be demonstrated, both in the peripheral and central nervous system. Thus, complicated end-organs such as muscle spindles stain with remarkable clarity, and a most striking feature is the demonstration of *boutons terminaux* in the central nervous system. *Boutons* have been observed in regions, such as the cerebral cortex, where they have previously been stained only with great difficulty or not at all.

There are many physiological problems to which this type of study might with advantage be applied. To take but one example, it should be possible, in cases of experimental poliomyelitis, to obtain a correlation between the condition of the affected muscles and that of the central nervous system in the same animal. For these reasons it appears that the method possesses considerable potentialities, in that it renders possible integrative studies of the functional anatomy of the nervous system.

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Influence of Low Bicarbonate Concentrations on the Growth of a Green Alga

THE role of bicarbonate ions as a source of carbon for aquatic plants has been a subject of discussion for a long time. Steemann Nielsen[1] has recently given a short history of this question and published experiments showing that *Myriophyllum* has a greater ability than *Fontinalis* to use carbon from bicarbonate.

My own experiments have been made with a planktonic Green Alga, *Scenedesmus quadricauda* (Turp.) Bréb., and show that its behaviour is rather different from that of higher plants. The culture conditions of the inoculating material were the same as previously described[2], except that half the sodium carbonate had been exchanged for an equivalent amount of potassium carbonate.

In the experiments the Algæ were cultured in Jena glass tubes with 10 ml. of solution in each. The cultures were aerated with air (0·03 per cent carbon dioxide), or a mixture of 5 per cent carbon dioxide and 95 per cent air. The nutrient solution contained the same constituents as the solution for growing the inoculating material except that the carbonates were exchanged for equivalent amounts of disodium and dipotassium hydrogen phosphate, thus giving the solution a buffer of 1/44 *M* phosphate. The *p*H was regulated by adding various amounts of hydrochloric acid. After inoculation, the gas mixture that was used was blown through the cultures in the dark until the pressure of carbon dioxide in the solution was the same as in the gas mixture, that is, until the *p*H had a constant value. Usually four hours was enough. The cultures were then illuminated for ten hours. Four parallels were run, one of which was used up for *p*H determination at the beginning of the growth period, so that the growth determinations were made on three tubes the mean values of which are given in the accompanying figures. Growth was measured photometrically.

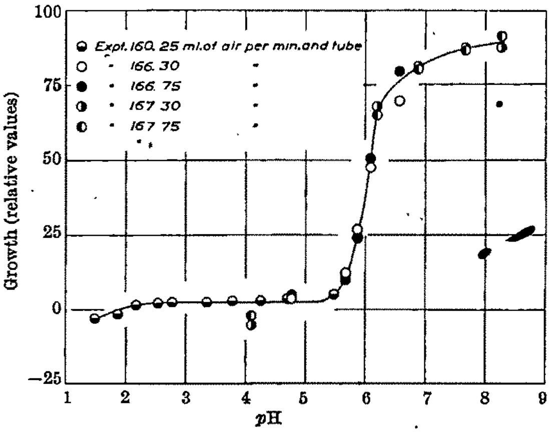

Fig. 1. GROWTH OF *Scenedesmus quadricauda* AT VARIOUS *p*H-VALUES IN CULTURES AERATED WITH AIR

When air is blown through the cultures, we get the curve of Fig. 1. Three experiments have been combined to form it because it was technically impossible to get all the points from one experiment. In two of the experiments two different rates of aeration have been used, and they show no difference. Another experiment has shown that carbon dioxide is taken up so rapidly from the air that, with the density of population used, the solution is practically in equilibrium with the air all the time. If a larger amount of inoculating material is used, this is no longer the case, and then the *p*H rises during illumination and falls to the original value in the dark if the aeration is continued.

The curve (Fig. 1) shows that growth is low between *p*H 2 and 5·5. Between *p*H 5·5 and 6·2 the curve rises very rapidly and continues to *p*H 8·2, which is the highest obtainable *p*H-value with this solution. In other experiments, not reported here, carbonate buffers have been used; and it is then possible to make growth determinations up to *p*H 9·8. The curve from this experiment shows an optimum at about *p*H 9 to which the 100 per cent in Fig. 1 refers.

The rapid rise in growth between *p*H 5·5 and 6·2 is not a direct effect of the acidity, for if 5 per cent carbon dioxide is blown through the cultures, growth is good even at *p*H 3–4.

I think the cause is to be found in the concentration of bicarbonate ions. In Fig. 2 we see the critical points of Fig. 1 placed in a graph where the abscissæ are the concentrations of bicarbonate ions, calculated from known constants. The growth is directly proportional to the concentration of bicarbonate between 1·5 and 9 μmol./l.

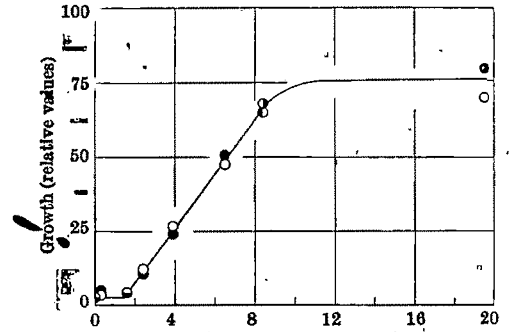

Fig. 2. GROWTH OF *Scenedesmus quadricauda* AT VARIOUS CONCENTRATIONS OF BICARBONATE IONS

The slight growth below 1·5 μmol./l. must be ascribed to the free carbon dioxide or carbonic acid, the concentration of which is 10 μmol./l. at all *p*H-values. A strange fact is that bicarbonate in concentrations below 1·5 μmol./l. was not assimilated. At bicarbonate concentrations greater than 9 μmol./l., growth is no longer limited by this substance but by other factors.

Steemann Nielsen (*loc. cit.*) has found that *Myriophyllum* and *Fontinalis* use carbon dioxide more rapidly than bicarbonate ions. In the case of *Scenedesmus*, we see that in a carbon dioxide concentration of 10 μmol./l., growth is very small; but in the same concentration of bicarbonate ion the growth amounts to 75 per cent of the optimal growth. Thus we see that various plants behave very differently with regard to the carbon source: *Fontinalis* assimilates about ten times better in carbon dioxide than in bicarbonate, and *Myriophyllum* two to five times better; but *Scenedesmus* grows twenty-five times better in bicarbonate than in carbon dioxide.

From Steemann Nielsen's curves one can see that the ability to use carbon dioxide is about the same for *Myriophyllum* and *Fontinalis*. The assimilation at 10 μmol./l. of carbon dioxide is very slow; and this is also the case with *Scenedesmus*. The differences are to be found instead in the ability to use bicarbonate. *Fontinalis* has a very slow assimilation in 10 mmol. of bicarbonate per litre, the assimilation of *Myriophyllum* amounts to 50 per cent of the optimal at 1 mmol./l., and *Scenedesmus* has 75 per cent of its optimal growth at 0·01 mmol./l.

It is very probable that these facts affect the distribution of the plants in lakes.

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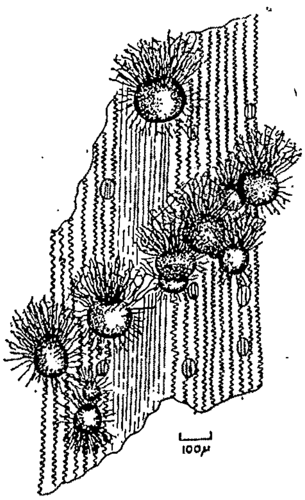
A *Chætomium*-like Thermophile Fungus

AMONG the various organisms which have been isolated at this Station from fermenting straw composts, one, *M.R.A.* No. 112, is of special interest. It is a thermophile Ascomycete producing perithecia which in many respects resemble those of the genus *Chætomium*.

Between the temperatures 40° C. and 50° C., on slopes of 3 per cent malt extract agar, *p*H 5·5, in a saturated atmosphere, vegetative growth is most luxuriant and perithecia are most abundant and most fertile. At 45° C. a small amount of mycelium deposited about the centre of a slope 7 cm. × 1·5 cm. spreads over the whole surface, often within the first twenty-four hours; procarpal structures and perithecial initials are well developed within thirty to sixty hours, and many fully formed perithecia containing ascogenous structures, asci or even liberated spores are to be found within ninety-six hours.



PERITHECIA OF THERMOPHILE FUNGUS, *M.R.A.* NO. 112, ON PIECE OF STRAW, APPROX. × 40 (SEMI-DIAGRAMMATIC)

Below 37° C. and above 55° C., growth on 3 per cent malt extract agar slows down markedly and ceases between 25° and 26° C. and between 61° and 62° C.

This remarkable fungus, which is probably a new species, surely holds the high-temperature record for vegetative growth and production of perithecia among Ascomycetes. Its taxonomic position is still under consideration; but as soon as this has been decided, further data, including descriptive details, will be published.

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Treatment of Apple Canker Lesions with Plant-growth Substances

GIVEN that the formation and spread of a canker depends on the balance between the growth of the pathogen and the regeneration of the host, a substance which stimulates wound healing may prove as effective in combating the disease as one which aims at suppressing the pathogen. A number of the chemicals known as plant-growth substances stimulate callus formation, and it is possible that some of these may also suppress the development of the pathogen.

The effect of a number of growth substances on *Nectria galligena* Bres., the cause of apple canker, has been examined. In the first method used, records were made of the growth of the fungus on 2 per cent malt agar (*p*H 4·8) to which had been added 100 p.p.m. of the substance. It was found that during the greater part of the growth the increase in diameter was constant, and it was therefore possible to calculate a coefficient of linear regression of diameter on time which gave a fair estimate of the average growth-rate. Secondly, the effect of these substances on the growth of the fungus in liquid culture was observed by comparing dry weights of colonies grown in nutrient solutions containing varying concentrations of the substances in question. None of the substances used was strongly fungicidal and, although the more toxic produced a marked reduction in growth in relatively small concentrations, growth was not completely inhibited at very much higher concentrations. It was therefore found convenient to record as the toxic concentration the quantity required to reduce growth to less than 5 per cent of the controls. As the toxicity of these compounds is increased with increasing acidity, it is necessary to state the *p*H of the medium when quoting toxicity figures. The results of the tests described above are shown in the accompanying table, in which the second column relates to the tests on agar and the third column is derived from the results obtained in nutrient solution.

EFFECT OF PLANT-GROWTH SUBSTANCES ON THE GROWTH OF *N. galligena*

Substance	Growth-rate (mm. per day)	Toxic conc. in p.p.m. (*p*H 3·8)
2,4,6-Trichlorophenoxyacetic acid	1·22 (± 0·07)	40
1-Chloro-2-naphthoxyacetic acid*	1·07 (± 0·02)	40
α-Naphthaleneacetic acid	1·40 (± 0·05)	20
β-Indolylbutyric acid	2·37 (± 0·11)	60
β-Indolylacetic acid	2·59 (± 0·04)	100
β-Naphthoxyacetic acid	2·67 (± 0·16)	60
2,4-Dichlorophenoxyacetic acid	2·20 (± 0·09)	80
Control	3·01 (± 0·09)	

* Supplied by F. E. Smith, of Pal Chemicals, Ltd.

In preliminary field trials these substances were applied to established cankers at a strength of 1 per cent in lanoline; the cankers treated with β-indolylbutyric acid showed a marked improvement over the controls, but the others showed little difference.

These failures may possibly be due to the use of concentrations which were high enough to be toxic to the host.

I am grateful to Dr. L. C. Luckwill and to Mr. R. W. Marsh for their advice during the course of this work.

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Nov. 11.

A New Dry Test for Gold

DURING the course of a systematic investigation of the mechanism of the blue mantle test for tin[1], it has been recently observed in these Laboratories that gold shows a similar reaction, but the colour of the mantle is a brilliant green.

The following procedure is adopted. Add to the gold salt in a porcelain dish a quantity of concentrated hydrochloric acid. Add a speck of metallic zinc and immediately dip a test tube, full of water, in the solution over the point where the hydrogen is bubbling up. On holding the test tube in the hottest portion of a Bunsen flame, a brilliant green mantle forms around the bottom of the test tube. The test is sensitive to 0·1 mgm. of gold per c.c. of concentrated hydrochloric acid. The presence of tin, however, interferes, and the green mantle is replaced by the characteristic blue mantle of tin. Copper also interferes.

As mercury, lead, silver and even platinum ions do not interfere, gold can be easily detected in a tin-free ore or alloy by dissolving the nitric acid insoluble portion in *aqua regia* and then applying the above test.

The mechanism of the test is not known.

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University of Allahabad.
Oct. 14.

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[1] Meissner, H., *Z. Anal. Chem.*, 80, 247 (1930). Schröer, E., and Balandin, A., *Z. Anorg. Chem.*, 189, 258 (1930).

Demonstration of the Heart Beat

THE explanation of Dr. C. A. Beevers' observations[1] (which I can confirm and to which I would add the further observation that the puffs of smoke correspond to cardiac systole) would seem to lie in the close resemblance of the human chest to the box used for the production of smoke rings to which he refers. Both have relatively rigid walls with a diaphragm and an orifice. In the case of the chest the contraction of the heart muscle during systole, acting from the relatively fixed great vessels of the head and arms, pulls its diaphragmatic attachment upwards, thus reducing the volume of the thorax. Air, being the most easily displaced thoracic content, is expelled in small jets corresponding to each cardiac systole and produces the effect noted by Beevers.

That it is not brought about by arterial pulsation in the mouth is certain because, during the process of blowing smoke from the mouth, the latter is in free communication with the lower air passages, and the comparatively small effect of local vascular changes would be lost in the very much greater volume of air (approximately 3 litres) present in the lungs and respiratory passages.

A possible additional cause is the throwing during each systole of upwards of 60 ml. of blood into the pulmonary circulation with displacement of air from the alveoli as the pulmonary capillaries dilate. This, however, is likely to be a much more gradual process and to be delayed for a considerable interval after systole.

Changes in the volume of the heart itself during the cardiac cycle might be thought to play a part; but consideration will show that any expulsion of air would be diastolic in time and also more gradual than a similar effect accompanying systole, being dependent on the flow of blood into the thorax via the superior and inferior venæ cavæ rather than its sudden expulsion from the heart.

It is doubtful if the accurate measurement of these pressure changes suggested by Dr. Beevers would provide any more valuable evidence of the condition of blood vessels than can at present be obtained by direct observations on an artery, as with various forms of sphygmograph, or on the volume changes in a limb with a plethysmograph.

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[1] Beevers, C. A., *Nature*, 161, 65 (1948).

ON looking further into the literature, I find that the 'cardio-pneumatic movement' has been described many times previously. For example, Haycroft and Edie (*J. Physiol.*, 12, 426; 1891) quote C. Voight as having recorded the phenomenon in 1865. However, these workers seem to have used a glass tube inserted into the mouth with a drawn-out portion in which the movements of the smoke particles are observed.

C. A. BEEVERS

INTERNATIONAL MEETING ON ANIMAL PRODUCTION

By I. L. MASON

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A MEETING, sponsored by the Swiss Zootechnical Society, was held in Zurich during October 8–9, 1947, in order to renew professional and personal contacts severed by the War and to discuss the proposed formation of an International Society of Zootechny (or Animal Production). It was organised by Dr. W. Engeler, secretary of the Swiss society, and great credit is due to him and his colleagues for arranging the meeting at such short notice.

There were about 250 participants from twenty-six countries, and eighteen of these countries were represented by official Government delegates. Apparently the only delegate from outside Europe was Dr. Riddell, the United States agricultural attaché at The Hague, who was the official American representative. The only visitors from Great Britain were Mr. Alec Hobson (secretary of the Royal Agricultural Society of England and also representing the British Society of Animal Production), Mr. and Mrs. Gerald Strutt (Royal Agricultural Society of England), and Mr. and Mrs. I. L. Mason.

At the opening ceremony addresses of welcome were given by representatives of the Federal Department of Agriculture, the Swiss Zootechnical Society, the Swiss Breeders' Federation, and the Federal Technical College, where the meetings were held. All the speakers recalled with pleasure the International Conference on Animal Breeding held in Zurich in 1939, and hoped that the work interrupted by the War could now be continued.

At the first technical session, Dr. I. Moskovits, head of the animal husbandry section of the Temporary European Bureau of the Food and Agriculture Organisation, Rome, gave an exhaustive account of the international livestock situation, with particular reference to changes in livestock numbers, country by country, during the War, and Dr. A. Kiener presented a vivid picture of the Swiss livestock industry. It was very interesting to observe that the War had had much the same effects on livestock production policy in Switzerland as in Britain, namely, sharp reduction in pig and poultry stocks, owing to absence of imported feeding-stuffs, and emphasis on milk rather than on meat production.

On the second day of the meeting, official reports on the state of animal breeding in the following European countries were circulated: Austria, Belgium, Denmark, Finland, France and the Netherlands. In addition, Dr. Riddell and Prof. Csukás gave verbal accounts of animal breeding in the United States and Hungary respectively. Dr. H. Aersoe spoke on bull testing in Denmark; this information is already available in published form (*226. Beretning fra Forsøgslaboratoriet*, Copenhagen, 1947). In the discussion, Dr. Rijssenbeek (Netherlands) criticized the absence of daughter/dam comparisons and the restriction of the test to autumn calves. Dr. Horn (Hungary) pointed out the difficulty of comparing one year with another in a Continental climate; his observations also showed that some bulls might raise the annual yield, but depress the life-time production of daughters compared with dams. Dr. Rijssenbeek read a paper entitled "Horse-Breeding in the Netherlands"; it included an account of an apparatus for measuring the pulling power of horses, designed by Prof. Visser.

The rest of the day was devoted to the proposed International Society of Animal Production. The discussion was based on the provisional statutes drawn-up by the 1939 meeting. Those most desirous of forming the Society were Dr. Rijssenbeek, Dr. Engeler and Prof. Leroy (France). It was finally decided: (1) that an International Society of Animal Production should be formed on a Continental basis; the Continental sections could later link to form a world association; (2) that the society should be private and not governmental, and should be based on the zootechnical societies of each country; these societies include scientific workers, breeders, and administrators; (3) that a preparatory committee should be formed by representatives of the national zootechnical societies in Belgium, Denmark, France, Hungary, Netherlands, Switzerland and the United Kingdom; (4) that the secretariat should be at the Food and Agriculture Organisation Bureau in Rome, and Dr. Moskovits would be responsible for convening the committee; (5) that the committee should prepare a draft constitution and report at the next International Meeting on Animal Production, to be held in Paris in 1949. The preparatory committee would also prepare the agenda for the next conference. Dr. Moskovits suggested that the projected International Society might help to co-ordinate the research programmes in the smaller countries. At the moment, too many small experiment stations are attempting too much for their resources and achieving too little. Mr. Hobson described the formation and objects of the British Society of Animal Production, and promised its co-operation.

The meeting was conveniently arranged to coincide with the sixteenth Swiss National Livestock Show. This is a big event, lasting for nearly a month, horses, small stock and cattle being shown in succession. Judging was done before the public was admitted, and the prize animals were periodically paraded round the ring. In this parade, however, the emphasis was on the breed rather than the individual, and attention was directed to the characteristics, distribution and performance of each. In this way we were able to see the famous improved breeds of Swiss goats—the Saanen, Toggenburg, Appenzell, and polled Chamois—as well as the horned Chamois, Grisons, Verzasca, and Valais Blackneck, representing the mountain types. Most of the pigs in the country are Improved Landschwein or Large White. Sheep are of less importance; we saw the White Swiss Alpine, Brown-headed Mutton (Oxford) and the Black-brown Mountain breeds.

Cattle are by far the most important livestock in Switzerland. Two breeds divide the country between them—the Swiss Brown in the east and the Simmental in the west. They were excellently presented at the show, and in view of the single- versus dual-purpose controversy in Great Britain, it was extremely interesting to see such good examples of functional *triple*-purpose animals. In presenting them, the emphasis was placed on the importance of maintaining a balance between the production of milk, work and meat.

Further opportunity of studying these animals was provided by the expeditions organised in connexion with the meeting. We went to Einsiedeln in Canton Schwyz, the place of origin not only of the Swiss Brown cattle, but also of the Swiss Confederation itself. We saw three herds of Simmental cattle in the

Emmental and Simmental. Finally, we inspected Jura (or Freiberg) horses in the neighbourhood of Delémont, in the Bernese Juras. This is the only native Swiss breed ; it is a light-draft type, developed during the last fifty years. Wherever we went we were warmly welcomed and most hospitably entertained.

The arrangements for the conference were excellent. It is all the more unfortunate that the currency restrictions which prevail at every frontier prevented many people attending the conference and reduced to a minimum the stay of many others. Voluminous literature was available about the Swiss breeds of livestock. More important, these books and brochures were not merely propaganda, but gave factual accounts of characteristics and performance of animals and of methods of breeding and herd book registration.

INSULATING MATERIALS AND METHODS FOR USE AT LOW TEMPERATURES

THE Low Temperature Group of the Physical Society at a meeting on December 18, 1947, discussed insulating materials for use at low temperatures.

Sir Alfred Egerton, in the course of his presidential address to the Group, referred to the fact that the heat transfer by radiation in vacuum-jacketed vessels is greater than that predicted from theoretical calculations based on emissivities obtained from the electrical conductivities, and mentioned that a copper surface reduced with hydrogen at 300° C. is a better reflector for heat waves than a polished surface.

Sir Alfred then described thermal conductivity determinations carried out under his and Prof. Newitt's direction by Dr. C. S. Chow at the Imperial College. The apparatus consisted of an inner cylinder maintained at low temperature by liquid oxygen and an outer cylinder which served both as a heater and a water flow-calorimeter ; the material under test being packed between. Thermocouples were located at various positions to give the temperature distribution. Some of the data obtained are quoted below. They are mean thermal conductivities for a cold-face temperature of −181° C. and a mean temperature of about −84° C.

Material	Description	Bulk density (gm./c.c.)	Thermal conductivity (gm. cal. cm./$cm.^2$ sec. °C.)
Granulated cork, baked	49·5% 10–20 mesh 50·5% through 20 mesh	0·101	0·000066
Vermiculite	10–14 mesh	0·216	0·000112
	4–10 mesh	0·144	0·000082
Mixed ,,	7·9% 3–4 mesh 26·5% 4–10 ,, 65·6% 10–14 ,,	0·157	0·000101
Wadding	Crude cotton wool	0·042	0·000062
Slag wool		0·059	0·000076
,, ,,		0·130	0·000044
,, ,,		0·197	0·000062
Cotton waste	Tangled thread form	0·131	0·000092

In a contribution from the National Physical Laboratory, Dr. Ezer Griffiths and Mr. M. J. Hickman reviewed the physical properties of insulating materials which have to be taken into account in practice in addition to thermal conductivity. They are bulk density, specific heat, fire resistance, water absorption, water repellency, permeability to water vapour, mechanical strength and settlement under vibration. The procedures for measuring these properties were outlined. For measuring thermal conductivity over the range of temperature of interest in refrigeration work, the hot-plate method was adopted : the plate being fitted with a coplanar guard ring. For the measurement of thermal conductivity down to about −78° C., a box or cylinder method has been used, the box being made of the material under test. The cold-face temperature was maintained at a constant low temperature by the use of a block of solid carbon dioxide, and the rate of sublimation of the solid carbon dioxide afforded a measure of the heat flow into the box.

A few of the results obtained with the various forms of apparatus are summarized below :

Material	Bulk density (gm./c.c.)	Mean temperature (°C.)	Thermal conductivity (gm. cal. cm./$cm.^2$ sec. °C)
Expanded ebonite	0·086	−27	0·000067
Balsa wood ..	0·101	−27	0·000075
Baked slab cork ..	0·107	−27	0·000079
,, ,, ,, ..	0·160	−27	0·000082
Cellular polystyrene	0·08	0	0·00010
Cellular chlorinated rubber	0·11	0	0·000092
Corrugated cellulose acetate sheets superimposed		−2	0·00011
Kapok (cieba fibre)	0·016	0	0·000072
Slag wool (water repellent)	0·176	−8	0·000085
Bonded glass fibre	0·048	0	0·000080
Cellular glass (fine pored)	0·18	−2	0·00013
Cellular polyvinyl formal	0·06	10	0·000090
Cellular ebonite (synthetic rubber)	0·07	10	0·000080
Foamed glue	0·03	16	0·000085

Dr. A. M. Clark (British Oxygen Co.) stated that the energy required to compensate the leakage of a unit of heat into a system at liquid oxygen temperature is fifteen to twenty times as great as that required to compensate for the leakage of the same quantity of heat at −30° C. The efficiency of a vacuum at liquid air temperature is about fourteen times that of a 10-cm. layer of a material such as baked slab cork. The complexity of the arrangement of a large industrial low-temperature plant, however, renders vacuum insulation impracticable to any great extent. He stated that the largest vacuum-insulated tank yet made for the storage of liquid oxygen had a capacity of 57 tons and an evaporation loss of 0·16 per cent of its contents per 24 hours. The largest storage vessel insulated with rock wool had an evaporation loss on the same basis of 0·2 per cent.

Sir Alfred Egerton stated that a vacuum-jacketed vessel of 30 gallons capacity for the storage of liquid methane had a rate of loss of 1½ gallons per 24 hours.

Dr. P. M. Schuftan (Gas Separation Branch, British Oxygen Co.) gave figures to show that the effect of improved insulation in oxygen plants was rather smaller than expected. For example, in an oxygen storage tank of 300,000 $ft.^3$ capacity fitted with the usual magnesia insulation, about 3 per cent of the product is gasified by heat influx from outside. This amount of gas can, as a rule, be fully utilized for cylinder filling and only the latent heat of the oxygen is lost, adding about 2 per cent to power consumption and 1 per cent to total operating costs.

Prof. F. E. Simon discussed the process of heat conduction in solids, emphasizing the role of the mean free path of the heat waves. Reduction of the mean free path by disturbing the lattice, either physically (mechanical distortion, use of super-cooled disordered phases) or chemically (alloying), gave a very low thermal conductivity at low temperatures.

In the subsequent general discussion, stress was laid on the possibilities of an insulator composed of powder or fibres with gas at low pressures in the interspaces.

EZER GRIFFITHS

SOME NEW ANISOTROPIC TIME EFFECTS IN RHEOLOGY

By S. M. FREEMAN and K. WEISSENBERG
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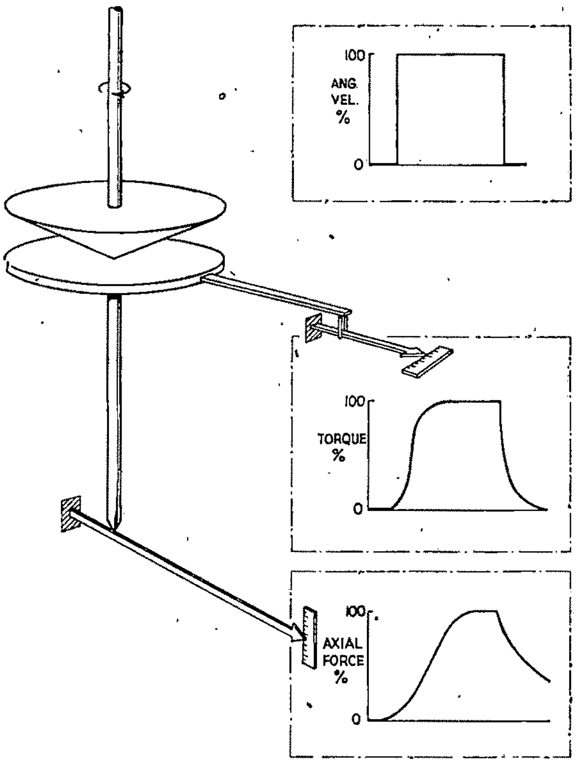
IN rheology we study the development in space and time of the *mechanical variables*, that is, of the stresses and strains which co-exist in a material in every differential cell, and at every instant. Our concern here will be the comparison between different directions in space, and we shall speak with respect to any quantity, or development, of *isotropic* symmetry to denote identity in the various directions, and of *anisotropic* symmetry to denote differences from one direction to another.

Let a material be observed as it passes under some mechanical action through a series of rheological states, and let all such states be divided into *sheared* and *shear-free* states according as we can, or can not, find a tangential component of the mechanical variable under consideration on a plane of at least one orientation. It can then be shown that any passage between a shear-free and a sheared state will necessarily exhibit some anisotropic development in time, even if the material itself is of the isotropic kind, that is, shows the same response to mechanical actions in all directions of space when tested in a *ground-state*, where it is at rest and free from externally applied forces. (It follows from symmetry considerations that every shear-free state must be isotropic, and every sheared state anisotropic; and hence, any passage between the states of the two classes must exhibit anisotropic time effects with respect to the mechanical variable which possesses a tangential component.) We shall restrict our attention here to such isotropic materials, subjected to laminar shearing displacements. The laminæ which glide over one another will then suffer tangential and normal components of stress which—according to the theory[1]—must vary simultaneously at differing percentage rates, showing, for example, different exponential indices during an exponential build up, or relaxation. In general, when the tangential component varies as an odd function of time, the normal one must simultaneously vary according to an even function, so that under vibrational displacements in which the former varies with some frequency around a mean value of zero and according to a sine function, the latter must vary simultaneously with double that frequency around a mean value different from zero, and according to a cosine function.

The experiments were actually made on isotropic materials of the visco-elastic type, such as liquid and solid colloids containing rubber, saponified oils, pastes of starch, cellulose acetate, etc., because this type exhibits the anisotropic time effects in an easily accessible range of mechanical actions. (Liquids are understood here as materials which flow under any shearing stress, however small; while solids are capable of maintaining such stresses statically up to a certain limit.) Further, the materials were so selected as to be sensibly incompressible (within the range of applied actions), as this brings about a simplification of the effects here considered.



The accompanying illustration shows on the left-hand side a schematic diagram of the apparatus, and on the right-hand side a typical set of experimental results. The apparatus used was a version of the rheogoniometer[2] specially designed to impose on a material laminar shearing displacements and to measure along various directions in space the development in time of the stresses. The framework of the apparatus consists of a watchmaker's precision lathe with its axis mounted in a vertical position. Concentric with this axis, and secured respectively in the head- and tail-stock of the lathe, are a circular cone (vertex downwards) and a plane circular disk, which touch one another, and form respectively the roof and the base of a horizontal gap of small height, containing the material under examination. One may impose on the material any laminar shearing displacement desired. For this the cone is rotated about its axis but held rigidly against axial translations, while the disk is kept sensibly at rest by constraints against both rotations and axial translations. The wedge-like shape of the gap then ensures that the material suffers the same amount of shear strain in every differential cell of the gap. The apparatus is equipped with measuring devices. For the strains the angle of rotation of the cone is measured and recorded as a function of time, while for the stresses it is necessary to register the action which the material exercises on the disk. To do this, the constraints of the disk are given the form of elastic cantilevers which yield immediately to the action and thereby measure, and record as functions of time, the *torque* and the *axial force*, that is, the moment about the axis, and the force perpendicular to the plane of the disk. As the yield of the cantilevers changes the dimensions of the gap, it is necessary to prevent these changes from becoming large enough to disturb the time effects significantly, and to use combinations of mechanical and optical lever systems (not shown in the figure) with a sensitivity of about 10^{-6} cm.

The experimental results are conveniently expressed by three graphs in which are plotted, against time, the angular velocity of the cone and the torque and axial force on the disk, each quantity being expressed in percentage of its maximum value. Assume the material to be incompressible, and the motion one of laminar shear throughout the gap. The torque, T, and the axial force, F, are then related to the stress components tangential and normal to the plane of the disk by a purely geometrical factor, and as this factor is independent of time, it cancels out when the percentage values are considered as functions of time. Explicitly, introducing cylindrical co-ordinates, we find that in a differential cell at a point (r, φ, z) the stress, P, has in the plane of the disk the tangential and normal components

$$P_{\varphi z} = P'_{\varphi z} \text{ and } P_{zz} = -P'_{\varphi\varphi} \log R/r,$$

whence integrating over the area of the disk we deduce

$$T = \tfrac{2}{3}\pi R^3 P'_{\varphi z} \text{ and } F = \frac{\pi}{2} R^2 P'_{\varphi\varphi},$$

where the indices attached to P indicate the co-ordinates involved and the dash denotes the value at a point of the rim of the gap $(r = R)$.

For such an ideal case the three graphs obtained for the macroscopic development in time must be identical with those obtained in every differential cell of the material for the percentages respectively of the strain velocity, and of the stress components tangential and normal to the plane of the disk. (The height of the gap is chosen sufficiently small to make the forces of inertia negligible under the motions of the material here considered.)

In one type of experiment we used visco-elastic liquids; solids are more troublesome for this type of experiments, since in the build-up period they tend to break under the large strains required, and in the relaxation period show inconveniently slow changes of stress. We were concerned with the time effects encountered in the build-up, and in the relaxation of the various components of stress during periods of stationary rates of laminar shearing displacements. It might appear that during these periods any liquid would run out of the gap. However, in the conditions of shear considered, the visco-elastic liquids used here develop hoop-stresses sufficiently strong to form a cylindrical free boundary, and prevent the running out. At first the material was in its ground-state, and the cone and disk were at rest. Next we started a period of build-up of stress by keeping the disk at rest and suddenly imparting to the cone a rotation with an angular velocity that was maintained throughout the period at a constant level sufficiently high to bring about measurable torques and axial forces on the disk. Finally we proceeded to a period of relaxation of stress by suddenly arresting the motion of the cone and keeping the cone and the disk at rest henceforth. Both periods were covered by a photographic record, and a typical set of results is shown on the right-hand side of the figure in the three graphs. The actions applied to the cone are seen in the graph of the angular velocity, and the anisotropic time effects in the differences between the graphs of the torque and axial force. Interpreting the graphs for every differential cell of the material, we find that the strain velocity is exactly synchronized with the action on the cone, while the stress components are delayed, and show anisotropic time effects, the percentage rates of build-up and relaxation being different as between the components tangential and normal to the plane of the disk.

In a second type of experiment we used visco-elastic materials, both liquid and solid, and proceeded as in the first type, except that the shearing displacement imposed by the rotation of the cone was now varied harmonically in time, with a frequency and amplitude chosen sufficiently high to give measurable torques and axial forces. The results obtained so far showed that, in this case, the torque, and the tangential component of stress, varied around a mean value of zero with the same frequency as the imposed displacement, while the axial force and the normal component varied around a mean value different from zero with twice that frequency. The phase and amplitude relations are still being investigated.

The experiments thus show that anisotropic time effects are produced even in isotropic materials during transitions between shear-free and sheared states, and that in the case of laminar shearing displacements the tangential and normal components of stress conform to the theory, showing simultaneously different times of build-up under a stationary rate of displacement, different times of relaxation under constantly maintained displacement, and different frequencies of vibrations under harmonically varying displacements.

The authors' thanks are due to the Director of Research at the Shirley Institute for the opportunity of performing this work and permission to publish it.

[1] Weissenberg, K., *Arch. Sci. Phys. et Nat.*, **17**, 1 (1934); *Nature*, **159**, 310 (1947).

[2] Weissenberg, K., Conf. British Rheologists' Club, London, 1946.

DIELECTRIC CONSTANT AND PIEZO-ELECTRIC RESONANCE OF BARIUM TITANATE CRYSTALS

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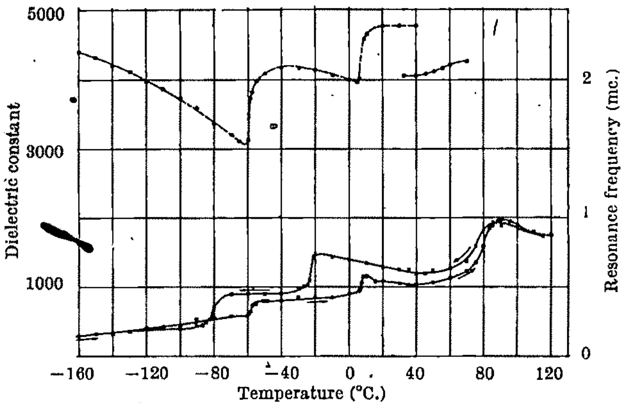
THE growth of barium titanate single crystals and the ferro-electric behaviour of their pseudocubic modification have been described earlier[1,2], and more detailed data can now be given.

There can be obtained at least four modifications of barium titanium compounds, among which the hexagonal and the pseudocubic ones definitely are stoichiometrically $BaTiO_3$[1,2,3]. The dielectric constant of the hexagonal modification is comparatively low, namely, between 100 and 200. The temperature characteristic shows two small peaks near 0° C. and 100° C., at which points maxima of the dielectric constant for the pseudocubic crystals have been found[3].

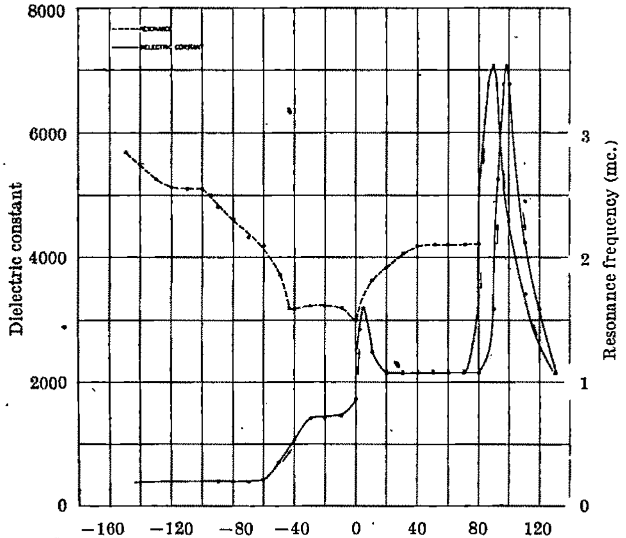


Barium titanate crystal (100)

Crystals of the pseudocubic modification grown from alkali carbonates or barium chloride show a discoloration which ranges from yellow to clear red. Spectroscopic investigation confirmed that this colour is mainly due to dissolved platinum. Colourless crystals were obtained by using carbon crucibles.

The dielectric constant and the piezo-electric resonance frequency have now been measured as a function of temperature, parallel to the three crystallographic directions of the *same* crystal, that is, along its cube edges. The electric field strength was less than 1 volt per cm. at a frequency of 1 kc. The Miller indices on the graphs serve merely to distinguish the three directions in which the electric field was applied to the cube. The crystals usually are twinned with respect to the 011 and 01$\bar{1}$ planes[4].

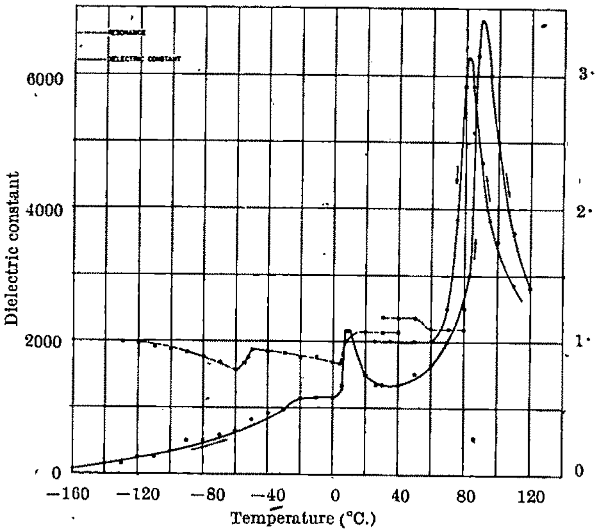
Dielectric hysteresis characteristics have been observed in all three directions and show that the hysteresis disappears only above 100° C. (Slight deviations in temperature from values observed by other authors are probably due to impurities.) Therefore, this temperature represents the only Curie point in contrast to the peaks around 5° C. and −70° C., as already shown in previous measurements[2,3,6]. The course of the piezo-electric resonance indicates some kind of a transition at these temperatures[5], but more investigation is necessary to reveal its nature.



Barium titanate crystal (001)

The thermal hysteresis is considerable and has to be attributed to the existence of large (about 1–2 mm.) spontaneously polarized domains, which are easily visible[7].

From the crystallographic point of view, the present situation is different from that of Rochelle salt or the di-hydrogenphosphates in that barium titanate is a new type of ferro-electric in which all the three crystallographic axes seem to show a similar behaviour. The twinning might give some erroneous results for the absolute value of the dielectric constant; but as microscopic observations with a heating stage show, the twinning should only affect the 010 and 001 results, since here the different axes might overlap one another. That there is virtually no twinning perpendicular to 100 confirms the fact that the ferro-electric behaviour of barium titanate is much less anisotropic than that of the above-named salts, and much more similar to the ferro-magnetics. Considerable progress has been made in obtaining untwinned crystals, and more conclusive results will be given shortly[7].



Barium titanate crystal (010)

Whether the crystals in the Curie range really are tetragonal seems doubtful. Observations with polarized light, made by Prof. Fairbairn of this Institute, give no evidence whatsoever for a tetragonal structure, but point to optical biaxiality. More complete optical data would be desirable and will be obtained when larger unstrained crystal sections become available.

From the dielectric and piezo-electric behaviour of single crystals given above, the peculiar piezo-electric property of barium titanate ceramics[8] may be perhaps interpreted similarly to the quadratic magnetostrictive effects in polycrystalline iron.

[1] Blattner, H., Matthias, B., and Merz, W., *Helv. Phys. Acta*, **20**, 225 (1947).

[2] Blattner, H., Matthias, B., Merz, W., and Scherrer, P., *Experientia*, 3, No. 4 (1947).

[3] Matthias, B. T., Breckenridge, R. G., and Beaumont, D. W., *Phys. Rev.*, **72**, 532 (1947).

[4] Kay, H. R., and Rhodes, R. B., *Nature*, **160**, 127 (1947).

[5] Matthias, B., *Helv. Phys. Acta*, **16**, 209 (1943).

[6] von Hippel, A., Breckenridge, R. G., Chesley, F. G., and Tisza, Laszlo, *Ind. and Eng. Chem.*, **38**, 1097 (November 1946).

[7] Data presented at the meeting of the National Research Council in Cambridge, Massachusetts, September 26, 1947. A paper by B. T. Matthias and A. von Hippel is in preparation.

[8] Roberts, Shephard, *Phys. Rev.*, **17**, 12, 890 (1947).

EXPLORATION OF THE LLOYD GEORGE MOUNTAINS IN THE NORTHERN CANADIAN ROCKIES

By Dr. N. E. ODELL

AN Anglo-Canadian-American expedition, sponsored by F. S. Smyth, and consisting of seven members, was able during the past summer (1947) to carry out the exploration of the Lloyd George Mountains, which are situated in northern British Columbia. This mountain group lies just south of lat. 58° N., and only the foothill district to the south of it had previously been visited. The name Lloyd George Mountains, in honour of the late British premier, was given in 1916 by P. L. Haworth, who made a difficult journey to the lake, now named after him. It was Haworth Lake, fed by the melt-waters draining the Lloyd George Icefield, which was utilized by this year's expedition as a base.

We were an airborne expedition, and flew in a sea-plane in two parties, from a take-off some 250 miles to the southward. A reconnaissance flight was made from Haworth Lake (altitude *c.* 3,800 ft.) before the departure of the aircraft, and this revealed a vast snowy range lying to the north-west as well as the south-east of the contiguous Lloyd George Group. It is a highly complicated and deeply dissected mountain region, with the highest peaks approaching 10,000 ft. in elevation. The eastward flowing Liard River, bounding this belt of mountains on the north, would seem to form the true northern limit of the Rocky Mountains proper, as originally suggested by R. G. McConnell and again recently by M. Y. Willams[1].

The dominating physiographic feature, from which rise the highest peaks, all of which were ascended, is the Lloyd George Icefield, and its main *névé* covers some 45 sq. miles, but with dependent glaciers it is 90–100 sq. miles in total extent. Steep glaciers descend to an altitude of 4,000 ft. in heavily forested valleys, which are the haunt of bear, deer and other game. A very rich and beautiful alpine flora was found, particularly in July, up to an elevation of 7,000 ft. and more. More than two hundred species were collected, some believed new, and these were sent for determination to the Royal Botanic Garden, Edinburgh. The flora was quite as profuse as hundreds of miles farther south in the Canadian Rockies.

As to the solid geology, the district explored lies entirely eastward of the Rocky Mountain Trench, that great structural feature which separates the Rocky Mountains proper from the diverse ranges of the central portions of British Columbia. The latter region is underlain by sedimentary and volcanic rocks of Palæozoic and Mesozoic age, with immense batholithic intrusions, ranging in age from pre-Carboniferous to Tertiary, and considered to have been the source of the metallic mineral deposits of central British Columbia.

In contrast, the ranges of the Rocky Mountains eastward of the Great Trench are a series of highly folded sediments with representatives of practically the whole geological succession, but without eruptive rocks, and devoid of ore deposits.

The Lloyd George Mountains are carved out of a great thickness of Palæozoic rocks, which are overfolded towards the east and often display in individual peaks the characteristic tilted fault-block type of structure and so-called 'writing desk' form, so prevalent elsewhere in the Canadian Rockies. Mainly composed of hard limestones, the softer interbedded shales and slates, with the softer limestone, are normally highly folded and sheared. No extensive overthrust masses (*nappes de recouvrement*) were observed. Compression and shear have been responsible for the destruction of almost all organic remains, and only in one locality high up in a mountain face was found a fossil coral horizon which appears to be of Silurian age. The field collection made by me has yet to be worked out.

Regarding the glacial geology, an outstanding discovery was a large stagnant glacier, lying in a deep canyon-like valley, which was entirely blanketed in moraine, and upon which trees and plants were growing. This glacier, extending through a range of altitudes of from 4,500 to 6,000 ft., appears to be the only one of its kind which is known south of Alaska.

The glaciers of the region generally appear to be in a state of slow recession. The present summer snow-line lies at approximately 7,900 ft.

The survey, and other scientific work of the Expedition, was greatly hampered by the prevailing bad weather, which, throughout the Rockies during the summer of 1947, was the worst on record for forty or more years.

[1] Willams, M. Y., *Trans. Roy. Soc. Can.*, 41, (4), 73 (1947).

CAMBRIDGE ARCHÆOLOGICAL EXPEDITION TO CYRENAICA

By C. B. M. McBURNEY, R. W. HEY and W. WATSON

THE first Cambridge Archæological Expedition to Cyrenaica, North Africa, took place during the summer of 1947. A total of three months was spent in the field, and the following were the principal results obtained.

The primary object of the expedition was to investigate the Palæolithic succession in the coastal area, and to correlate it, if possible, with any traces that might be found of a marine Pleistocene succession. Italian geological literature of the pre-war period mentions the presence of marine Pleistocene deposits in the Benghazi plain, and refers to probable Pleistocene shore-lines at several points along the Cyrenaican coast. So far as we know, however, no detailed study of these was ever undertaken.

Accordingly, the first part of our time was spent in an examination of the more accessible portions of the coast between Benghazi and Derna, in order to locate beach conglomerates, wave-cut terraces and other traces of high level shore-lines. These were discovered in fair abundance, though obscured in many places by masses of alluvial material. From the results obtained by levelling such features, it is hoped to establish the Pleistocene succession of sea-levels for this part of the coast. The highest shore-line of which traces were found was at some 80 metres, in the Derna region; the lowest lay at about 6 metres and was preserved in most of the areas examined. The intermediate levels are still under consideration.

The cultural succession associated with these events proved most instructive. Traces of the Middle Palæolithic could be recognized at various points along the coast, and a few specimens embedded in the beach conglomerates can probably also be attributed to the same stage. A rich Levallois station was discovered five miles west of Derna and can almost certainly be associated with the terra rossa at 5 metres above sea-level.

On the other hand, an evolved Mousterian industry occurred in a silt deposit in a tributary of the Wadi Derna, associated with a vertebrate fauna and well-preserved plant remains. This deposit interdigitates with the high terrace of the Wadi Derna, which was surveyed down-stream to a point about three-quarters of a mile from the sea. There is no doubt that this terrace was formed in connexion with a sea-level much higher than the present, though further work will be necessary before an exact estimate of the height of this level can be given.

No traces earlier than blade industries of Upper Palæolithic or later date occur on the consolidated dunes which line the modern shore, and which presumably belong to the low sea-level of the last glaciation.

Detailed information regarding the form and associated fauna of at least one phase of these later industries was obtained from a cave discovered and excavated in the Wadi Cuf, fifteen miles from the coast. The two faunas, and the flora from the Wadi Derna, should provide considerable information on the Pleistocene climatic sequence of the east Libyan seaboard.

We should like to express our gratitude for the assistance afforded by King's College, Cambridge, and the British Museum, in defraying the expenses of two of the members of the expedition, and particularly to the Trustees of the Percy Sladen Memorial Fund for their generous grant, without which the expedition would never have been undertaken. The constant help and co-operation of the authorities of the British Military Administration of Cyrenaica was also an important factor in the success of the expedition.

A further visit, in the near future, to amplify and complete these findings, is planned.

THE COMMON COLD

THE Cantor Lecture before the Royal Society of Arts, delivered on January 20 by Dr. C. H. Andrewes, of the National Institute for Medical Research, is an admirable summary of the essential features of our knowledge of that world-wide scourge, the common cold; and nobody is better fitted than Dr. Andrewes to state what we know and what we do not know about it. This problem is being attacked energetically by a research unit of the Medical Research Council in a hospital built at Salisbury during the War by Harvard Medical School and the American Red Cross, and eventually presented to the Ministry of Health.

If, as Dr. Andrewes showed, those who are working on this problem in Great Britain and other countries are only beginning to pick up clues to the solution of what is one of the most complex problems of virology, there is plenty of evidence that this relative ignorance will not persist for very long. All the portents, indeed, suggest that presently the common cold, like typhus, typhoid, cholera, smallpox, yellow fever and other plagues, will have yielded to human domination. But this will not come about without much patient research and, when that research has found the methods of control and cure, the co-operation of the public will be required. For, as Dr. Andrewes explained, the common cold, or more accurately, perhaps, the various varieties of it which probably exist, depend very much for their dissemination upon such human habits as sneezing, coughing, handkerchief-waving and so on—all of them habits which people will not readily alter to the degree that scientific control of infection requires.

The work of the Air-Hygiene Unit, the members of which are collaborating more and more closely with the workers on the common cold, demonstrates the importance of this aspect of the problem. It has been shown, for example, that handkerchiefs shaken in the air can disseminate very many bacteria, and other work suggests that impregnation of handkerchiefs with certain substances, among which phenyl mercuric bromide is promising, may make them less dangerous. Possibly the handling of infected handkerchiefs, rather than waving them about, may be an even more important means of dissemination of the organisms concerned.

Research on the common cold, like all work on diseases caused by viruses, was hampered until methods of cultivating viruses in the laboratory were discovered. Now that these are available, it is possible to use, for work on the common cold, the method of cultivation of viruses which has been more successful than any other, namely, their cultivation on the fertile hen's egg. American workers have claimed that they have successfully grown the 'cold' virus in hen's eggs; Dr. Andrewes and his colleagues, who are attacking the whole problem in Britain, have used the same techniques, but have so far been unable to confirm the American results. Dr. Andrewes discussed this point and suggested that probably the two groups of workers are studying colds due to different causes, the American type of cold being more like the condition known as sinusitis, whereas the British workers are studying the runny-nose type. Thus one of the important requirements is successful isolation and cultivation in the laboratory of the viruses concerned, of which there may be several.

Another great handicap in this work is the lack of a suitable experimental animal. The virus of human influenza will 'take' in ferrets, but the chimpanzee is the only animal so far known to be susceptible to the human common cold; and chimpanzees are expensive and difficult to handle. Human volunteers must therefore be used, and in his lecture Dr. Andrewes described the work being done at Salisbury where the Medical Research Council Unit has so far had the help of five hundred human volunteers. A sound technique has now been evolved; methods of storing and filtering the virus have been worked out; it has been shown that the incubation period of the colds studied was two to three days, and that the nasal secretions will not communicate a cold if they are diluted beyond 1 in 100. Bacteria-free filtrates of nasal washings from volunteers with colds have produced colds in about 50 per cent of subjects, and this has happened all the year round, with possibly a lower percentage of colds acquired during the winter.

This last point will surprise those who believe that cold and wet precipitate, or even cause, colds; but Dr. Andrewes made wise and salutary comments on this view in the section of his lecture devoted to the effect of the season and the weather, and in the interesting section on the incidence of colds in the Arctic and in Spitsbergen, where the outbreak of colds is intimately connected with the arrival and departure of ships from the outside world. This part of the lecture and also Dr. Andrewes' remarks on the value of the many cold cures that are constantly recommended should certainly be read by the "scores, perhaps hundreds" of people who have written to the Salisbury Unit to tell them how to solve this difficult problem.

Men of science will appreciate this lecture as an example of how to handle an intricate subject with a charm and simplicity of phrase which make it readily intelligible to everybody.

G. LAPAGE

BRITISH ROCKET WEAPONS RESEARCH

THERE is nobody better qualified to discuss our war-time development of rocket weapons than Sir Alwyn Crow, and it would therefore be unprofitable to attempt to dispute the clear statement of facts which he presented as the thirty-fourth Thomas Hawksley Lecture at the Institution of Mechanical Engineers on November 21, 1947, his subject being "The Rocket as a Weapon of War in the British Forces".

Sir Alwyn first traced the development begun in 1935 of the three main types of motor which formed the basis of almost all British rocket-propelled weapons. These were steel tubes of 2 in., 3 in. and 5 in. diameter containing a solid cordite propellant charge, which was ignited at the front, the gases being discharged in each case through a single nozzle at the rear. Pointing out that from the military point of view one of the greatest advantages of the rocket propulsion of missiles is the absence of recoil forces on the projector, Sir Alwyn went on to describe how these motors were combined with different types of explosive head and projection apparatus to meet such varied demands as for anti-aircraft fire, barrage weapons for mass bombardment and airborne projectiles for land and sea targets. He also described the development of rocket motors of the high degree of reliability necessary to provide the extra thrust which enabled aircraft to take off with a much shorter run. An idea of what was achieved in these fields may be gathered from the fact that "a single craft was able to fire highly lethal ammunition on the chosen target area at the rate of half a ton a minute for nearly a minute at a time", and the hitting power of a single aircraft was "momentarily the equivalent of the full firing power of a medium cruiser".

As this was his main concern, Sir Alwyn's paper dealt primarily with the detailed development of solid-fuelled rockets to meet a number of specific requirements; but since there can be little doubt that British progress in the field of rocket development at the end of the War was some ten years behind that of the Germans, it would be interesting if Sir Alwyn could be persuaded to present his views on a number of the other aspects of this type of armament, aspects which must have been the subject of much discussion because of their fundamental nature. Were difficulties of production and the impossibility of making the necessary research in the early stages the obstacles that precluded the use of liquid fuels, with the enhanced index of performance which would be expected from them? Why was so much greater emphasis placed on fin stabilization than on spin stabilization? Was progress made in the examination of methods of control and guidance of the projectile during its flight, or was it considered in Britain that the inherent advantages of the unguided weapon outweighed any which might accrue from guidance? Even our choice of solid propellants appears to have been very limited, and it would be interesting to know what attempts were made to develop other types. The use of light alloy tubing for the motor body would seem to be an obvious way to increase the charge/weight ratio, and the steps made to investigate its possibilities would be worth knowing.

The only fair criticism which can perhaps be made of Sir Alwyn's lecture is that he made no mention of the aiming and sighting equipment developed to ensure that the projectiles would arrive at the right spot at the right moment, for if they fail to do this all the ingenuity lavished on the design of the weapon is useless.

R. H. MACMILLAN

PHOTO-ELASTICITY IN MECHANICAL ENGINEERING

TWO papers which make a very useful addition to the sparse literature on photo-elasticity were presented to the Institution of Mechanical Engineers on December 12, 1947. Mr. W. A. P. Fisher's paper dealt with the basic physical properties of model materials which are relied upon in the 'frozen stress' technique of three-dimensional stress analysis. This technique, which was originated in Germany and the United States, is based on the fact that certain photo-elastic model materials have a very low Young's modulus at elevated temperatures and consequently suffer considerable deformations under small loads. If such small loads remain in position during subsequent cooling, it is found that the materials set in the strained position and retain, after the removal of the loads, virtually the whole of the strain and the photo-elastic effect associated with the loading at the elevated temperature; hence the term 'frozen stress'. This phenomenon is utilized in three-dimensional analysis by cutting thin slices from a three-dimensional model, which can then be examined in a photo-elastic polariscope in accordance with the ordinary two-dimensional technique. The 'frozen stress' patterns are not found to be appreciably disturbed by careful cutting.

The major part of Mr. Fisher's paper was devoted to a discussion of the suitability of phenol-formaldehyde resins, particularly 'Catalin 800', for use with this technique. In the United States, glyptal resins have been used for this purpose almost without exception; but as this material is very expensive and difficult to obtain in Britain, considerable interest is attached to the detailed investigation of the merits of 'Catalin' which was carried out at the Royal Aircraft Establishment, Farnborough, by Mr. Fisher. Data were given in the paper of the physical properties of 'Catalin', both at room temperature and at its softening temperature. Young's modulus at 80° C. appears to be about 1/120 of the value at room temperature. The paper also contained some practical illustrations of the 'freezing' technique.

Mr. R. B. Heywood's paper on "Some Modern Applications of Photo-elasticity" contained a brief outline of photo-elastic theory and a summary of the properties of the more important model materials, followed by some interesting examples of applications to design problems taken from the field of mechanical engineering.

It will be an encouragement to everyone interested in photo-elasticity that the engineering institutions are once more, after a long interval, taking an interest in this valuable method of stress analysis.

E. K. FRANKL

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, March 1

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Prof. G. E. Blackman: "Oil as a Farm Crop".

CHEMICAL SOCIETY, BIRMINGHAM SECTION (in the Chemistry Lecture Theatre, The University, Birmingham), at 4.30 p.m.—Prof. C. K. Ingold, F.R.S.: "Steric Hindrance".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 4.30 p.m.—Prof. Eric K. Rideal, F.R.S.: "Colloids". (Further lectures on March 8 and 15.) (Cantor Lectures.)

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON SECTION of the INSTITUTE OF METALS, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. C. J. P. Ball: "The Manufacture and Usage of Magnesium and its Alloys".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Central Library, Hempstead Road, Watford), at 7.30 p.m.—Dr. F. Wokes: "Nutrition in relation to Post-War Problems". (To be repeated on Saturday, March 20, at 3 p.m., at the South-East Essex Technical College, Longbridge Road, Dagenham.)

Tuesday, March 2

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. Z. Young, F.R.S.: "The Brain and its Functions".*

CHEMICAL SOCIETY, LEEDS SECTION (joint meeting with the LEEDS UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Leeds), at 5 p.m.—Film Display of Scientific Films; at 6.30 p.m.—Prof. J. A. V. Butler: "The Protein Molecule and its Degradation by Enzymes".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. Roger Duff: "Digging up the Moa Hunters—an Earlier Phase of Maori Culture".

UNIVERSITY COLLEGE LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. L. E. Bayliss: "Some Aspects of General Physiology". (Further Lectures on March 9, 16 and 23.)*

KING'S COLLEGE (Strand, London, W.C.2), at 5.30 p.m.—Prof. C. A. Coulson: "Quantum Theory in Physics and Chemistry". (Inaugural Lecture in the Chair of Theoretical Physics.)*

CHEMICAL SOCIETY, DUBLIN SECTION (at University College, Dublin), at 7.30 p.m.—Sir Ian Heilbron, F.R.S.: "Recent Developments in the Vitamin A Field" (Pedler Lecture).

Wednesday, March 3

MANCHESTER METALLURGICAL SOCIETY (at the Engineers Club, Albert Square, Manchester), at 6.30 p.m.—Mr. E. Mills: "Metallurgical Problems arising from the Use of Non-Ferrous Metals in the Telecommunication Industry".

INSTITUTE OF WELDING, MANCHESTER AND DISTRICT BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. E. McMinn: "Welded Tubular Structures".

Thursday, March 4

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. S. E. Hollingworth: "Geology—a Preliminary to Planning".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion on "Calculating Machines" (to be opened by Prof. M. H. A. Newman, F.R.S.).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Lawrence Bragg, F.R.S.: "Current Research Work in the Cavendish Laboratory". (Further Lectures on March 11 and 18.)

KING'S COLLEGE (Strand, London, W.C.2), at 5.30 p.m.—Prof. S. W. Wooldridge: "The Role and Relations of Geomorphology". (Inaugural Lecture in the Chair of Geography.)*

INSTITUTE OF PETROLEUM, LONDON BRANCH (at Manson House, 26 Portland Place, London, W.1), at 6 p.m.—Inaugural Meeting; Mr. J. A. Oriel: "Petroleum in the Modern World".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.15 p.m.—Dr. R. M. Ruhemann: "The Measurement of Low Temperatures".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. E. L. Hirst, F.R.S.: "The Occurrence and Significance of the Pentose Sugars in Nature, and their Relationship to the Hexoses" (Hugo Müller Lecture).

Friday, March 5

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting; Dr. G. M. Bennett, F.R.S.: "The Proximate Analysis of Mixtures by Methods depending on Differential Solubility and Saturation".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. A. Butterworth: "Development and Use of Magnetic Apparatus for Bomb and Mine Location"; Mr. B. Roston: "Development of Locators of Small Metallic Bodies Buried in the Ground".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. W. Muckle: "Resistance to Buckling of Light Alloy Plates"; Dr. E. G. Richardson: "Measurement of Water Movements Associated with Ships".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Prof. Arne Tiselius: "Some Recent Advances in Adsorption Analysis".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Edward Salisbury, F.R.S.: "Flowers of Spring".

CHEMICAL SOCIETY (joint meeting with the UNIVERSITY COLLEGE OF SWANSEA STUDENTS' CHEMICAL SOCIETY, at University College, Swansea).—Prof. F. S. Spring: "The Antibacterial Compound, Aspergillic Acid".

Saturday, March 6

INSTITUTE OF ECONOMIC ENGINEERING, MIDLAND REGION (at the Chamber of Commerce, Birmingham), at 2.30 p.m.—Mr. D. R. Burrows: "Rubber and its Manufacture".

SCHOOL NATURE STUDY UNION (at the City Literary Institute, Stukeley Street, Drury Lane, London, W.C.2), at 2.30 p.m.—42nd Annual Conference; at 3 p.m.—Prof. S. W. Wooldridge: "Geology and the Study of Natural Environment".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. A. Bake: "Ladakh and the Dances at Hemis Monastery".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT EXPERIMENTAL OFFICERS (2) in a team which is to carry out research work on insecticides at Porton for the Colonial Insecticides Committee—The Under-Secretary of State, Research Department, Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (March 8).

ASSISTANT CURATOR at the Royal Botanic Gardens, Kew—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2113 (March 12).

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, The University, Sheffield (March 13).

ASSISTANT LECTURER IN PHILOSOPHY—The Registrar, The University, Manchester (March 13).

RESEARCH WORKER (temporary) IN THE DEPARTMENT OF ANIMAL HEALTH—The Registrar, University College of Wales, Aberystwyth (March 14).

ANALYTICAL CHEMIST IN THE DEPARTMENT OF GEOLOGICAL SURVEY, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (March 15).

LECTURERS IN MATHEMATICS (pure or applied)—The Registrar, King's College, Newcastle-upon-Tyne (March 15).

CHEMIST-IN-CHARGE (temporary) at the Royal Ordnance Factory, Birtley, Co. Durham, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F.135/48A (March 16).

CHEMIST-IN-CHARGE (temporary) at the Royal Ordnance Factory, Nottingham, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F.413/48A (March 16).

PRINCIPAL LECTURERS, SENIOR LECTURERS, and LECTURERS, IN MECHANICS, MACHINES, MATERIALS AND STRUCTURES, HEAT ENGINES, ELECTRICAL ENGINEERING, and TELECOMMUNICATIONS, at the Military College of Science, Shrivenham, Swindon—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2119 (March 22).

METEOROLOGISTS (2) as Professional Assistants in the Royal Observatory in Hong Kong—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1 (March 22).

TOBACCO OFFICERS (General) and TOBACCO OFFICERS (Special) in the Professional Officers' Grade in the Tobacco Branch of the Department of Agriculture, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (March 26).

ASSISTANT DIRECTOR OF NATIVE AGRICULTURE to the Government of Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (March 26).

UNIVERSITY DEMONSTRATOR IN PHYSICS, and a UNIVERSITY LECTURER IN PHYSICS—The Secretary, Appointments Committee of the Faculty of Physics and Chemistry, Chemical Laboratory, Pembroke Street, Cambridge (March 31).

ASSISTANT PROFESSOR OF MINING ENGINEERING at Fouad I University, Giza, Egypt—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (March 31).

JUNIOR CHEMISTS (female) for service in Tanganyika Territory in connexion with a Fertilizer Research Scheme—The Under-Secretary of State, Research Department, Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (April 3).

LECTURER IN PSYCHOLOGY (including Experimental Psychology)—The Secretary, The University, Aberdeen (April 15).

ASSISTANT LECTURERS or LECTURERS IN (*a*) PURE MATHEMATICS, (*b*) APPLIED MATHEMATICS, and (*c*) STATISTICS—The Registrar, The University, Leeds 2 (April 17).

PLANT BREEDERS (2), primarily for cereals—The Secretary, School of Agriculture, Cambridge (April 30).

ENTOMOLOGIST IN THE MEDICAL DEPARTMENT (Yellow Fever Research Institute), Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

RESEARCH ASSISTANT (male) IN THE MECHANICAL WORKING DIVISION—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Mechanical Working Division'.

RESEARCH ASSISTANT to work on new biological methods of hormone assay—Prof. N. F. Maclagan, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1.

TECHNICIAN IN THE DEPARTMENT OF ANATOMY—The Secretary, University College London, Gower Street, London, W.C.1, quoting "Anatomy/1".

NATURE

No. 4088 SATURDAY, MARCH 6, 1948 Vol. 161

CONTENTS

Page
British Colonial Development 331
Nuclear Physics in Photographs. By Prof. P. I. Dee, F.R.S. . . 333
Physical Patterns of Speech. By Dr. W. G. Radley, C.B.E. . . 334
Modern Radio Technique. By Dr. R. L. Smith-Rose . . . 334
Modern Inorganic Chemistry. By G. R. Martin 335
Experimental Study of Human Health. By Dr. G. Lapâge . . 336
Factors of Agricultural Production in the British Colonial Empire. By Sir Frank Stockdale, G.C.M.G., C.B.E. 337
Aircraft Attack on Locusts. By Dr. D. L. Gunn 342
News and Views 344
Letters to the Editors :
  Birth and Growth of the Explosion in Solids Initiated by Impact.—Dr. F. P. Bowden and O. A. Gurton 348
  Initiation of Explosives by Adiabatic Compression of their own Vapour.—A. Yoffe 349
  Acetylation of Sugars.—S. D. Nicholas and Dr. F. Smith . . 349
  Paper Chromatography of Flavine Nucleotides.—Dr. J. L. Crammer. 349
  Inactivation of Flavine Adenine Dinucleotide by Tissue Extracts. —R. S. Comline and F. R. Whatley 350
  New Amino-Acids in Bacterial Hydrolysates.—A. Polson . . 351
  Citric Acid in Semen.—G. F. Humphrey and Dr. T. Mann. . 352
  Effect of p-Aminobenzoic Acid on the Leucocyte Count in Leukæmia.—Dr. J. Bichel 353
  Electron Microscope Observation of Renosine.—A. G. Matoltsy 353
  Raman Spectra of Some Synthetic Mixtures of α-Chloroacids.— Dr. Marcel Renard 354
  Regeneration of Prothrombin Activity by Carbon Dioxide.— I. M. Chak and Dr. K. V. Giri 354
  Ovarian Activity in the Pregnant Mare.—Prof. E. C. Amoroso, J. L. Hancock and Dr. I. W. Rowlands. 355
  Bile Acids of the Whale.—Dr. G. A. D. Haslewood and Veryan Wootton 356
  Production of Helium by Cosmic Rays.—H. E. Huntley . . 356
  Phase-Contrast in Polarized Light.—Prof. A. Kastler and R. Montarnal 357
  Recording Crevices in Plane Surfaces by Pigment-fillings Held in Cellulose Acetate Moulds.—Dr. A. T. J. Dollar . . . 358
  Photometric Measurement of Specific Surface.—B. A. Scott . 358
  Luminescence Efficiency Changes in Zinc Sulphide Phosphors Below Room Temperature.—G. F. J. Garlick and A. F. Gibson 359
  'Low-Temperature' Oxidation of Higher Hydrocarbons at Atmospheric Pressure.—Dr. G. Friedlander and L. Grunberg 360
  Economy in Cell Counts.—Dr. B. Woolf. 361
  Empirical Data on Hilbert's Inequality.—E. H. Copsey, H. Frazer and W. W. Sawyer 361
Early History of the Royal Botanic Garden, Calcutta. By Dr. D. Chatterjee 362
Trace Elements in Plant Physiology 364
New Zealand Department of Scientific and Industrial Research : Annual Report for 1946–47 365
Photo-elastic Investigation of Internal Stresses in Silver Chloride Caused by Plastic Deformation. By J. F. Nye 367
Scientific Research and Industry 368

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BRITISH COLONIAL DEVELOPMENT

THE debate in the House of Commons on January 20 on the occasion of the third reading of the Overseas Resources Development Bill was poorly attended ; the apparent lack of interest was the more remarkable, since, as Mr. Creech Jones quite rightly said in moving the third reading, the Bill had the general support of all political parties and had been acclaimed with some enthusiasm outside the House. The Secretary of State for the Colonies asserted, indeed, that the Bill was as much designed for the purpose of meeting the needs of the world as for meeting the special needs of the Colonial peoples. As Sir Frank Stockdale pointed out in a discourse at the Royal Institution on January 23 (see p. 337), it marks a further big step forward in the British conception of Colonial development, from the social and economic schemes planned under the Colonial Development and Welfare Acts of 1940 and 1945, in exploiting the economic resources for the general development of these territories.

Mr. Creech Jones said he is satisfied that, under the Bill, the needs of Great Britain and Western Europe will not dominate the essential development requirements of the Colonial peoples themselves, and no apprehension need be felt that the provision for an Overseas Food Corporation will divert us from the main purpose of building up Colonial standards. The intervention of the Minister of Food, through the establishment of this Overseas Food Corporation, in matters that should be the responsibility of the Colonial Secretary was the main point at issue in the debate. Mr. Creech Jones believes that the creation of such corporations can give enormous assistance to enterprise ; and in announcing that on the Colonial Development Corporation, the chairman, Lord Trefgarne, would have the support of Sir Frank Stockdale as full-time deputy-chairman, he showed that, as Mr. Oliver Stanley said later, the Government is calling on people of exactly the character and experience which seem desirable. Others who have accepted the invitation to join the Board include Mr. E. C. Tansley, formerly marketing director of the West African Produce Control Board, Sir Miles Thomas and Sir Charles Darwin. Mr. J. Rosa, who was on the Commission of the East African groundnut scheme, links up the Board with the Overseas Food Corporation.

Before making this latter announcement, the Minister of Food had again rejected amendments designed to exclude the Overseas Food Corporation from the Colonial territories, or to enable its projects to be transferred to the Colonial Development Corporation. Mr. Strachey was not altogether convincing as to why two Corporations should be necessary, and he did not dispose of the argument that the Government has allowed to stray into Colonial affairs a by-product of its own failure to deal with the large and vital question of the organisation of government and the division of functions and responsibilities at the highest level, on which the Select Committee on Estimates commented so pointedly in a recent report. For the rest, however, there was only welcome for the general purpose of the Bill, though some wished to see an industrial development scheme linked up with the activities contemplated in the present Bill. While it was obvious that welfare considerations were prominent in the minds of members generally, and that it was the intention of the House that the Development Corporation should use its powers to promote the health and nutrition of the Colonial peoples and to further the prevention as well as the cure of disease, it was equally clear that they had not forgotten the close connexion between our ability to develop Africa and the survival of Britain, to which the Chancellor of the Exchequer had referred.

There are, however, very real dangers in the pace at which political development is proceeding. Their reality is well indicated in a recent book by Mr. O. Awolowo*. Its forthright definition from the African side of the common purpose for which the British and the Nigerians have to work is the product of hard thinking as well as of strong feeling; and even if the latter sometimes tends to discolour the thought and lead to some misinterpretation of the facts, as Miss Perham suggests in her foreword, that does not detract greatly from the inherent value of the book. The book, moreover, has a certain representative importance; as Mr. Awolowo believes that concurrent developments in the Gold Coast are not limited in their significance to Nigeria, so the mental 'climate' of the Nigerian people has an importance far beyond Nigeria. Any constructive contribution from the Colonial peoples has a general as well as a local and particular significance, particularly in meeting the demands which the Colonial situation makes upon our intelligence and the continuous attention which for some reason or other the House of Commons seems unable to give.

The importance of this factor is well brought out by Miss Perham. The main barriers between the British and the small educated minority among the Nigerians and other Colonial peoples are psychological rather than in the sphere of practical politics. This, of course, underlines the importance of that policy of expansion of higher education in the Colonial Empire to which we have already committed ourselves as a result of the reports of the Asquith and Elliot Commissions on Higher Education in the Colonies and in West Africa. But it means also that we should bend our energies and intelligence to the achievement of self-government within the British Commonwealth with something of the sense of urgency which Mr. Awolowo attaches to it, and with a new resolution to make the task of administrative education succeed.

Mr. Awolowo's book deserves attention; but it should be remembered that co-operation along this path involves obligations not only upon the part of the British but also upon the Africans themselves. Moreover, that co-operation is seriously hindered by the distortions of history which propaganda continues to disseminate. Here, as so often elsewhere, propaganda is a deadly enemy of real advance and achievement; it is most effectively countered by accurate knowledge, and the whole trend of Colonial development in recent years has brought the scientific worker into a position where he must not only be increasingly responsible for supplying much of the factual knowledge required, but also himself needs for the execution of his duties more background knowledge of the political and economic situation in which his scientific contribution is being made. It will be noticed, for example, that Mr. Awolowo, who recognizes that the best interests of the coloured peoples lie in co-operating wholeheartedly with those white groups which support their development, considers health and education to be the only important functions of government which the coloured peoples can at present discharge with efficiency. Here Mr. Awolowo's book is often suggestive even where he may be biased and perhaps subconsciously not quite accurate in his presentation. But to the trained mind accustomed to sift and weigh evidence, his frankness and sincerity, his appreciation of the British, for all his impatience, give his book a real value in understanding the mind of the Colonial peoples.

No one who followed the debate in the House of Commons on January 20 could doubt the reality of the desire for effective co-operation between the Colonial and the British peoples, or of the appreciation of the extent to which such co-operation must depend on the calibre of those responsible for handling the educational, labour and medical sides of the work of the Overseas Food and the Colonial Development Corporations. Like the admirable survey of Colonial administration during the war years and the opening phase of reconstruction which the Colonial Office issued last year*, it afforded an impressive tribute to British policy and administration during that time of stress. Unlike that Blue-book, however, the debate testified to the support which the new developments have drawn from all parties of the House of Commons, and indicates once more that differences of opinion as to method or detail have not hindered support for the general policy or impeded the flow of constructive suggestion.

This comprehensive Blue-book is valuable from several points of view It replaces the annual reports on the work of the Colonial Office, publication of which, interrupted by the War, is now to be resumed. In addition, it has the merit of bringing out certain consequences of the impact of the War common to all the Colonies in spite of the differences in their material fortunes. The very prominence which such developments as the East African groundnut scheme and the plan for the development of Uganda give to particular aspects makes it important that such projects should be seen in perspective against the broad background of general policy and those features in the British Colonial Empire which are independent of race and place.

This is the more important because, on one hand, of the increasing approach to Colonial affairs by international collaboration, quite apart from the influence of the Trusteeship Council of the United Nations, and, on the other, because a number of studies of special aspects of the problems of particular areas require consideration against that general background; many have their own contribution to make to the solution of the general problem or of specific problems in other areas. A comprehensive perspective is important in appraising the significance of some of the recent changes and moves in government, such as the appointment of Lord Listowel as Minister of State for the Colonies, and Mr. H. A. Marquand's mission to Africa to discuss general trade developments with the Union of South Africa and Southern Rhodesia, and other developments in regional organisation outlined in this survey. The appointment to West Africa of a resident Minister of Cabinet rank has, for example, been perpetuated in the formation of a West African Council of the Governors of the four colonies, with its permanent secretariat, and the Conference on West Indian Federation in Jamaica last September over which Mr. Creech Jones presided, are no less notable as evidence of Britain's readiness to place her unrivalled political experience at the disposal of the Colonial peoples in their progress to self-government.

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* Path to Nigerian Freedom. By Obafemi Awolowo. Pp. 137. (London: Faber and Faber, Ltd., 1947.) 7s. 6d. net.

* The Colonial Empire (1939–1947). (Cmd. 7167.) (London: H.M. Stationery Office, 1947.) 2s. 6d. net.

Such steps indicate how fully the Government appreciates that the changed needs of the time call for an increasing devolution of authority, as well as for the closer integration of government on democratic lines. Moreover, the whole range of government has to be extended so that it may become the instrument of economic and social as well as of political development. Sir Stafford Cripps told the Governors' Conference in November that we are to increase out of all recognition the tempo of African development. Accordingly, just when it is important that new developments of democratic institutions should be firmly based and suited to the capacity of the peoples concerned, it has become imperative that the far-reaching changes involved in the relations of governors and governed should be carried through as expeditiously as possible. Any undue time-lag between new legislative and administrative conceptions in Britain and their application to Colonial policy may, indeed, become a positive danger.

NUCLEAR PHYSICS IN PHOTOGRAPHS

Nuclear Physics in Photographs

Tracks of Charged Particles in Photographic Emulsions. By C. F. Powell and G. P. S. Occhialini. Pp. ix + 124 (50 plates). (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 18s. net.

THE epoch-making discoveries in the field of nuclear physics during the past thirty years have been predominantly due to the development and use of methods of detection of single fast-moving nuclei and electrons. In the experiments of Lord Rutherford upon the scattering of α-particles which established the concept of the nuclear atom, in the discovery of the neutron and of artificial transmutation, and in the more recent investigations upon cosmic rays leading to the discovery of the positron and the meson, the part played by the detectors of single charged particles and quanta has been universal and indispensable. It is, therefore, very surprising to reflect that practically all this work has been done with only four basic techniques: the scintillation screen, the Geiger counter, the ionization chamber plus amplifier and the expansion chamber.

For a long time the possibility of direct recording of the tracks of ionizing particles in photographic emulsions has been recognized, but until the immediate pre-war years comparatively few serious experiments had been made by this technique owing to its limitations and insensitivity. During the past ten years, however, Dr. C. F. Powell and his collaborators at the University of Bristol have taken a leading part in the application of this method to a wide range of nuclear investigations, and, with important improvements in the production of more suitable emulsions by Messrs. Ilford, this technique now ranks in power and efficiency with the counter and expansion chamber. The publication of a book by these authors, illustrating so clearly the present potentialities and limitations of the method in expert hands, is, therefore, noteworthy and welcome.

The volume under notice is not, however, a detailed account either of the techniques of preparation and processing of the emulsions or of the experimental arrangements for exposure and measurement of the plates. It is rather, as implied by the title, an album of fifty beautiful photomicrographs illustrating a great variety of nuclear processes. In the brief space of seventy pages of text, the authors make a praiseworthy effort not only to explain the particular phenomena recorded in the photographs, but also to give an elementary account of atomic and nuclear structure and of the basic phenomena of nuclear physics and cosmic rays. It is only natural that such a limited text will confine the educational value, in a formal sense, to students and school teachers, and even for these the absence of phenomena concerning electrons, which are not recorded by this technique, causes a grave lack of generality and balance. However, such criticism is perhaps unreasonable. The avowed purpose of the authors is to present nuclear phenomena in "the robust form and vivid colouring of physical illustrations" which has greater appeal to many minds than purely mathematical expressions. This volume will, I think, be best appreciated by those who can travel, in imagination, with the meson along the tortuous path in the photograph and wonder at the events transpiring at its brief halting point.

Despite the textual limitations, therefore, the authors are to be congratulated on having produced a volume which every experimental-nuclear physicist will wish to possess, together with the "Atlas typischer Nebelkammerbilder", by Gentner, Maier-Leibnitz and Bothe, which plays a similar part in relation to work which has been done with the expansion chamber. These two volumes have a beauty both of subject-matter and of artistry of reproduction comparable in every way with that of the illustrated books which are so common in the realm of the fine arts. Scientific workers can use them to refute the narrow dogma that "Science deals with facts and Arts with values", which is frequently advanced by their classical friends. We should, indeed, do well to persuade these latter to add these volumes to their own libraries.

P. I. DEE

PHYSICAL PATTERNS OF SPEECH

Visible Speech

By Ralph K. Potter, George A. Kopp and Harriet C. Green. (Bell Telephone Laboratories Series.) Pp. xvi + 441. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 25*s*. net.

AS pointed out by Dr. Oliver E. Buckley in the foreword to this book, improvement in the telephone and extension of its service are the principal aims of research in the Bell Telephone Laboratories. It is well known, however, that from these Laboratories have come many other devices which have been of very considerable value to the community quite apart from the use of the telephone. It will be recollected that, shortly before the War, Homer Dudley published the results of fundamental research which had been carried out there on the formation of speech sounds. This may have applications in the future in the field of long-distance telephony. A little later another instrument was devised for the analysis of speech sounds and named the 'sound spectrograph'. This background, which does not appear in the book, makes the development which it describes the more interesting.

The title of the book, "Visible Speech", is the same as that of a book published by the father of Alexander Graham Bell, the inventor of the telephone. The elder Bell's work, however, was only concerned with the use of hand-written symbols which would define the accenting of words more precisely. The sound spectrograph, on the other hand, is essentially a device for making recorded patterns showing the frequency and intensity of the components in short samples of speech. As a first stage in its operation, the speech is recorded on a magnetic tape or by other means. The recorded sample of speech is then scanned electrically many times in succession by means of a circuit which includes a variable-frequency band-pass filter. The result of this analysis may be presented as a photographic record in which time is represented horizontally, frequency vertically and the intensity of the sound by the density of the record. Such records are useful in a study of speech sounds; but in order to enable the deaf to carry on a conversation more direct presentation of the speech in visual form is needed. Various means of doing this are possible: the final result in one case is presented on the screen of a cathode ray tube.

The techniques do, however, make possible methods of depicting speech sounds in such a way that they can be comparatively easily recognized. They have been explored as a means of conveying the information in speech sounds to the totally deaf, and of teaching them to speak by way of training them to reproduce the patterns. It is interesting to note that some of the most useful contributions to the later work have been made by a congenitally deaf engineer. The early part of the book is largely concerned with the description of the patterns which are produced by the basic sounds in speech. The relationship of these fascinating patterns to the use which the speaker makes of his different speech organs, and the basic phonetic principles underlying the patterns, are discussed; information bearing clues which enable a student to recognize and interpret them are pointed out. Although to a beginner the vowel sounds are distinctive, it would seem to him that long practice would be needed to pick out the consonants which convey so much of the information in speech.

The second part of the book, and the bulk of its pages, are occupied by lessons units copiously illustrated with patterns of American speech. This part has been written to be studied by the adult who wishes to learn how to read visible speech, and is adapted to one who either has hearing, or has relatively recently lost hearing, so that sounds and words may be recalled. To be appreciated it must be studied carefully and the various sounds practised and imitated from the patterns.

The experimental work that has been done so far has provided assurance that the patterns of visible speech are distinctive and can be interpreted. It has indicated that visible speech can possibly be used in the speech and general education of the deaf. It is fair to say, however, that a great deal of work so far has been with subjects who have been capable of quickly appreciating the speech patterns; but the practical value of visible speech as a means of making contact with the normal deaf person of no more than average education and intelligence has yet to be evaluated. As the authors say, the primary purpose of the book is that of turning over to all those who would carry on the work the major results and development to date.

This book can be unreservedly recommended to all those who have a specialist's interest in speech sounds, and in particular to those who are intimately concerned with the interests of the deaf. 'Visible speech' may also have other more varied applications, both as a research tool or for more widespread use; but these will emerge later. W. G. RADLEY

MODERN RADIO TECHNIQUE

(1) A Survey of the Principles and Practice of Wave Guides

By Dr. L. G. H. Huxley. (Modern Radio Technique Series.) Pp. xi+328. (Cambridge: At the University Press, 1947.) 21*s*. net.

(2) Radio Aids to Navigation

By Dr. R. A. Smith. (Modern Radio Technique Series.) Pp. xii+114+7 plates. (Cambridge: At the University Press, 1947.) 9*s*. net.

THE introduction of radar and the widespread development of radio wave technique during the past ten years have resulted in a considerable addition to our knowledge and experience, the records of which were confined during the war years to confidential and secret reports. Much of this information has recently been published in the form of scientific and technical papers in the proceedings of societies and institutions. There is clearly a need in addition, however, for a more compact form of publication in which the information on various aspects of the subject is collected together in separate volumes or books. It is therefore gratifying to note the proposal by the Cambridge University Press to publish a new series of monographs under the editorship of Mr. J. A. Ratcliffe and dealing with the advances in radio technique made during the War. All the monographs are being prepared by men who were personally responsible for important advances in the subjects they write about; two volumes have already been published, and some six more are in active preparation.

(1) Although the subject of the propagation of electric waves in metal tubes—or wave guides as they are now called—has been studied theoretically

for some fifty years, it was not until radar technique began to be developed on centimetre wave-lengths that the subject suddenly became of outstanding practical importance. Dr. Huxley was, during the War, head of the Radar School of the Telecommunications Research Establishment, and thus had a unique opportunity of becoming fully acquainted with the development of the subject, and the manner in which it should be treated for teaching purposes. The first six chapters of his book are based on courses of instruction on microwave techniques given at the above School, while the seventh and last chapter contains a more systematic mathematical treatment of various matters dealt with earlier.

This is a very satisfactory arrangement, for the reader who is not mathematically inclined will find that the early chapters, which comprise about three-quarters of the book, provide an extremely clear exposition of the phenomena associated with wave guides, and of the many practical applications of wave-guide systems. The reader is introduced to the conception of the transmission of waves having electric or magnetic field components in the direction of transmission by considering the superposition of the fields of a series of transverse waves travelling at an angle to the axis of the guide and being subjected to repeated reflexions from its walls. The phenomena of multiple-mode transmission and the frequency cut-off characteristics of wave guides are also clearly described. Among the practical topics dealt with in Chapters 4 and 5 are standing-wave detectors, crystal mixers, wave-guide couplers and matching transformers, means of producing circularly polarized waves, and the behaviour and use of slots cut in the walls of the guide. These two chapters occupy nearly half the book, and will be found invaluable by those who have to use wave guides as an essential part of any equipment for centimetre wave-lengths.

Chapter 6 deals with cavity resonators and their various applications, whether as tuned elements in oscillators in place of the conventional lumped circuits, as wavemeters or as echo boxes which are resonators of very low decrement, which when shock-excited by a pulse continue to 'ring' or emit a radio signal for an appreciable time after the cessation of the exciting pulse. This chapter also contains an indication of the manner in which resonant cavities may be used in the measurement of dielectric properties of materials of interest to the radio engineer and physicist.

The book is well produced and liberally illustrated, and it is to be recommended to all classes of reader interested in wave guides; and those concerned with practical applications will find the physical treatment most illuminating.

(2) The author of the second book, Dr. R. A. Smith, also has the advantage of being a member of the staff of the Telecommunications Research Establishment, where remarkable developments in radio technique took place during the war years, following the successful application of pulse technique to the detection and location of aircraft, ships and other objects. The field of radio navigational aids is nowadays very wide, and the author has, perhaps wisely, made no more than a brief mention of the use of medium- and high-frequency direction finding, and the associated developments in radio beacons and radio ranges for course-indicating purposes. Furthermore, the book is, on the whole, concerned with the navigation of aircraft, although some reference is made to the problems of navigation at sea in the two chapters on "Long-Range Navigational Aids" which deal with pulse and continuous wave systems respectively.

Within these limitations, Dr. Smith has provided an interesting account of the radio navigational aids developed primarily in Great Britain. The style throughout is descriptive, and in parts almost of a historical narrative nature; and to the reader with some general knowledge of the subject, the monograph forms a most useful and concise survey of this particular field of development. The author has quite rightly omitted all circuit diagrams and technical details; but sufficient values are given of the performance of the various systems to enable an appreciation to be made of the relative merits and fields of application of these navigational aids, some of which are now being adapted to the needs of civil aviation and merchant shipping.

It is very satisfactory to see material which has hitherto been scattered over a number of published papers and confidential reports collected together and presented in this way for the general scientific reader. For the benefit of those who wish to delve deeper into the subject, some references are given to recent detailed publications, many of which are the result of the Radiolocation and Radiocommunication Conventions held by the Institution of Electrical Engineers in 1946 and 1947 respectively.

R. L. SMITH-ROSE

MODERN INORGANIC CHEMISTRY

Modern Advances in Inorganic Chemistry

By E. B. Maxted. Pp. vii + 296. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 20s. net.

THE last two or three decades have seen very substantial advances in inorganic chemistry, as regards both technique and the fundamental concepts on which the subject is based. Any volume which succeeds in making a critical survey of the field so opened up is therefore most welcome.

Most needed at the present time, perhaps, is a concise account of the physical background to inorganic chemistry, which would enable the student to obtain a sufficient grasp of atomic and nuclear physics to follow current developments in the theory of valency and in artificial radioactivity. The first chapter of Dr. Maxted's book sets out to provide such an introduction, but, unfortunately, falls short in several particulars of what might well have been achieved. It is surely essential that the account should be authoritative, and that points settled beyond any reasonable doubt should be presented in a clear-cut manner. In this respect the section on nuclear structure is not at all satisfactory; it contains a number of cautious understatements of well-established facts, coupled with a few rather positive assertions on matters which are by no means finally settled. The remainder of this chapter is devoted to an account of modern ideas of valency, as developed by Pauling and others.

The following chapters give more detailed accounts of recent work on a few specialized topics. Some of these subjects are dealt with in a completely satisfactory manner—the chapter on the "Recent Chemistry of the Halogens", for example, appears to be unexceptionable—and it is therefore all the more disappointing to have to record that this state of affairs does not appear to extend to some questions for which a more critical outlook is required.

Perhaps the most serious example occurs in the chapter "Masurium and Rhenium". Here, the author does not appear to be at all perturbed by the absence of any confirmation of the claim of Noddack and Tacke to the discovery of element 43. The reviewer feels that the very least that should be done in this case is to make it abundantly clear that the existence of stable isotopes of this element is still an open question. The uncritical reproduction of published work is evident also in the discussion of the hydrogen isotope of mass 3. The author records the abundance of tritium in ordinary water as about 7 parts in 10^{10}, as reported by Selwood, Taylor, Lozier and Bleakney; he does not appear to wonder how so short-lived an atomic species (its half-life is about thirty years) could continue to exist even in this small concentration. In point of fact, subsequent experiments led Bleakney and his collaborators to retract their claim in favour of a much lower figure for the upper limit of abundance, and yet more recent work has set the upper limit at 1 part in 10^{17}.

The remainder of the purely inorganic part of the book calls for little comment: Chapter 4 on hafnium, and the remainder of Chapter 5, on rhenium, are quite satisfactory; the chapter on the halogens has already been commended. Hydrogen and deuterium are given a fairly adequate treatment in Chapter 2, although on one or two occasions a distinct displacement of emphasis is apparent. Chapter 6 contains a very useful account of "Reactions in Discharge Tubes", a subject which, hitherto, has tended rather to be neglected.

The book concludes with two chapters inspired by the current interest in nuclear reactions: "The Preparation and Uses of Artificial Radioactive Elements" and "Uranium and the Transuranic Elements". For a superficial study of these two related topics these chapters give an adequate account, although it cannot be claimed that the treatment is outstanding. From the book as a whole one is tempted to draw the conclusion that, human fallibility being what it is, reviews covering so wide a range of topics should be a co-operative effort on the part of two or more authors. G. R. MARTIN

EXPERIMENTAL STUDY OF HUMAN HEALTH

Biologists in Search of Material

an Interim Report on the Work of the Pioneer Health Centre, Peckham. Edited by Dr. G. Scott Williamson and Dr. I. H. Pearse. Second edition. Pp. 107 + 2 plates. (London: Faber and Faber, Ltd., 1947.) 5s. net.

THE aims of the Peckham Health Centre are nowadays so well known that they need no explanation here. The plan was to offer to families living within a specified area containing about 5,000 families a health service in the form of a family club, supported by a weekly subscription which is now 2s. per family. This doubling of the original subscription was suggested by old members of the Centre themselves. The details given in this book of the health examinations made show that the families participating obtain for this small subscription a very valuable service. But the scheme would be fundamentally misunderstood if it were thought that it seeks to replace or compete with other health services. It is essentially a biological experiment of a very interesting kind. With the full co-operation of each family it studies this social unit together with its environment, and it is claimed for it that it has also great social and educational value and can be used for the training of medical and social workers.

A short review can do no more than indicate the kind of results so far obtained and direct attention to the originality of the minds which direct the whole experiment. Stating, for example, that the efficiency of medical services depends primarily upon diagnosis, the authors of this book remind us that the first diagnosis is made by the patient. The medical man can do nothing until the patient, because he suffers from pain, discomfort, disability or limitation of action, seeks advice; and observations made at the Centre indicate that the patient seeks treatment, not because of his subjective state of disease, but because he is aware of his social incapacity. The word 'disease' is here used as meaning only the subjective state of the sufferer, the objective facts discovered by the medical man, such as adenoids, rickets, pneumonia, and so on, being called 'disorders'.

The authors' analysis of the condition which they call 'well-being' also presents some interesting observations. Well-being, they claim, can mask both grave and minor disorders. An instance of the former is the youth aged twenty-one, who said he had never felt better in his life and who was able, because he was ambitious to become a boxer and a gymnastic champion, cheerfully to sustain valvular disease of the heart, nephritis, high blood pressure and albuminuria. He compensated, as the authors put it, for his body's shortcomings, but only at considerable cost to his body. The dangers of this kind of compensation, which produces, often at a great price, a balanced action of the whole organism, are well described. This state of well-being, which deceives both the patient and the casual observer, is differentiated from the state of health which exists when the organism is not turned in on itself to effect a compensation, but is exerting an adaptive function to the whole situation and operates on the environment rather than upon itself.

Interesting also is the view that the general practitioner and the outpatients' departments and dispensaries of the hospitals treat maladies in order to relieve the social inconveniences of the patients, such as pain, discomfort, and so on; whereas the specialist tends to study the malady as if it were a detached objective thing. The practitioner thus becomes a highly skilled craftsman in the relief of social disabilities associated with disease, and this is what the patients demand of him. "But it is very clear," say the authors, "that what the public demands and gets from the practitioner is not what the State, the friendly societies and the industrialists expect of the doctor." Nor is this all that the medical man, when he emerges from his training, hopes to give.

Certainly the further progress of this experiment will be watched with the greatest interest. The subsidy required per head at the present expensive experimental stage is £4 15s. per year, a figure which may be compared with the calculation made in this book that £6 per head of the population is wasted every year through illness. The claim is made that, given time, the Centre can be made self-supporting. Let us hope that the solution of this problem of time and money, which is, the book says, the major one still remaining, will quickly be found. G. LAPAGE

FACTORS OF AGRICULTURAL PRODUCTION IN THE BRITISH COLONIAL EMPIRE*

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CONSIDERABLE interest is now being taken by Great Britain in colonial development. This interest has been further stimulated by the Government's decision during the past year to undertake the East African groundnut scheme and to establish a Colonial Development Corporation and an Overseas Food Corporation. The latter, when constituted, will take over the operations of the East African ground-nut scheme and start other food production projects overseas, while the Colonial Development Corporation will deal with developmental projects of a widely varying character throughout the colonial territories—the importance of which has been emphasized in recent months by the difficulties which are being experienced by Britain in the balance of dollar payments.

It is, however, well to realize that this decision by the Government to establish a Colonial Development Corporation is but another advance in Britain's colonial policy, which is designed to improve the standard of living of the colonial peoples, to extend their social services and to advance political self-government. The British people are convinced that the standards of life of the colonial peoples must be raised and that better economic standards in colonial territories will provide expanding markets and a general improvement of world trade.

Improved standards of life cannot be obtained or better social services maintained without expanded production. Indeed, the emphasis in the activities of Colonial Governments in the future is certain to be in the developmental field, and to be directed towards the utilization of the natural resources of the territories to the fullest extent possible, coupled with a general advancement of their peoples.

Looking at the colonial territories as a whole, the one outstanding feature which calls for comment is the very considerable increase of population during the past twenty to thirty years. It is rapidly becoming apparent that the present systems of production may very shortly be unable to provide sufficient food for satisfactory nutritional standards for these increasing populations and that marked changes in the methods of production must be made. In certain places, particularly in Eastern and Central Africa, soil erosion has assumed alarming proportions, and considerable areas, through pressure on the land and by poor systems of agricultural husbandry and stock keeping, have been rendered incapable of further production for many years.

Food will, undoubtedly, figure prominently in the requirements of the future and must be given the highest place in colonial policy. At the same time, if standards of living are to be raised, commercial crops must be grown and a more diversified production established.

I propose here to limit myself to a consideration of some of the factors which influence agricultural production under colonial conditions. They may be dealt with under the following headings: climate, soils, water, systems of agriculture, use of livestock, crop varieties, pests and diseases of man and his stock and crops, marketing arrangements and social organisation.

Climate

The climates of the British Colonial Empire range from the super-humid of the tropical rain belt with its heavy forest, through the humid with its lesser forest or parkland vegetation to the sub-humid with grass-covered savannas and thence to semi-arid steppe or desert with sparse vegetation. Climate, after all, plays the part of master influence on agricultural activities and production, and it determines not only the major soil zones, but also the systems of agriculture which prevail.

In the eastern group of Colonies, the climate of Malaya, Sarawak and North Borneo may be classified as super-humid and that of Ceylon either super-humid, humid or sub-humid according to aspect and altitude. In the West Indies, and the continental territories of British Guiana and British Honduras, the range is similar to that of Ceylon, but there are occasionally years of serious drought.

A study of Africa reveals wide climatic belts which range from super-humid to the semi-arid. Types of vegetation and the agricultural crops correspond to a greater or lesser degree with the different climatic belts. In West Africa, dense equatorial forest covers the coastal regions of the Gold Coast and Nigeria, and extends throughout French Equatorial Africa into the Congo basin. North of this equatorial rain forest occur zones which pass from humid and sub-humid to arid, with corresponding tall grass savanna, dry savanna or desert. In East Africa, humid regions occur as coastal or lake belts, sub-humidity prevailing elsewhere except where influenced by altitude. In Uganda, the area with a humid climate exceeds that under sub-humidity which is characteristic of the other East African territories. At the higher altitudes in East Africa, as well as in the Central African territories, there are zones of mountain forest and grasslands with variable rainfall.

Production in the tropical rain belt with an annual rainfall in excess of 80 in. includes timbers and forest products, oil palms, coconuts, rubber, cacao, bananas, sugar, rice and certain root crops, whereas the production of the drier forest, parkland or grass savanna areas with rainfalls ranging from 30 in. to 60 in. includes coffee, cotton, yams, maize, millets, groundnuts and livestock, and in the areas of low rainfall millets are grown and livestock are found to predominate. In the higher altitudes with rainfalls of 60 in. or more, tea and wattle flourish, and where the rainfall is lower, coffee and some of the crops of temperate zones thrive.

Soils

These cover a wide range and naturally vary in composition according to the nature and age of the rocks from which they have derived. Laterites are common. They contain an appreciable quantity of iron concretions—sometimes resembling lumps of iron ore and sometimes small pebbles. They are caused by the leaching of iron salts from the upper soil layers and their subsequent re-oxidation around particles of quartz. In many areas, particularly where the climate is humid or sub-humid, definite hard pans are formed and these have to be watched for with care. Tropical soils generally are acid in reaction, especially in the wetter areas and where not derived from limestone. Some crops require soils of acid reaction for maximum production and will not thrive when the lime content in the soil is high, while others only prosper where the soils are neutral or only slightly acid in reaction. Throughout the soils of the tropics a deficiency of nitrogen is widespread. Phosphatic deficiency also occurs over wide areas.

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* From a Friday Evening Discourse at the Royal Institution delivered on January 23.

Climatic factors have their influence upon soil formation; but in general the soils correspond closely with the geological formations and are the product of the rapid weathering of the rocks under the influence of rainfall and high temperatures. There are marked differences between the formation of soils under tropical conditions and those of the temperate regions, although the fundamental scientific principles are the same. Such factors as depth of soil, moisture content, drainage, soil structure and tilth, and the nature of the rocks from which they have derived, all have their influence. The interdependence of these several factors must be recognized.

In the wetter areas of the tropics, weathering is much more rapid than in temperate zones, and the biological activities in the soils are speeded up. Under super-humid conditions a dense growth of rain forest exists; but this luxurious cover must not be taken as an index of soil fertility, because as soon as the forest cover has been removed and the land brought into cultivation, there is a rapid fall in fertility. Nitrogen is leached rapidly by the heavy rains, and the forest floor cover of decaying vegetation is rapidly oxidized and lost. It is, indeed, now recognized that in the very wet areas, where there is no well-marked dry season, it is essential for land to be kept under cover of growing vegetation if soil fertility is to be maintained. Tree crops are the best suited for cultivation under these conditions.

Humus is the regulator of good conditions of tilth and of water distribution under the conditions prevailing in the wet tropics, and with perennial crops under a heavy and well-distributed rainfall, green manuring is the most suitable means of maintaining humus. The chief requisite for the successful use of green manures is the availability in the soils of sufficient moisture to ensure decomposition. A green manure crop must, however, be handled with skill so that the carbon and nitrogen cycles are dovetailed with the growth of the main crop.

It may here also be mentioned that one of the striking features of native agricultural systems in the wet tropics is the system of mixed cropping. There is sound justification for this practice.

In the zones of sub-humid climates the sequence of events is somewhat different from those occurring in the super-humid zones. Here there are marked dry seasons when chemical and biological activities are slowed down through inadequate supplies of soil moisture. Green manuring can be used under these conditions only with care, and in areas where the rainfall is poorly distributed their use may indeed be detrimental because of the drain which these green manures make, during their periods of growth, upon the soil moisture. In areas where there are marked contrasts between wet and dry seasons and where high temperatures prevail in the dry periods, it is difficult to maintain under a system of cropping the content of organic matter in the soils; but these soils do not appear to lose fertility so rapidly as the soils in the wetter areas because the losses from leaching are so very much less. In dry areas, much value has been derived from mulching, and in certain places agricultural production has been dependent upon the adoption of this practice.

In soils in the sub-humid zones, the available nitrogen is greater at the end of a long dry and hot period than at the beginning of the drought. Systems of bare fallow between crops are therefore used. This nitrogen is mainly in ammoniacal form; but with remoistening by rain a rapid biological conversion to nitrate takes place and rapid plant-growth results therefrom. One has only to see the rapid flush of grass after the first rains to realize the importance of this store of nitrogen, and where agriculture is practised the aim must be to make the fullest use of it. Weed-growth flourishes in such conditions and causes losses in crops unless promptly and adequately dealt with. It is this weed-growth which peasant cultivators often find it difficult to control.

Soils in the sub-humid zones are also prone to lose crumb structure and to suffer severely from erosion. Examples are to be found in East Africa.

The use of grass leys has been shown in Uganda and elsewhere to improve the crumb structure of the soil, and this system is now extending there and being tried elsewhere. Grass also is a natural good protection against erosion. In short-grass country, overgrazing of stock can, however, easily bring disaster. It has also been found in many parts of the tropics that farm practices may accelerate the destruction of tilth and that cultivation in excess of what is required to control weeds may depress crop yields. Hence the general tendency to reduce cultivations to those which are necessary for the destruction or suppression of weed-growth. It is under sub-humid conditions that the majority of the lands of colonial territories in Africa are found, and while mixed farming is likely to be the best system for peasant production, other systems involving the use of grass leys and fertilizers will have to be worked out for large-scale production.

Water

While some colonial territories have given special attention to the question of water development, there are many others in which much remains to be done. In general, there is a great scarcity of rural water supplies. Populations in certain areas are crowded together because of the limited development of water over a wider area, and in East Africa there is a serious maldistribution of livestock as a consequence of the inadequacy of the supplies of water for such stock.

Irrigation is a recognized part of the agricultural system in the eastern territories, where rice-growing is an old-established occupation; in Malaya, drainage control must be linked with irrigation. This is also the case in British Guiana on the flat coastal lands and in the coastal and internal swamp areas of Sierra Leone. Irrigation is practised in certain of the drier parts of Mauritius and also in Cyprus, where considerable success has recently been achieved with small village irrigation schemes. In areas where rainfall is normally erratic or deficient or where population increases are causing pressure on the land, the further development of irrigation is essential if increased production is to be achieved.

Systems of Agriculture

These range from highly organised systems under estate management, where considerable use of the services of science has been made, to the most primitive of systems of 'shifting cultivation' for the production of subsistence foods. In the West Indies, science can justify a claim to have been responsible for increased yields of sugar of the order of 25–30 per cent, and in the rubber industry of the Far East, production yields of double or treble those previously obtained from unimproved seedling growths have been achieved since the vegetative propagation of improved strains of rubber has been adopted.

At the same time, it may be safely assumed that productivity could easily be increased by a further 25 per cent in large-scale operations and up to 50 per cent in the smaller holdings from greater efficiency in the methods of husbandry.

At the bottom of the scale is the system of 'shifting cultivation' which is the basic system of subsistence agriculture. This system is still the standard practice of a very large number of the peasant cultivators of Africa and also of other tropical territories in areas where rice cultivation has not been established. These peasant cultivators, in sparsely populated areas, have plenty of land at their disposal, and a system of rotation of land has preference over rotation of crops. This is understandable when land is plentiful and where the people have only the hoe and the axe, in addition to fire, as their aids to the production of their food requirements. They may choose their lands with care, and they may be skilled in the choice of plant indicators of good soils; but their operations are restricted by the tools at their disposal, by the fall in soil fertility which follows the first year of cultivation and, most of all, by their inability to deal with the luxuriant weed-growth, which becomes really troublesome in the second season. It is this weed-growth which is generally the controlling factor in shifting cultivation in the wet tropics.

In some parts of Africa there have been natural evolutions from the primitive system of 'shifting cultivation' to a more settled form of continuing production, especially where cash crops have been established; but in some places it has been necessary to arrange for new settlements because of the low fertility to which the land has been reduced. In such cases, it is not unknown for reluctance to be shown to the abandonment of land occupied by the tribal group in favour of a movement to new sites, because of the beliefs of the people; and this has been even more marked when the occupation of the new land has been conditioned by arrangements for its proper use.

Advances in tropical agricultural systems have, however, in general been most rapid under European management, or where there has been a mingling of large-scale and peasant production. The progress made in the past twenty years has been considerable; but the needs of the next decade will necessitate a revolution in methods of production, especially if the standards of life of the colonial peoples are to be markedly advanced. The hoe system of agriculture will have to give place to other methods; and the introduction of mechanized aids and of fertilizers is inevitable.

Estate cultivations have made increasing use of fertilizers; but the experimental work with fertilizers has been mainly confined to the requirements of the cash or export crops. Little has been done where food crops are concerned except in regard to rice, largely because of the low unit monetary values of these crops. Some useful work has, however, been done in Northern Nigeria and in isolated instances elsewhere; but a wide scheme of fertilizer trials, planned in accordance with the most modern techniques for field experiments, has recently been started in East Africa.

Use of Livestock

Agricultural progress in Western countries has been linked with the use that has been made of livestock, and this has led to the development of important animal industries. In the colonial territories livestock industries are but little developed. It is true that considerable use is made of buffaloes and cattle for draught purposes, as well as in connexion with rice cultivation in the Eastern colonial territories and also for the production of milk and milk products. An important livestock industry also is developing in the highlands of Kenya, where European strains, especially when crossed with selected animals from the native stock, thrive satisfactorily, and where a number of co-operative creameries have been established. Similarly, European strains form the basis of the livestock in the West Indian colonies, and a thriving dairy industry has been developed in Jamaica since the establishment some seven years ago of a milk condensary.

This use of European strains of livestock in tropical areas cannot, however, be general, and reliance has to be placed on the improvement of the native breeds. The heat-regulating mechanism of European cattle is adapted to life in temperate climates, and the high ranges of atmospheric temperatures and humidity, especially where there is a low rate of air movement, cause adverse physiological reactions under tropical conditions. The stock have higher body temperatures, higher respiration-rates and a change in the pulse-rate. European breeds are not suited to those areas in colonial territories where high average temperatures and high humidity prevail, and under these conditions they can only be kept in full productivity when they are maintained under artificial conditions of controlled temperatures, as they were before the War in some special dairies in Singapore. It is only at the higher altitudes where temperate conditions prevail, or in the island territories where air movements are considerable, that European stock can be satisfactorily maintained if the higher plane of nutrition required is available. Even in these conditions it is necessary to provide a sufficiency of shade and to see that the stock are not subjected to the full blaze of the tropical sun between the hours of 10 a.m. and 4 p.m. The crossing of European stock with Indian or the indigenous breeds of Africa has been fairly widely practised. This system can, however, only be used in restricted areas and, in general, selection from the indigenous stock will be the soundest policy.

So far, the livestock of the colonial territories of Africa have been little used in agriculture. The herds are grazed on the natural pastures and move over fairly wide ranges from area to area according to the seasons and the nature of the herbage. Their owners are reluctant to sell them, and agriculturists frequently have difficulty in acquiring stock for their farm needs.

Where there is overstocking, soil erosion and land deterioration can be traced directly to the damaging effects of overgrazing and excessive trampling of the land; but experimental trials have shown that where controlled grazing is practised and where stock numbers are limited to the carrying capacity of the land, considerable improvements can be effected.

In some colonial territories there has been an extension of the use of livestock for the manuring of agricultural land, for the production of dairy products, for the conversion of farm wastes and for purposes of draught. In African territories, however, numbers are placed before quality because of the fear of losses from disease and because the social status of their owners in the community is judged by the number of stock owned. The problem of livestock in Africa is full of difficulties; but it must be tackled resolutely and with imagination if the present damage to land is to be checked, and if an animal industry of full value to the inhabitants of the territories concerned and to the world in general is to be established.

Livestock management by colonial peoples is still very backward even where mixed husbandry or dairying has been established; but it is general to find that peasant farmers with livestock are better off and live at higher standards than do those who possess no livestock.

Crop Varieties

Some reference has already been made to the increased yields which have been secured from the use of improved seed or planting material. In no sphere of the application of science to tropical agriculture has more progress been made.

Sugar cultivations now depend almost entirely upon the growth of improved strains of seedling varieties. Cotton production also requires the continuing production of new types suited to the particular conditions under which they are grown. Rubber growing has been transformed by the selection of high-yielding strains which, when proved, have been propagated vegetatively or planted in special isolated gardens for the production of self-fertilized seed. Similar progress has been made with coffee, cacao and, to a lesser degree, with tea, while the successful cultivation of tung depends entirely upon selection work. Many other examples could be quoted.

In certain areas, breeding work has been done with tropical food crops; but the progress in this field has not been so pronounced as could have been hoped for. The genetics of the genus *Musa*, to which the banana belongs, has received considerable attention at the Imperial College of Tropical Agriculture in Trinidad and also in Jamaica, where large numbers of seedlings have been produced. None of these, as yet, fully meets the commercial requirements of the trade, and a further search for new breeding material is shortly to be made. In Barbados, all sweet potatoes now grown are of seedling origin, and the yields are markedly in excess of those obtained from the earlier standard varieties. Similarly, strains of cassava which are improvements on the earlier types have also been evolved. Marked improvements have been made with rice in Ceylon, in Malaya and in British Guiana. The millets have not, so far, received the attention that should have been given to them, and it is hoped that early steps will be taken to establish special stations in Africa for meeting this need.

Pests and Diseases

In the past, the human diseases of the tropics and the pests and diseases of crops and stock controlled output. Malaria is of frequent occurrence, and its debilitating effects are still considerable. The lessons of certain operations in the Second World War have proved that a large measure of control over malaria is possible, and the value of *D.D.T.* in the control of mosquitoes in houses and villages has already been successfully demonstrated in British Guiana, Uganda, Mauritius and elsewhere, while a large-scale experiment in the Karpas peninsula of Cyprus has given such satisfactory results as to warrant wider trials in that Colony and to the planning of an all-island campaign against malarial-carrying mosquitoes in Mauritius.

The tsetse still holds under its control vast areas of Africa, and trypanosomiasis in man and in stock is still a controlling factor in certain areas. In Tanganyika, it is estimated that two-thirds of the total land area is infested by different species of tsetse flies; vast stretches of that territory are, in consequence, devoid of population. Much research work has been done on tsetse control and some advances have been made.

Among stock diseases, rinderpest, East Coast fever, pleuro-pneumonia and intestinal parasites have to be contended with. Progress has certainly been made by the veterinarians; but rinderpest is still a factor which cannot be regarded with equanimity in the African territories.

Locusts still cause damage to crops from time to time in Africa; but marked advances have been made in our knowledge of the bionomics of the three species of locusts with which colonial territories in that continent have still to contend. The application of control measures based upon this knowledge is steadily continuing, but final success cannot yet be claimed.

Crop pests account for losses, and in certain areas they are a controlling factor. Those of cotton have received special attention, and the work of the entomologists of the Empire Cotton Growing Corporation has been outstanding. A considerable knowledge has been accumulated and this enables an assessment to be made with a fair measure of accuracy of the areas in which cotton cultivation can be extended and those in which such extension would at present be unwise. Control of certain pests of cotton and of several diseases has been achieved by the breeding of resistant strains, although it is still estimated that if the lygus pest in Uganda were controlled, output would be increased by 50 per cent. Similarly, there are still considerable losses during storage, especially in food crops or grains, and these are now under special investigation in West Africa.

Among plant diseases mention should be made of the witches' broom of cacao which has had devastating effects in Trinidad and South America, the swollen shoot virus disease of cacao in West Africa, the die-back of cloves in Zanzibar, the mosaic disease of cassava, the Panama disease of bananas in the West Indies and the bunchy top disease of bananas and manila hemp in the East. The virus disease of cacao has already caused the loss of nearly one-third of cacao production in the Gold Coast. A special West African Cacao Research Institute has been established [see *Nature*, January 24, p. 117] and very considerable progress has been made. It is, however, unlikely that the disease will be finally defeated until new types immune or resistant to the virus have been found. Further expeditions in search of new strains of cacao from South America are contemplated and, in order to assist banana producers, a scientific expedition to collect wild species of *Musa* from south-east Asia is in process of being arranged.

Marketing Arrangements

Marketing arrangements and the prices of commodities have their place of importance in the efforts of all producers and agriculturists, as well as others. Price fluctuations often affect total production, and frequently the productivity of individual producers or groups of producers. When prices are low, agriculturists tend to cut out maintenance works, and efficiency suffers. The fluctuations and the general trend of low prices for primary products between the two World Wars were not without their effect upon efficiency of production in the colonial territories.

The Second World War saw the introduction of bulk buying and selling of certain colonial commodities, and this system has introduced a system of agreements under which prices have been fixed by negotiation.

The value of such a system was appreciated by colonial producers, as it enabled them to plan their production ahead with some measure of confidence. Peasant producers have also benefited from, and have generally recognized the value of, the systems of price fixing which were adopted. There have, however, been fears that these arrangements could not be continued, and at the present moment further consideration is being given to the matter. Commodity marketing organisations are being continued, and steps are being taken to build up price equalization funds so that when prices fall the producers will not suffer unduly. Contracts for purchase of some commodities now include provision for (*a*) equipment replacement, (*b*) the building up of price equalization funds, and (*c*) expenditure on welfare amenities for the labourers employed.

The above arrangements relate to export commodities, and they should have a stabilizing and encouraging effect on production; but there are some who still contend that the contract periods are of too short a duration. Production for home consumption in the Colonies, especially of foodstuffs, would be stimulated if price-regulating methods similar to those contemplated under the recent United Kingdom Agriculture Act could be brought into effect.

Social Organisation

In the West Indies and some of the older Colonies, lands have from the first been held on forms of tenure and title similar to those prevailing in the United Kingdom, and social organisation has followed, with adaptations, the English pattern. In others, the forms of tenure have originated in indigenous customs which were an integral part of the social structure. In the African territories and also in some others, this structure, which is based upon the village, is built upon communities. Rights to particular plots of land are often recognized; but these rights are limited to the period of occupation, restricted as to succession and qualified by membership of a kinship, clan or other group. These plots are usually small in size, and the community interest generally prevails so far as land is concerned. This is usually not the case in respect of the produce from the land.

Customary rights have undergone, and still are undergoing, a rapid process of change as the result of economic influences. The expansion of education, as well as the development of urban areas, and of mining, have had their effects. Introduction of new types of crops and of new methods of agriculture also have brought about important changes. The introduction of permanent tree crops such as cacao and coffee, for example, has resulted in a firm growth and expansion of the conception of ownership as against the previously held conception of a collective right in land derived from indigenous custom, and changes have been accelerated by the necessity for adjustment to the needs of modern economy of production and marketing. In some territories defined native reserves have been established, and in others there are to be found land tenures based upon the indigenous customs alongside those which have been introduced from elsewhere for alienated lands.

It is impossible to deal here, however, with the varying systems of land tenure which are found in colonial territories, to the tribal restraints which are sometimes imposed upon enterprise and initiative, or to discuss the strains and stresses which are resulting from the spread of education.

Productivity of land, however, depends as much upon sound systems of land tenure as upon improved agricultural practices, and any policy of development must increase the range of land matters and social issues to which colonial administrations will have to give urgent attention. It would seem that a solution of the social issues involved must lie in finding a balance between the advantages and disadvantages of the traditions of the past, the customs of the present and the needs of the future. Bold experiments may have to be made.

Conclusion

I have attempted, briefly, to review those factors which affect production in colonial agriculture. They are many and varied, and several of them are interdependent. In the early stages of colonial endeavour empirical measures sufficed, but these have gradually given place to methods which are being evolved on an ever-widening basis of knowledge. The man of science and the administrator are equally concerned, and a closely knit partnership between them must be established for the combined operations which are required.

Science has an important part to play. All research work must be planned in such a way that it is relevant to the objectives in view, and the utilization of this knowledge must be regarded as a duty of the administrative machine.

In agriculture, the scientific research worker should have full and frequent contact with production at all stages and with the persons engaged in that production. Without this contact, research is liable to become sterile and ineffective. Research organisations for specific industries, when they can be afforded, have their value, as they do ensure that the results of their work are translated quickly into practice. When, however, research work is planned on a wider basis, steps must be taken to ensure that it is not divorced from those charged with helping the advancement of the cultivators of the land. The chain must be complete to be effective.

Equally, the human side must not be disregarded. In many respects, it is the more important, as support for change or advancement can only be secured when the peoples concerned are convinced that such change will be for their advantage and worth the effort. Education has an important part to play here.

To the majority of the colonial peoples, agriculture is the foundation of their lives, their well-being and their hopes. With good will and understanding and with proper organisation, agricultural production can make great strides forward, but the traditions and customs of the colonial peoples must always be regarded sympathetically and with understanding. If the objective of greater production is made clear, enthusiasm aroused and willing co-operation secured, progress is certain. There are hazards which have to be surmounted, but with the aid of science, these will be overcome, and in future years they may be regarded as having been only the 'whistle points' along the track of development and progress.

AIRCRAFT ATTACK ON LOCUSTS

By Dr. D. L. GUNN

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THE most commonly effective method of destroying locusts at present is to poison the hoppers (nymphs) before they can fly. Some kind of bait, such as moistened bran, which is eaten in preference to other food, is poisoned with benzene hexachloride (hexachlorocyclohexane, 'Gammexane', 'Benhex') and is scattered thinly in front of the advancing bands. For an infestation of any magnitude, this requires a large labour force. In some parts of the world, even in Africa, there is a severe shortage of labour, so that it is increasingly difficult to get adequate supplies of casual seasonal workers. When a widespread plague occurs, it is sometimes necessary to call upon the army to do much of the work. In addition, the work must often be done in areas which are so far from sources of supply of food and even water that the cost of transport becomes considerable. It is therefore not surprising that attention has been given to the use of machinery to replace much of the unskilled labour.

The aeroplane is the machine which is most independent of difficulties of terrain, such as occur in the great spaces of Africa. One therefore naturally thinks of the aeroplane as the primary weapon for coping with inaccessibility of locusts and with mobility of migrating swarms; such a weapon would be especially valuable if the adults could be attacked before breeding. A number of attempts have been made during the past decade or so to use aircraft for attacking various kinds of insects; in few cases does it appear that these have led to the establishment of routine methods. The exceptions are mostly concerned with dusting or spraying particular places, so that a small airstrip can be cleared very close by, and light aircraft can attack day after day and year after year.

Much more difficult problems arise when the target is as mobile as a swarm of locusts. From time to time, aircraft trials against locusts have been made in various countries, usually with much optimism but with too little scientific background research to enable much to be learnt. These sporadic and disconnected trials have received newspaper publicity out of proportion to their real value. We have therefore set out systematically to find whether aircraft methods are applicable to locust destruction, and to work out where and when they may compete in effectiveness and in cost with other methods. This article is a summary of as yet unpublished material obtained in work initiated by the Anti-Locust Research Centre on behalf of the Colonial Office, and carried out in co-operation with the Royal Air Force, the Middle East Anti-Locust Unit, the East African Anti-Locust Directorate, the International Red Locust Control Organisation, the South African Air Force and the Union Department of Agriculture (Locust Control and Research Section), the Colonial Office Insecticide Flight, and perhaps most important of all, the Ministry of Supply, especially the Chemical Defence Experimental Station at Porton, Wiltshire.

The first experiments were carried out in 1944, by the Anti-Locust Flight (R.A.F. and S.A.A.F.) and Dr. J. S. Kennedy in the Kenya Highlands[1]. It was found that the most effective contact locusticide available was dinitro-*ortho*-cresol[2] (*D.N.O.C.*), and a dust containing 14 per cent of this was scattered from Avro Anson (Mark I) aircraft on to the locusts (*Schistocerca gregaria* Forsk.). The apparatus and methods were derived from the Russians, with whom the Flight had been preparing the work in Persia. It was found that the effectiveness of the dust varied enormously, apparently with atmospheric humidity, so that in wet conditions a high mortality occurred with less than 7 lb. of dinitro-*ortho*-cresol dust per acre, while in dry conditions there was a low mortality with more than 60 lb. per acre. The aircraft had to fly very low—below the tops of the occasional trees—to get the dust down relatively evenly in the right place, so that the swaths were narrow (7–25 yards), and the locusts were often disturbed and avoided the dust. The hastily improvised apparatus was heavy, it increased the air resistance of the aircraft, and it required a man in the aircraft to operate it, so that the useful load carried was only 650 lb.; consequently a single load would cover only twenty acres or so at a middling dosage, and even that took rather a long time. The mobility of a swarm caused very great difficulties, for it had to be located, its limits found, markers placed to guide the aircraft on each run, and the attack had to be completed between the time when the swarm went to roost in the evening and its departure a few hours after daybreak next morning. Further research was thus required on the insecticide and its distribution, on locust behaviour and on field organisation and methods.

Dr. Kennedy then returned to England, to the Ministry of Supply's laboratory at Porton, and began laboratory studies on the spraying of settled and of flying locusts with contact poisons, in close relation to his field experience[3]. These investigations covered the study of the dose required to kill an individual locust, the amount of spray which a locust would pick up under various conditions at rest and in flight, the effectiveness of poison falling on various parts of the body and the area dosage required in the field; they were, in fact, partly fundamental investigations on the principles of insecticide application, and have since been continued by others at Porton. A 5 per cent solution of *D.D.T.* was found to be ineffective at 9 gal./acre, while a 2½ per cent solution of dinitro-*ortho*-cresol in a mixture of aliphatic fractions of petroleum produced 50 per cent mortality at about 1½ gal./acre. Benzene hexachloride was less effective and slower in its contact action, which contrasts markedly with its superiority as a stomach poison for locusts.

By August 1945, a programme of spraying trials against locusts in Kenya had been prepared at Porton. The methods recommended, instead of being hindered by all except a narrow range of air conditions, were to take advantage of the wind in a calculated way so as to produce a wide and predictable swath. The solution was to be released from a single simple orifice placed outside the wash of the propellers, so that it broke up into drops in comparatively constant conditions; with a solution of constant physical properties, the drop spectrum could be determined and the way in which the drops would fall in ideal conditions could be calculated; inferences could then be made for applying the spray in real conditions. Methods of determining the proportion of the poison reaching the ground were worked out.

In early 1945, I was seconded from the University of Birmingham to the Anti-Locust Research Centre

The Commission emphasizes the need for a good library, though it will probably inevitably be a small one. The need for carefully considered medical arrangements, including a sick-bay for students, is fully discussed. A warden in charge is recommended; but a vice-warden is not considered essential unless the hall accommodates more than 150 students. Members of the university or college staff should not be admitted as residents unless they are prepared to assist in the creation of an academic and friendly atmosphere. Domestic administration should be in the hands of a bursar; it should not be left to the warden. General opinion favoured 100–150 as the most satisfactory number of students; though there are arguments for smaller units, mainly on grounds of congeniality.

The Report will prove of considerable value to academic and other authorities who are considering constructing halls of residence, and those who are interested in halls already in existence will read it with profit. Literary quotations in a factual report of this sort seem out of place; in fact, that introducing the index is fatuous.

Amalgamation of Instrument Makers: Hilger and Watts, Ltd.

The well-known instrument makers Messrs E. R. Watts and Son, Ltd., and Adam Hilger, Ltd., are being formed into one company registered as Hilger and Watts, Ltd. Watts was founded in 1856 and has specialized in the manufacture of surveying and engineers' measuring instruments, while Hilger, started in 1874, has built up a world reputation for instruments for research and industry. The products of the two firms are complementary to some extent, and the instruments developed by Hilger for chemical, biological and medical research are closely related with the products of James Swift and Son, Ltd., microscope makers, who are a subsidiary of Watts. The resources for research which have been at the service of Hilger and Watts respectively, and to which their success has been largely due, will be combined. The board of directors of the new Company is an amalgamation of the boards of Hilger and Watts, namely, G. A. Whipple, who has been managing director of Watts and Hilger since 1939 and 1946 respectively (chairman and managing director); F. Twyman (technical adviser); Dr. A. C. Menzies (controller of research); D. R. Stanley (controller of sales); V. W. H. Towns (technical controller); R. H. Watts (assistant controller of sales). Hilger and Watts, Ltd., will employ 1,300 people in the six existing factories. A new factory in the Greater London area has been planned and approved.

Export Organisation for British Scientific Instruments

Scientific Exports (Great Britain), Ltd., Buckingham House, Buckingham Street, London, W.C.2, is a co-operative marketing organisation set up by a group of British firms specializing in the production of high-quality scientific and surgical equipment. Through its world-wide agency, customers will be able to obtain from one source a very wide range of the finest equipment available. For circulation abroad, the organisation is issuing an illustrated bulletin, the first number of the technical series of which has recently been received. The bulletin is intended to supply regular and up-to-date information of progress in the above fields, and will include detailed descriptions of products, techniques, and developments in the spheres covered by the manufacturing members of the group of manufacturers involved. The members introduced in the first number are Allen and Hanburys, Ltd., founded in 1715 and famous for their pharmaceutical products; Baird and Tatlock (London), Ltd., laboratory suppliers for more than fifty years; W. Edwards and Co. (London), Ltd., high-vacuum specialists; Adam Hilger, Ltd., founded in 1874 and specialists in spectroscopes and astronomical instruments; Hopkins and Williams, Ltd., who have been engaged in the manufacture of fine chemicals for nearly a century; W. Watson and Sons, Ltd., founded in 1837 and chiefly noted for microscopes; and E. R. Watts and Son, Ltd., established in 1857, and makers of theodolites, levels and other surveying equipment.

Animal Health in British Guiana

A report on British Guiana, by Prof. W. C. Miller, forming part of a survey of animal husbandry, feeding, management and veterinary services in the West Indies, has been issued as Bulletin 19A of the series "Development and Welfare in the West Indies" (Bridgetown: Advocate Pub. Co., Ltd. 10 cents). Reviewing the general position of livestock, Prof. Miller points out that the running of estate dairies in the coastal belt has great potentialities from the point of view of improved human nutrition and of the general improvement of the livestock reservoir of the Colony, and suggestions are included both for a Government ranch and for a breeding policy for two types of herds. Stress is laid on the great potential asset of the cattle ranches; and in addition to proposals for changing the character of the breeding stock in the hinterlands, the report discusses transport of meat by air and the establishment of an abattoir. Dealing with peasant-owned livestock, Prof. Miller regards prospects for dairying as reasonably good; but now that extension of livestock production has been started, more adequate provision for control of disease and for improving animal health by the formation of a properly constituted veterinary service is imperative. In Prof. Miller's opinion, the minimum effective service would consist of one deputy director of agriculture, stationed in Georgetown, with two senior veterinary officers, one on the coastlands and the other in the Rupununi; two veterinary officers, one on the coast and the other available for emergency work; one senior and two other animal husbandry officers, one of whom would be stationed in the Rupununi or other part of the hinterland. Technical staff would also be required in the veterinary laboratory now being equipped. There is already more than sufficient work to keep such a staff fully employed, and basic agricultural education is also required at all levels. In particular, Prof. Miller directs attention to the question of scholarships for higher training in veterinary science and animal husbandry for locally born persons, and to the desirability of arrangements for periods of study-leave for officers already in the service to be spent at institutes investigating associated or cognate problems.

Lundy Field Society

The first annual report of the Lundy Field Society, Lundy Island, shows that the year's working was more one of growth, exploration and experiment than of achievement. The total membership is now 127, of whom thirty-four have visited and worked on Lundy during the season. Most of the work already attempted has been concerned with the building up of ornithological records, although the difficulty of maintaining a Heligoland-type trap on Lundy has meant that work on birds so far has been mainly carried out by observation. The report contains a full list of the species recorded and also an account of various ecological surveys begun in different terrestrial and freshwater habitats on the island.

National Museums of Ceylon

THE Administration Report of the Director of National Museums for 1946 (Ceylon Government Press, Colombo, 1947) gives news of the commencement of museum reconstruction in Ceylon. The Colombo Museum was derequisitioned by the military authorities in January 1946 ; but although the Public Works Department had the building under repair, it was not until the following July that any part of it was fit for the return of some of the Museum's collections. In spite of this and other difficulties, however, it is recorded that when part of the building was reopened there were 22,128 visitors to it between December 20 and 30 of the same year. Reference is made in this section of the report to the requisitioning of show cases by the military authorities in 1942 ; of the 262 taken over, only 85 were returned fit for use. To replace those lost, orders have been placed with the Crown Agents to the sum of Rs. 91,950, while a further sum of Rs. 41,850 was assigned to the Government Factory Engineer "for building show cases locally, with what was left of the glass that was removed from the original show cases at the time of requisitioning". One is left wondering to what use military authority could have put museum exhibition cases that they suffered so much damage. A new south wing to the Kandy Museum is under construction, and what is left of the King's Palace will be converted into a part of the same Museum. A special strong room will house the Sinhala Regalia. The Ratnapura Museum was reopened to the public in April 1946, while the Jaffna Museum was expected to reopen in July 1947. Under the different museum headings, the report includes long lists of acquisitions made during the year under review.

Standardization of Micro-film Technique

BRITISH STANDARD SPECIFICATION 1371 : 1947 for microfilm, readers and reels has been produced in co-operation with the American Standards Association's Committee, and American standards about to be published will provide equivalents to B.S. 1371, so that microfilms made in Great Britain should be capable of satisfactory projection on a reader made in the Commonwealth or in the United States, and vice versa. The specification covers 16 mm. and 35 mm. microfilm readers and reels for processed microfilm, each in a separate section. The first section specifies the stock to be used, dimensions, method of winding, the leader trailer and title frame, as well as the arrangement of images and correct sequence of pages for convenient reproduction. Essential dimensions for microfilm readers are specified in the next section, as well as other features for satisfactory reproduction, including the type of lens and magnification and the limiting temperature for the film in the gate, a method of measuring which is described in an appendix. Dimensions and features of reels for processed microfilm are specified in the third section. Standardization along the lines indicated in this specification and the three forthcoming American standards should materially assist the satisfactory use of microfilm and its extension to further fields.

Growth and Nature of Egyptology

AT long last the University of Cambridge has a chair of Egyptology, and Prof. S. R. K. Glanville's inaugural address has been published (London : Camb. Univ. Press. Pp. 37. 1*s*. 6*d*. net). The subject has for some time been taught officially in London, Oxford, Liverpool and Manchester ; but although so late in the creation of a chair, Prof. Glanville directs attention to three eminent Cambridge men—C. W. Goodwin, E. A. Wallis Budge and Sir Herbert Thompson—who played a big part in the building up of the subject. Actually, it is owing to the generosity of the last of this trio that the creation of the present chair has been made possible. Prof. Glanville continues with a brief survey of the subject under the three headings : monuments, antiquities and writings. He concludes with a strong plea that Egyptology, although not of immediate use like engineering and medicine, yet has its place in the teaching of a great university; he ends with a quotation from Housman : "The pursuit of knowledge, like the pursuit of righteousness, is part of man's duty to himself".

Society of Engineers : Awards

AT the inaugural meeting for 1948 of the Society of Engineers (Inc.), the first award was made of the Simms Gold Medal, established under a bequest by the late F. R. Simms, for "a paper or lecture describing a new technical discovery, an outstanding invention, or the results of useful research work". The medal was presented to Mr. J. G. Milton for his paper on "Research and New Developments in Water Treatment". Other awards were as follows : Bessemer Premium to Mr. C. D. Mitchell, for his paper on "Prefabricated Pre-cast Concrete Structures" ; Nursey Premium to Mr. R. Cecil Smart, for his paper on "Industrial Organisation as a Factor in Productive Efficiency" ; Bernays Premium to Mr. Bernard Payne, for his paper on "Water Supply Engineering". Two other papers, namely, "The Engineer and the Law", by C. L. Boucher, and "Liquid Springs", by R. H. Bound, were of particular merit; but their authors, as members of Council of the Society, were ineligible for awards, and they were presented with certificates under seal. The new president of the Society is Mr. E. E. Turner, formerly chief engineer to H.M. Airship *R*.34, and an authority on high-speed engine lubrication.

Research on the Biochemistry of Brain Tissue

THE Rockefeller Foundation has given £9,000 for research at the Neuropsychiatric Research Centre at Whitchurch Hospital, Cardiff, for research on the normal and pathological biochemistry of brain tissue under the direction of Dr. Derek Richter. Whitchurch Hospital is one of the leading hospitals in Britain for the investigation and treatment of mental disorders, and a Neuropsychiatric Research Centre has recently been established for which the present grant has been made. The magnitude of the problem of nervous and mental disease in Britain alone is not generally recognized. There are more hospital beds occupied by mental patients than by all other diseases put together, and the annual cost of upkeep exceeds £12,000,000. Research on mental disease has been very much neglected in the past. The object of the work now being carried out at Cardiff is to find out more about the working of the brain and nervous system in health and disease, so that this knowledge can be applied to the treatment of mental disorders of every kind. The lines of research now in progress include biochemical work on the enzymes in the brain, and work using the radioactive 'tracer' technique. Clinical research is also being carried out on problems related to schizophrenia, epilepsy and senility.

Capper, Pass Awards for Metallurgy

Messrs. Capper, Pass and Son, Ltd., of Bristol, have offered the Institution of Mining and Metallurgy and the Institute of Metals £200 a year for seven years, to be applied as follows: (*a*) £100 a year for one or more awards for papers on some aspect of non-ferrous extraction metallurgy; (*b*) £100 a year for one or more awards for papers relating to some process or plant used in the extraction or fabrication of non-ferrous metals. Both awards are for persons engaged full-time in industry or practice. The Councils of the Institution of Mining and Metallurgy and of the Institute of Metals have appointed a joint adjudicating committee which will examine annually all papers published by both societies; no special applications should be made for these awards.

Scholarships at Foreign Universities, 1948–49

The British Council has been informed that scholarships for the academic year 1948–49 will be offered to students and graduates of British universities and colleges by the Governments of a number of foreign countries, including Belgium, Hungary, the Netherlands, Sweden (with the Swedish Institute for Cultural Relations) and the University of Teheran, Persia. The scholarships are normally intended for study on the postgraduate level. They cover in general the cost of tuition and maintenance and in some cases the cost of travel. Two scholarships have also been offered by the University of Cologne, and two by the University of Munster. Negotiations with the Control Commission are proceeding with regard to facilities for food and accommodation. Particulars can be obtained from the Controller of the Education Division, the British Council, 3 Hanover Street, London, W.1.

University of London

The following appointments in the University of London have been announced:

Dr. L. J. Audus has been appointed to the Hildred Carlile chair of botany tenable at Bedford College as from October 1, 1948.

Dr. Eric Boyland has been appointed to the University chair of biochemistry tenable at the Royal Cancer Hospital (Free) as from January 1, 1948. In 1935 he was appointed reader in biochemistry at the hospital.

The degree of Doctor of Science has been conferred on Sir Alfred C. G. Egerton, University professor of chemical technology in the Imperial College of Science and Technology.

Royal Institute of Chemistry: Annual Meeting

The annual general meeting of the Royal Institute of Chemistry will be held during April 15–17 in Birmingham; this is the first occasion since the Institute was founded that the meeting has been held in the provinces, and in honour of the occasion the Birmingham and Midlands Section has arranged a programme of scientific and social events. The Lord Mayor of Birmingham will give a civic welcome to the president (Mr. Roche Lynche). The programme includes an exhibition, "The Chemist in the Midlands", to be held in the Central Technical College, Birmingham, which will feature the training of the chemist, research, production, and the chemist and the public services. The exhibition will be open to the public. Prof. R. P. Linstead will give a lecture on "The Chemical Research Laboratory, Teddington"; and Prof. Maurice Stacey will speak on "The New Fluorocarbon Chemistry". Visits have been arranged to the University of Birmingham and the Barber Institute of Fine Arts, Messrs. Chance Bros. glassworks at Smethwick, and Messrs. Marston, Thompson and Eversheds brewery at Burton-on-Trent.

Announcements

Lord Brabazon of Tara has been elected president of the Royal Institution in succession to the late Lord Rayleigh.

A memorial ceremony in honour of Max Planck is being arranged by the Max Planck Society for the Advancement of Science, the Academy of Science at Göttingen, the University of Göttingen, and the German Physical Society in the British Zone of Germany, and will be held in the University of Göttingen on April 23 at 11 a.m. This date would have been Planck's ninetieth birthday.

An international symposium on the "Kinetics and Mechanism of Combustion and Ignition Reactions in the Gas Phase" will be held in Paris during April 26–May 1. This symposium is being organised by the Centre National de la Recherche Scientifique, with the assistance of the Rockefeller Foundation. Detailed information can be obtained from Prof. P. Laffitte, 12 rue Cuvier, Paris (5ème).

Dr. Risto Jurva has been appointed director of the Finnish Institute for the Exploration of the Sea.

Dr. Cyril J. W. Hooper has been appointed editor and general secretary of the Society of Dyers and Colourists. Dr. Hooper, who was born in London in 1913, received his education at Tottenham County School and the Royal College of Science, and eventually obtained the London degree of Ph.D. for work in physical chemistry. After some experience in industry, he became reader with Messrs. Charles Griffin and Co., Ltd., and recently he has been librarian and information officer in the Research and Development Department of Ascot Gas Water Heaters, Ltd.

A joint meeting of the British Society for the History of Science with the Science Masters' Association, the Historical Association and the Association of Women Science Teachers will be held on March 9 at 5 p.m. in the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7, to discuss "The Place of the History of Science in Education". The speakers will include Dr. E. J. Holmyard (chairman); Dr. Sherwood Taylor; Mr. G. Fowles, formerly chairman of the Science Masters' Association; Mr. S. M. Toyne, chairman of council, Historical Association; and Miss L. E. Higson, secretary of the Association of Women Science Teachers, and there will be a general discussion.

LETTERS TO THE EDITORS

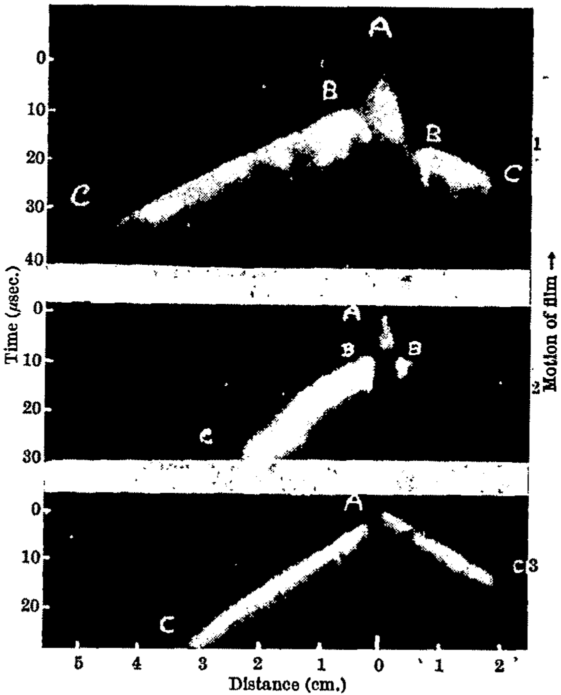
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Birth and Growth of the Explosion in Solids Initiated by Impact

It has been shown that when liquid explosives such as nitroglycerine are initiated by impact, the explosion begins as a comparatively slow burning which spreads for a short distance from the point of initiation at a speed of *c.* 400 metres per second, and is then suddenly transformed into a faster propagation at *c.* 1,800 m./sec., which has the property of a detonation wave[1,2,3]. This two-stage propagation occurs when the initiation is caused by impact and compression of a small included bubble, or by sparking, and is observed with all the liquid explosives which have so far been investigated.

A recent study of the initiation of solid explosives by impact reveals a similar effect. If a thin film of the solid explosive is distributed on the anvil as an annulus, so that a small gas space is included during the impact, the sensitivity is increased[4]. Photographic experiments show that initiation begins at the gas space. This gives a convenient method of ensuring that the point of initiation is on the slit of the camera, and high-speed photographic studies of the growth of the explosion in the immediate vicinity of the point of initiation have been made both for secondary and for primary explosives. A typical result for a thin film of solid *P.E.T.N.* is given in Fig. 1. The initiation begins at *A* at the small included gas space, and the flame spreads from this point at a comparatively slow rate. In Fig. 1 this initial rate of burning (*AB*) is 450 and 300 m./sec. We should expect this rate to be dependent on film thickness, density of packing, etc., and in these experiments the rate varied from 100 to 600 m./sec. After a short distance (at the point *B*), this burning was transformed into a detonation, the speed of which varied from 1,000 to 2,500 m./sec. according to the density and film thickness of the explosive. In Fig. 1 this second stage (*BC*) is spreading at 1,620 m./sec. The transition from low-speed to high-speed propagation usually occurred at a physical discontinuity, that is, at the edge of the hammer, but this was not always the case. Films of cyclonite and tetryl gave similar results; but the initial burning was slower (100–300 m./sec.), and the thin film of explosive surrounding the hammer did not propagate.

A similar study has also been made of the initiation of primary explosives by gentle impact, both with and without added grit; when a grit particle was present, initiation began at the particle. The result for mercury fulminate initiated without grit is shown in Fig. 2. The two-stage propagation is again apparent. After initiation, the explosion spread for a short distance at a speed of 250–300 m./sec. before passing over to a high-speed detonation. Lead azide, on the other hand, usually showed no slow initial stage (see Fig. 3); detonation set in immediately unless extremely thin low-density films were used. It is interesting to note that for the *thermal* initiation of unconfined trains of these two primary explosives, Patry[5] found that fulminate gave an initial burning and azide did not.



1. *P.E.T.N.* FROM THE POINT OF INITIATION *A*, THE EXPLOSION SPREADS AS A SLOW BURNING *AB*, FOLLOWED BY A DETONATION *BC*. 2. MERCURY FULMINATE. SIMILAR TO 1. 3. LEAD AZIDE. NO INITIAL BURNING

A parallel series of experiments was carried out with thin films of *P.E.T.N.*, mercury fulminate and lead azide confined between two surfaces and initiated at the centre by a spark instead of by impact. The growth of the explosion initiated by the spark was very similar to that obtained by impact. *P.E.T.N.* and mercury fulminate both gave an initial slow burning which changed over to a detonation (the photographs were similar to Figs. 1 and 2). With lead azide, the burning stage was not observed and the photograph was similar to Fig. 3.

It is clear that for a number of solid explosives the first stage of the initiation by impact is a burning, and that the general behaviour is very similar to that observed in liquids under similar conditions. It is probable that under the impact, many explosives, particularly the softer ones, are compressed and flow like liquids. The results again suggest that, for solids as well as for liquids, the initiation under impact is essentially thermal in origin, and that the explosion begins at a hot spot which can be generated either by the adiabatic compression of a gas pocket, or by friction on a particle of grit, or (under extreme conditions) by viscous heating of the rapidly flowing explosive.

We thank the Royal Society for a grant for the development of high-speed cameras and the Ministry of Supply (Air) for other equipment.

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Cambridge. Nov. 15.

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[3] Vines, R. G., *Nature*, 160, 400 (1947).

[4] Yoffe, A., *Nature* (see following communication).

[5] Patry, M., Thesis, Nancy (1938).

Initiation of Explosives by Adiabatic Compression of their own Vapour

Previous work has shown that the sensitivity of liquid explosives to impact is greatly increased by the presence of minute gas bubbles[1]. The initiation is of a thermal nature and is due to the adiabatic compression and heating of the trapped bubbles. A simple method of including a gas space in an explosive is to spread it as a small annulus on a flat anvil. When this is struck with a flat hammer, the small amount of gas in the centre is trapped and compressed.

In these experiments the size of the annulus was such that the initial volume of the gas space was *c.* 5×10^{-5} c.c. With nitroglycerine in air at atmospheric pressure, regular explosions are obtained with an impact energy of 300–500 gm. cm. When the nitroglycerine is spread as a continuous film so that gas spaces are not present, very high impact energies are necessary (10^5–10^6 gm. cm.). At low initial air pressures (less than 10^{-5} mm. mercury), it is found that the annulus still exercises a similar influence in increasing the sensitivity, and explosions are still obtained with impact energies of *c.* 500 gm. cm. Although the other gases have been pumped out, the vapour pressure of nitroglycerine itself at room temperature is *c.* 10^{-3} mm. The experiments suggest that the initiation of the explosion under these conditions is due to the compression and adiabatic heating of the nitroglycerine vapour itself. This would assume that the vapour is not condensed during the rapid compression produced by the impact. The same high sensitivity is obtained when the evacuated space is filled with 50 mm. of methyl nitrate vapour, another explosive similar to nitroglycerine. This supports the above view.

These results have a bearing on the handling of liquid explosives. The compression of any small space, whether filled with a gas or with the vapour of explosive only, may initiate an explosion. Such a condition could arise, for example, during the collapse of bubbles formed by cavitation.

When a solid such as *P.E.T.N.* is distributed on the anvil as an annulus rather than as a uniform film of crystals, an increase in the explosion efficiency is again observed: the energy necessary to give an explosion efficiency of 50 per cent is $2 \cdot 8 \times 10^4$ gm. cm. for an annulus and $7 \cdot 1 \times 10^4$ gm. cm. for a continuous film. This increase in efficiency due to the annulus occurs both when the air pressure is initially one atmosphere, and when it is initially less than 10^{-5} mm. and the total pressure, including that of the explosive vapour, is *c.* 10^{-4} mm. Again, it would appear that the compression of the vapour of the explosive may initiate the reaction.

The behaviour of some solid explosives under impact thus shows many similarities to that of the liquid explosives. Apparently the air spaces which are present between the crystals of solid explosive are sealed off by local melting or plastic flow during the impact, and the adiabatic compression of the air or vapour in these gas spaces may initiate the explosion.

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Acetylation of Sugars

The acetylation of sugars has hitherto involved the use of acetic anhydride and a catalyst such as sodium acetate[1], zinc chloride[2], sulphuric acid[3] or pyridine[4]. We have shown that glucose may be acetylated rapidly by means of a mixture of acetic anhydride and acetic acid if a small amount of perchloric acid is added to act as a catalyst[5]. No external application of heat is necessary to aid the reaction. By pouring the acetylation mixture into water, an almost quantitative yield of α-pentacetyl glucose is produced. This new procedure does not afford crystalline acetyl derivatives of galactose or mannose; but it works well for the acetylation of maltose, difructofuranose anhydride, α-methylglucoside, and polyhydric alcohols such as mannitol, sorbitol, erythritol, arabitol and pentaerythritol.

The method offers a rapid route to the formation of acetobromglucose and acetobrommaltose, inasmuch as the intermediate isolation of the acetylated sugars can be dispensed with and the acetylation reaction mixture treated directly with hydrogen bromide (cf. ref. 3). The advantages offered by this process arise not only from the fact that there is a great saving in time but also that the yields are improved. Thus acetobromglucose and acetobrommaltose, prepared as indicated above, give upon treatment in the usual manner with methyl alcohol in the presence of silver carbonate the corresponding tetracetyl β-methylglucopyranoside and heptacetyl β-methylmaltoside in yields of 55 per cent and 53 per cent respectively. Hitherto yields of 36 per cent and 24 per cent respectively have been recorded for the preparation of these glycosides by methods[6,7] involving the intermediate isolation of the acetates before treatment with hydrogen bromide.

A more detailed account of these experiments will be published elsewhere.

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Paper Chromatography of Flavine Nucleotides

Partition chromatography on paper[1] has not hitherto been reported for the analysis of riboflavine, its nucleotides and derivatives. However, 'Collidine', and a butyl alcohol–acetic acid mixture (shake 4 parts butyl alcohol with 1 part glacial acetic acid and 5 parts water, and use the upper layer), are two very suitable solvents for separating various flavine compounds, identified by their characteristic green fluorescence in ultra-violet light, which will detect as little as 0·01 μgm. flavine on the paper. The separated substances can be easily and quantitatively removed from the paper by the method of Dent[2] and used for enzymic or other experiments.

Approximate R_F values. $\left(R_F = \dfrac{\text{distance moved by substance}}{\text{distance moved by solvent}}\right)$

	'Collidine'	Butyl-acetic
Flavine adenine dinucleotide	0·11	0·02
Riboflavine phosphate	0·09	0·09
Riboflavine	0·5	0·3

About 0·005 ml. aqueous, protein-free and salt-free flavine solution is required for the analysis. The homogenized tissue, flavoprotein, etc., is denatured (by boiling for three minutes, or standing at *p*H 2 and room temperature for five minutes), half its weight of ammonium sulphate added, and the protein precipitate centrifuged off. The free flavine is then concentrated by extraction into liquid phenol, and returned to water by addition of ether to the phenol layer. Since liquid phenol readily extracts proteins (hæmoglobins, cytochrome *c*, diaphorase), it is important to use protein-free solutions. Xanthopterin and leucopterin are also concentrated by this procedure; but their fluorescence on the chromatogram is quite different, and they do not interfere.

Examination of various tissues of the rat and rabbit (heart, brain, kidney, liver) shows only the presence of flavine adenine dinucleotide and some riboflavine phosphate, but no free riboflavine or other flavine derivative. Even after five hours autolysis at 38° C. of homogenized rabbit liver at *p*H 6·8, the flavine it contains is all protein-bound, and no riboflavin is produced. This suggests that there is no true storage of riboflavine as such in rabbit liver. Rabbit spleen homogenate, on the other hand, contains no flavine adenine dinucleotide or riboflavine phosphate, and added flavine adenine dinucleotide is rapidly broken down to riboflavine by an enzyme also present in acetone powder of spleen. This enzyme was also found independently by Comline and Whatley[3] at the same time.

In view of its sensitivity, this method seems very suitable for the analysis of enzyme prosthetic groups.

I would like to thank Dr. M. Dixon for suggesting and encouraging this work, which was supported by a grant from the Medical Research Council.

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Nov. 22.

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[1] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, 38, 224 (1944).

[2] Dent, C. E., *Biochem. J.*, 41, 245 (1947).

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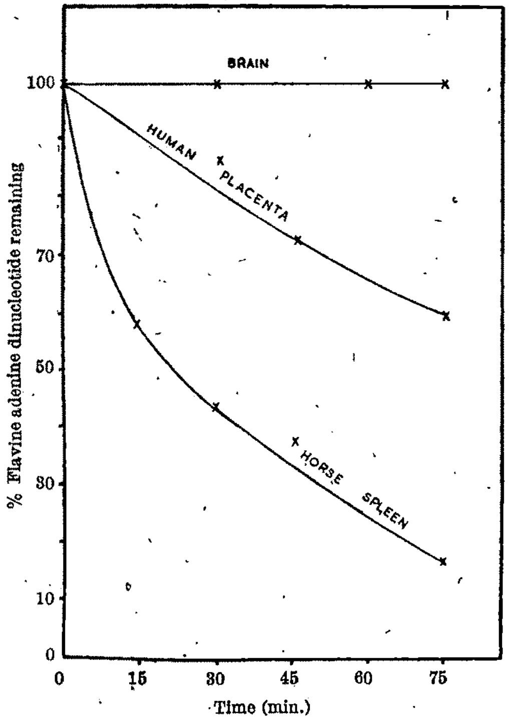
Inactivation of Flavine Adenine Dinucleotide by Tissue Extracts

RECENT experiments[1] on the synthesis of acetylcholine by tissue extracts, especially from acetone-dried brain, human placenta, and horse spleen, have shown that flavine adenine dinucleotide probably plays an essential part. It was found that spleen extracts only formed small amounts of acetylcholine under conditions giving a large synthesis with brain and placental extracts. Saline extracts of acetone-dried spleen, however, were found to contain a powerful inhibitor of acetylcholine synthesis. The effect of the inhibitor, which has the properties of an enzyme, was counteracted by adding large amounts of flavine adenine dinucleotide. This suggests that the inhibitor is an enzyme which breaks down flavine adenine dinucleotide; the action of tissue extracts on the dinucleotide has therefore been investigated in more detail.

Samples of flavine adenine dinucleotide were incubated at 37° C. for varying periods with saline extracts of acetone-dried guinea pig brain, human placenta or horse spleen. The samples were then placed in a boiling water-bath for 45 sec., cooled, and the coagulated protein centrifuged down. The flavine adenine dinucleotide content of the supernatant was estimated with a preparation of *d*-amino-acid oxidase protein from which the prosthetic group (flavine adenine dinucleotide) had been removed[2].



Flavine adenine dinucleotide was rapidly inactivated by spleen and more slowly by placental extracts; in contrast, brain extracts had no effect under the same conditions. This is illustrated in the accompanying graph. The optimum *p*H for the inactivation of the dinucleotide by spleen extracts was found to be about *p*H 7·2. After incubation for 75 min. with spleen extracts, the dinucleotide solutions had no effect on the synthesis of acetylcholine by human placenta.

These results may help to explain why brain extracts, in contrast to placental extracts, do not require a further addition of flavine adenine dinucleotide for maximal synthesis of acetylcholine. Spleen extracts, which rapidly inactivate the dinucleotide, only synthesize acetylcholine to an appreciable extent on the addition of very large amounts of the flavine adenine dinucleotide.

The presence in spleen of an enzyme breaking down flavine adenine dinucleotide was also shown at the same time by Crammer[3], using chromatographic methods.

Extracts of horse spleen did not reduce the oxygen uptake of unsplit *d*-amino oxidase, even after incubation for 1 hr. at 37° C. prior to adding the alanine; in addition, the splenic extracts did not prevent the reactivation of split *d*-amino-acid oxidase protein when added, together with flavine adenine dinucleotide, immediately before measurement of oxygen uptake, provided the spleen and the dinucleotide had not been previously incubated. This indicates that in the amino-acid oxidase system, the dinucleotide is not present to any considerable extent in the free state, but is bound to the oxidase protein.

From results on acetylcholine synthesis, it appears that the activator[4], which is another coenzyme required for this synthesis and which is probably identical with the coenzyme of acetylation[5], is also destroyed by spleen extracts.

These results will be fully described elsewhere. One of us (R. S. C.) has a research grant, and the other (F. R. W.) has a research training grant, from the Agricultural Research Council.

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New Amino-Acids in Bacterial Hydrolysates

As part of the programme in this Laboratory of studying the relation between a bacteriophage and its host organism, analyses have been made of the amino-acid contents of hydrochloric acid and barium hydroxide digests of *E. coli*. The methods used for this have been the partition chromatography of Consdon, Gordon and Martin[1] as modified[2] to yield quantitative results. The following known amino-acids have been identified in these hydrolysates: aspartic and glutamic acids, serine, glycine, alanine, threonine, valine, *iso*leucine, leucine, methionine, tryptophane, phenylalanine, tyrosine, proline, arginine, lysine and histidine. In addition, three weak spots, indicated by the letters *a*, *b*, *c* in Fig. 1, have been noticed which do not correspond to known naturally occurring amino-acids. Spots *b* and *c* have only been visible when concentrated hydrolysates containing *c.* 40 mgm. N/c.c. have been applied to the paper.

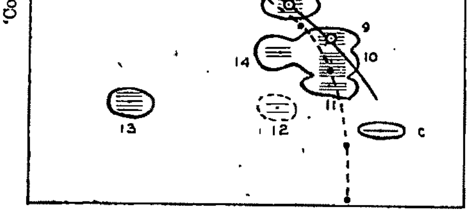

Fig. 1. TWO-DIMENSIONAL CHROMATOGRAM OF A 24-HOUR HYDROCHLORIC ACID DIGEST OF *E. coli* ORGANISMS IN *M* CRESOL + 0·1% AMMONIA AND 'COLLIDINE'

Aspartic acid, 1, glutamic acid, 2, glycine, 3, serine, 4, threonine, 5, alanine, 6, histidine, 7, valine, 8, *iso*leucine, 9, leucine, 10, phenylalanine, 11, tryptophane (present in barium hydroxide digests), 12, tyrosine, 13, methionine, 14, lysine, 15, arginine, 16, and proline, 17. The new amino-acids are *a*, *b* and *c*. The solid circles are the straight-chain amino-acids, and the open circles are the branched-chain compounds

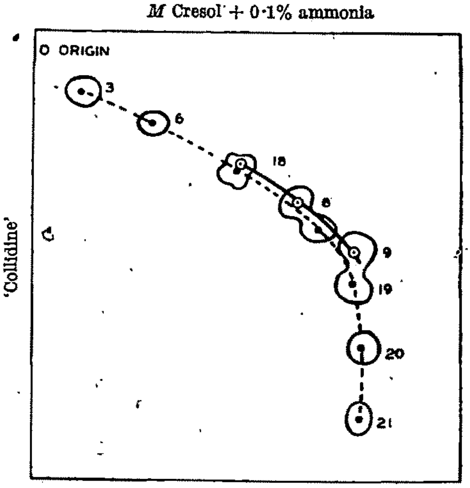

Fig. 2. TWO-DIMENSIONAL CHROMATOGRAM OF A MIXTURE OF ALIPHATIC AMINO-ACIDS

Glycine, 3, alanine, 6, α-amino *iso*butyric acid, 18, valine, 8, *iso*leucine, 9, *nor*leucine, 19, α-amino *n*-heptylic acid, 20, and α-amino *n*-caprylic acid, 21. The solid circle just below 18 is the position of α-amino *n*-butyric acid and the solid circle just below 8 is that of *nor*valine

Since Consdon, Gordon and Martin have shown that chemically related amino-acids occupy certain definite regions on a two-dimensional paper chromatogram, conclusions can be drawn regarding their probable identity. With the pair of solvents *M* cresol + 0·1 per cent ammonia plus a trace of cupron and 'Collidine' used in this work, the acidic, glutamic and aspartic acids occupy a region close to the origin. The basic arginine, lysine and histidine are in the top middle, while the neutral aromatic amino-acids tyrosine, phenylalanine and tryptophane are along the bottom of the chromatogram. Proline is an exception which, because of its high solubility in both organic and watery phase, forms a spot in the region of the bases. The neutral aliphatic amino-acids are regularly distributed. Whatever the pair of solvents employed, the straight-chain homologues of glycine and alanine always fall on a smooth curve. Branched-chain components of this series behave similarly, but their curves are slightly displaced. This is illustrated by Fig. 2, which is a tracing from a two-dimensional chromatogram of an artificial mixture containing the following substances: glycine, alanine, α-amino butyric acid, α-amino *iso*butyric acid, valine, *nor*valine, *iso*leucine, *nor*leucine, α-amino *n*-heptylic acid and α-amino *n*-caprylic acid.

Positions of the unidentified spots relative to the curves of the aliphatic amino-acids suggest that spot *c* may be due to a branched-chain isomer of α-amino *n*-heptylic acid. Spot *a* coincides exactly with that produced by α-amino *n*-butyric acid on a chromatogram of a standard mixture of amino-acids. Spot *b* lies in the region of the bases, but so far has not been identified.

There has been much controversial evidence about the occurrence of α-amino *n*-butyric acid in hydrolysates of proteins. It was reported to occur in alkaline hydrolysates of silk fibroin by Schützenberger and Bourgeois[3], but this was shown to be incorrect by Fischer and Skita[4]. Foreman[5] isolated a compound from casein which he believed to be this amino-acid ; but its melting point was lower than that reported for the synthetic product of Fischer and Mouneyrat[6]. Recently, Dent[7] has found it in the urine, blood and dilute acetic acid extracts of yeast.

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Citric Acid in Semen

The discovery of citric acid in mammalian semen is due to Scherstén[1,2], who was also the first to point out that the acid originates in the accessory glands of reproduction, chiefly the seminal vesicles. In this respect citric acid resembles another more recently discovered component of semen, namely, fructose[3], which has similarly been shown to be secreted mainly in the seminal vesicles[4,5]. The present study was undertaken primarily with the view of investigating the possibility that there may exist a link between the two substances with regard to their formation, distribution or function in reproductive organs and semen. Citric acid was estimated colorimetrically[6,7]. The results were briefly as follows.

(1) Citric acid constitutes a major component of the seminal plasma. With the exception of the rabbit, it is usually absent from epididymal semen. It can be present, however, already in the ampullar semen (bull, ram), although in a much smaller concentration than in the whole ejaculated semen. A high concentration of citric acid in whole semen (mgm./100 ml.) is characteristic for bull (510–1,100), ram (110–260) and rabbit (110–550), all of which are distinguished at the same time by a high level of seminal fructose. It is, however, also present in boar (130) and stallion (55), which have a very low content of seminal fructose. On the whole, there is no correlation between the contents of citric acid and fructose, and the ratio between the two substances can undergo considerable fluctuations, even in the same individual. Occasionally, samples of semen are met with which contain only one but not the other component ; for example on two occasions we had the opportunity of examining samples of fish semen (*Scylliorhinus caniculus* which contained fructose but not citric acid. On th other hand, dog semen seems to be devoid of botl fructose and citric acid.

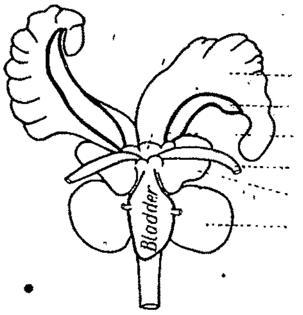
(2) The accessory organs of reproduction are th chief contributors of both seminal fructose and citri acid, yet the two substances can be shown to originat in different parts of the genital system. In rabbit, fo example, citric acid is met with principally in th glans vesicularis and is associated frequently witl the gel formation, whereas fructose is found in th highest concentration in the prostate organ[8]. A even clearer picture was obtained through the stud of the reproductive organs in the rat. The distributio of citric acid and fructose in the various parts o the reproductive system of the male rat is shown i the accompanying sketch, where it can be seen tha citric acid occurs chiefly in the ventral prostate an in the seminal vesicle, whereas fructose is foun mainly in the dorsal prostate and in the 'coagulatin gland', that is, the structure adjacent to the semina vesicle proper.

(3) Following castration, there is a remarkabl fall in the citric acid content of semen. In thi respect, citric acid resembles fructose[9]. However the post-castrate disappearance of citric acid is not s rapid as that of fructose. In rabbit, for example, th decrease may not become noticeable until three week after castration, whereas fructose has usually disappeared almost completely by the end of the secon week. Similarly, the reappearance of citric acid i response to testosterone usually follows some tim after seminal fructose.

(4) When fresh semen is incubated *in vitro*, citri acid disappears. The rate of disappearance, however is much lower than that of fructose. In bull an ram semen, for example, the rate of fructolysis[10] a 37° C. is 1·5–2 mgm. fructose/10^9 sperm cells/1 hour as compared with some 0·05 mgm. citric acid. Moreover, the rate at which spermatozoa metaboliz fructose is not affected by the presence of citrate On the other hand, the process of 'citricolysis' although very slow, may continue in semen for som time after the spermatozoa have exhausted the entir reserve of seminal fructose, that is, after the 'fructolysis' has come to an end.

(5) The observation has been confirmed tha mammalian spermatozoa contain aconitase and tha they are able to synthesize citric acid from oxaloacetic acid[11]. However, the bulk of the citric aci present in whole ejaculated semen is derived fro the seminal plasma and not from the spermatozoa It can be removed by centrifuging the seme and by washing the spermatozoa with Ringe solution. Citrate added to washed ram spermatozoa is incapable of maintainin the sperm respiration. In thi respect it differs from fructose a well as from many organic acid such as lactic, pyruvic, oxaloacetic acetic, propionic and butyric, al of which can maintain and prolong the respiration of washe spermatozoa.

This work has been carrie out on behalf of the Agricultura Research Council. We wish t acknowledge help and advice fro Prof. D. Keilin, Mr. J. Burkhardt



	Weight of organ (mgm.)	Citric acid (mgm./100 gm. tissue)	Fructose (mgm./100 gm. tissue)
Seminal vesicles	780	39	9
Coagulating glands	130	0	172
Median prostate	20	60	90
Ampullæ vas. def.	70	0	10
Dorsal prostate	250	20	82
Ventral prostate	320	122	0

The ultra-filtrate containing the inhibitors was divided into two portions, and carbon dioxide was passed through one of them. Equal amounts of the above two samples of the ultra-filtrate were added to two equal portions of the same enzyme solution, and it was found that the enzyme solution to which ultra-filtrate treated with carbon dioxide was added had a higher activity than the one treated with ultra-filtrate alone.

This clearly shows that carbon dioxide in some way neutralizes the action of inhibitors which are formed during the period of storage, thereby increasing the prothrombin activity of reversibly inactivated plasma.

In the accompanying table are presented the results of a typical experiment, using the same sample of plasma.

Treatment	Prothrombin activity (coagulation time)
Bovine plasma (fresh)	15 sec.
Bovine plasma (reversibly inactivated on storage) Before passing carbon dioxide	30 ,,
Bovine plasma (reversibly inactivated on storage) After passing carbon dioxide	15 ,,
Reversibly inactivated plasma (before ultra-filtration)	30 sec.
Ultra-filtered plasma	18 ,,
,, ,, + CO_2	17 ,,
,, ,, + ultra-filtrate	40 ,,
,, ,, ,, + CO_2	24 ,,

Our thanks are due to Prof. V. Subrahmanyan for his interest in this investigation.

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Ovarian Activity in the Pregnant Mare

OVARIAN activity in the mare in early pregnancy presents some unusual features which are inconsistent with the accepted normal behaviour of the mammalian gonad during gestation. In the first place, the corpus luteum of pregnancy is very short-lived, and unlike that of most other mammals its period of activity would not seem to be prolonged much in excess of that of the œstrous cycle of the non-pregnant animal. Harrison[1] has observed that the corpus luteum of pregnancy completely fills the cavity of the ruptured follicle in four to six days and attains maximum size by the tenth to fourteenth day. Regression is stated[2] to occur at about the end of the first month. Secondly, follicular development is a common feature of ovarian activity at this time, and Day[3] has observed the occurrence of ovulation in a mare on the twenty-third day of pregnancy. Ovarian activity reaches its peak during the second and third month of pregnancy, when gonadotrophic hormone is abundant in the blood.

Ovulation of the many Graafian follicles which are brought to maturity by these hormonal means was recently doubted[4], but a more extensive search has now shown that it occurs in a high proportion of pregnant mares. To date we have recovered one or more ova from the Fallopian tubes of nine of fourteen mares which have been examined post-mortem when 46–73 days in foal. The ovaries of all these fourteen mares contained one or more fully formed corpora lutea; but in none, with the possible exception of one mare examined on the 46th day, could the primary corpus luteum of pregnancy be recognized. It is highly probable that during this stage of pregnancy a succession of follicles ovulate, from which corpora lutea are rapidly formed to maintain gestational requirements. Of the nine mares from which ova were recovered, ovulation had occurred in five from the right, in two from the left, and in the remaining two from both left and right ovaries. In all, fifteen ova were recovered, nine from the right and six from the left Fallopian tubes; three of the latter were found in one tube. The corpora lutea of the whole series were distributed in a proportion of 22 to 18 between the left and right ovaries. There is no reason, therefore, to suppose that the frequency of ovulation between the two ovaries is dissimilar.

Our observations on ovulation during the œstrous cycle, however, show that it occurred more frequently in the left ovary, and our findings are in close agreement with the extensive data of Kedrov[5]. We have palpated per rectum 24 mares during 45 cycles and have observed that of 36 single ovulations 22 occurred in the left and 14 in the right ovaries, and that of 9 twin ovulations 4 took place in the left ovary and the remaining 5 involved both ovaries. This greater activity of the left ovary is of interest especially in view of Kedrov's findings that implantation occurs more frequently in the right horn of the uterus. Last summer we examined, either post-mortem or by rectal palpation, the uteri of fifteen mares carrying single pregnancies, of which thirteen were implanted in the right horn. Only in four of these thirteen mares could we be certain that ovulation at the time of mating occurred in the right ovary alone. In another eight it was established that ovulation took place only in the left ovary. We have encountered twin pregnancy in five mares; in two of them the ovulation of two follicles was recognized, at the time of mating, as having occurred in the left ovary. Fœtal migration occurred in both mares; in one, a fœtus had become implanted in each horn, and in the other the right horn contained both conceptuses. In this small series of twenty pregnancies, fœtal migration had occurred in ten mares, the direction of the migration being in all instances from left to right. A high incidence of fœtal migration was reported by Day, but, unlike us, he observed its occurrence in both directions within the uterus.

We have undertaken preliminary investigations on the fertilizability of the ova which are discharged from the ovaries in early pregnancy with the ultimate object of inducing a second concurrent pregnancy and observing the course of secretion of gonadotrophin into the blood. Two pregnant mares in which mature follicles were palpable were injected intravenously with 1,500 I.U. of chorionic gonadotrophin and inseminated artificially with 20 ml. of stallion semen. They were examined four days later after they had been bled to death under anæsthesia. One was found to have aborted a twin pregnancy and no ovum was recovered from the Fallopian tubes. The other, which at the time of injection and insemination was about to ovulate from the left ovary and was pregnant in the right uterus, had not aborted; ovulation had occurred but the ovum recovered from the left tube had not been fertilized. Failure to effect fertilization in the latter mare is ascribed to the existence of a mechanical barrier to sperm migration presented by a non-patent cervix or by an encroachment of the fœtal sac into the non-gravid left uterine horn. It is hoped to exclude the latter possibility by repeating this experiment at an earlier stage in pregnancy.

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Bile Acids of the Whale

As part of a general investigation into the nature of the 'bile salts' of vertebrates, we have examined the bile of a whale. So far as we know, no work on the 'bile salts' of cetaceans has previously been done. Through the kindness of Dr. M. Begg, of "Discovery" Investigations, we obtained bile from the fin whale (*Balænoptera physalus*): 3,000 ml. bile were collected from either the duodenum or the 'third stomach' of a single whale, and preserved with alcohol. The main biliary constituent has been found to be cholic acid, conjugated, apparently, chiefly with taurine. The chief 'bile salt' in this animal therefore resembles that of the teleostean fish, snakes and the majority of mammals so far investigated.

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Production of Helium by Cosmic Rays

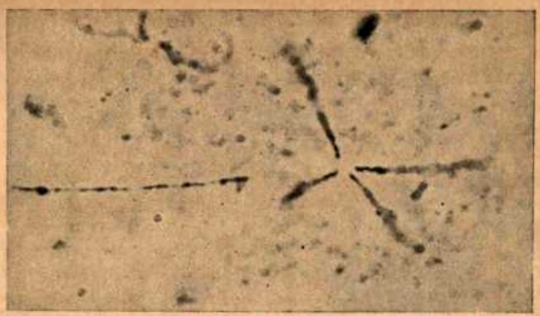
IN a recent experiment, a packet of Ilford's nuclear research plates (type $C2$) was exposed to cosmic rays for a period of six weeks at the summit of Mont aux Sources (11,000 ft.), Basutoland.

A preliminary examination of these plates has revealed several features of interest; the present communication, however, is concerned with one only of these, namely, the large number of nuclear disintegrations which occurred in the glass bases of the plates. These disintegrations become evident, of course, only when the product particles cross the glass surface and enter the emulsion. They then give rise either to a single track or to a 'star', which differs from a star originating in the emulsion in that its rays do not actually meet. The accompanying photomicrograph illustrates this.

The following classification summarizes observations over 4 sq. cm. of one of the plates. No disintegration is included which originates at a greater depth in the glass than 20 microns.

	2 rays	3 rays	4 rays	5 rays	Total
Number of stars	44	55	18	5	122

This is equivalent to a minimum of 15,000 disintegrations per c.c. of the glass. The great majority of the tracks appear to be due to α-particles, but if the conservative estimate of one α-particle per disintegration is allowed, the conclusion is that helium is produced in the glass at the rate of at least 10^5 atoms per c.c. per annum.



DISINTEGRATION OF A NUCLEUS WITHIN THE GLASS BASE OF THE PHOTOGRAPHIC PLATE. COOKE × 95 IMMERSION OBJECTIVE FOCUSED ON THE GLASS/EMULSION SURFACE

The chemical composition of the glass (by courtesy of Messrs. Ilford, Ltd.), excluding substances present in amounts of less than 1 per cent, is: SiO_2, 72; Na_2O, 14; CaO, 9; MgO, 3 per cent. Now these five elements, constituting 98 per cent of the glass, are among the most abundant and most widespread in the lithosphere. Oxygen, the most plentiful, accounts for 47 per cent of the earth's crust; silicon is next in order, with 28 per cent; calcium and sodium, fifth and sixth, with 4 and 3 per cent; magnesium, 2 per cent.

Rayleigh found that helium is present in almost all minerals. Its ubiquity has usually been ascribed solely to the presence of radioactive minerals throughout the earth's crust. The experimental results referred to above appear to indicate, however, that cosmic radiation may be responsible, first, for some part of the helium occluded in rocks, and secondly, for its widespread occurrence.

Estimates of the age of rocks and of meteorites obtained from measurements of the volume of helium occluded in them are based on the assumption that the helium is derived from radioactive minerals. If, however, cosmic radiation is also responsible for the production of measurable quantities of helium, then these estimates would appear to be unreliable in cases where the amount of helium is small. An example may illustrate this. The age of the Bethany meteorite[1] has been calculated as 100 million years on the basis of an analysis showing a helium content[2] (of radioactive origin) of 4×10^{-5} c.c. per 100 gm. But a short calculation shows that the helium produced by cosmic rays in the soda glass used in the Mont aux Sources experiment would amount to at least 2×10^{-5} c.c. per 100 gm. in the same geological period.

The estimate of the age of rocks by the helium method has always been reckoned to yield a minimum figure since helium diffuses so readily. If, however, a part of the occluded helium has been produced by cosmic rays, this 'minimum' will, in certain cases, need to be reduced.

My thanks are due to Prof. G. T. R. Evans, head of the Physics Department, for his personal interest in this research.

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Nov. 18.

[1] Prior's Catalogue, p. 17.

[2] Holmes, A., "Physics of the Earth", 423.

Phase-Contrast in Polarized Light

In a recent communication, Hartley[1] indicated a simple arrangement for realizing phase-contrast in polarized light. It consisted of a quarter-wave plate cut in two and reassembled after 90° rotation, so that the dioptric rays and the diffracted rays, crossing respectively the two parts of the plate, are changed in phase with respect to each other. This same method was indicated by one of us[2] at the international conference of the Institut d'Optique, Paris, held in October 1946, and its efficiency has been tested since by experiment. We tested also another design which has the advantage of giving the exact phase-change needed and independently permits the weakening of the dioptric rays in a continuous manner so that it can be adjusted to optimum intensity. (In the last paragraph of his letter in *Nature*, Hartley indicated a modification of his design in order to obtain also the weakening of the dioptric rays; in doing so, however, the correct phase retardation given by his first arrangement is lost.)

Our system is based on the following principle. The incident light is polarized by a 'Polaroid' screen before crossing the object. In the conjugate plane of the light source (which was a rectilinear slit in our experiment but which could have any other form, like a ring) there is a half-wave plate followed by a quarter-wave plate. The half-wave plate is cut into three, and the part to be crossed by the dioptric rays is rotated 45° to the rest of the surface (Fig. 1). In this manner the diffracted rays, and the dioptric rays after crossing this composite plate, have their vibrations oriented at right angles to each other, without any modification in phase. In crossing the quarter-wave plate placed behind, the convenient phase change between them is then obtained. The analyser (another 'Polaroid' screen) isolates the vibration components parallel to its principal direction[3].

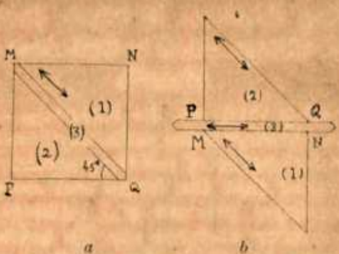

Fig. 1. (*a*) PLATE IS CUT INTO THREE PORTIONS, 1, 2, 3. (*b*) PORTION 3 IS TURNED THROUGH 45° AND INSERTED BETWEEN 1 AND 2

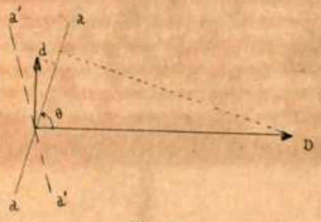

Fig. 2

Let D be the amplitude of the vibration in the dioptric rays, d that in the diffracted rays (Fig. 2) and θ the angle between the principal direction of polarizer (also the direction of vector D) and analyser. If $\theta = 90°$, the dioptric rays are suppressed and the system is equivalent to dark-ground illumination. If θ is less than 90° (position $a - a$ of the analyser) the resultant vibration will be: $D \cos \theta + d \sin \theta$, and the diffracted amplitude will add its effects to the dioptric amplitude. The system gives positive phase-contrast. If θ is greater than 90° (position $a' - a'$ of the analyser) the resultant vibration will be $D \cos \theta - d \sin \theta$ and the diffracted amplitude will be subtracted from the dioptric amplitude. We have negative phase-contrast. By rotating the analyser we can obtain zero intensity for $\cot \theta = d/D = \tan \varphi$.

If the diffracted light is produced by a small elevation of the object surface, the optical height z of this elevation will be given by the formula

$$z/\lambda = \frac{\varphi}{2\pi},$$

provided that $\varphi = \pi/2 - \theta$ remains a small angle.

In Fig. 3 are reproduced photographs taken for the three cases mentioned; the object is a piece of plain glass on which appears a line of transparent varnish $(1-1)$ and, crossing it, a small furrow made by a diamond point $(2-2)$. The composite half-wave plate used was cut in a fine 'Cellophane' sheet and imbedded in Canada balsam between optically flat glass plates. The quarter-wave plate was an ordinary $\lambda/4$ mica plate. The photographs were taken in monochromatic light (mercury 5461 A.).

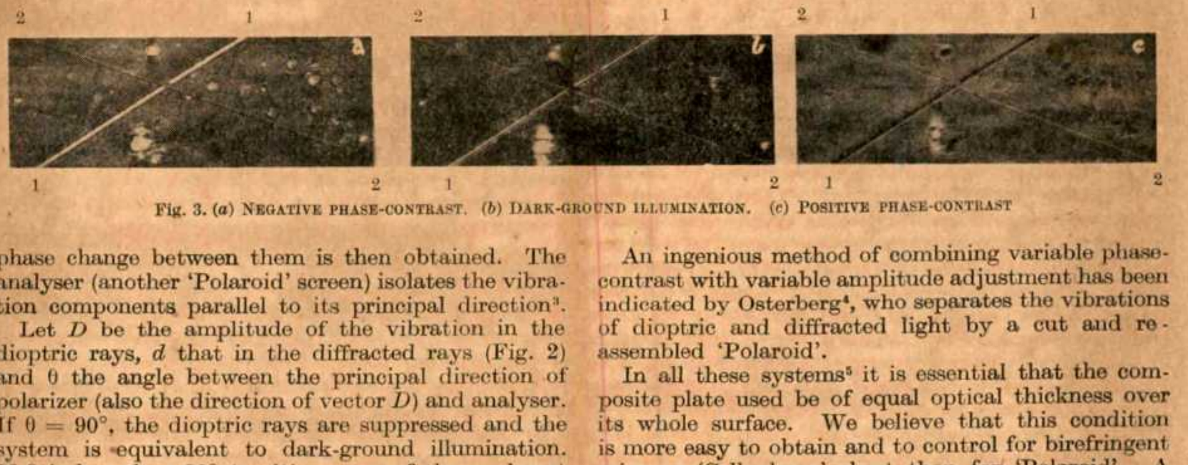

Fig. 3. (*a*) NEGATIVE PHASE-CONTRAST. (*b*) DARK-GROUND ILLUMINATION. (*c*) POSITIVE PHASE-CONTRAST

An ingenious method of combining variable phase-contrast with variable amplitude adjustment has been indicated by Osterberg[4], who separates the vibrations of dioptric and diffracted light by a cut and reassembled 'Polaroid'.

In all these systems[5] it is essential that the composite plate used be of equal optical thickness over its whole surface. We believe that this condition is more easy to obtain and to control for birefringent mica or 'Cellophane' sheet than for 'Polaroid'. A variable change of phase could be achieved in our design by replacing the quarter-wave plate by a Bravais compensator.

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Oct. 17.

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[1] Hartley, W. G., *Nature*, **159**, 880 (1947).

[2] Kastler, A., communication at the Colloque sur les Images Optiques, Paris, October 1946, *Revue d'Optique* (in the press).

[3] French Patent No. 534,779, May 17, 1947.

[4] Osterberg, H., *Opt. Soc. Amer.*, **36**, 710 (1946).

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Recording Crevices in Plane Surfaces by Pigment-fillings Held in Cellulose Acetate Moulds

In extending work on the recording of low relief in etched or abraded plane surfaces of rocks, minerals and metals by means of cellulose acetate moulds[1], it has been found that the forms and distributions of narrow structural crevices and microscopic pits in these and similar surfaces can be accentuated, for detailed study, by filling them with a suitable pigment which is then removed by, and retained in, the thin cellulose acetate moulds made from these prepared surfaces (Fig. 1). For this purpose a dispersion of cellulose acetate in tetrachloroethane is convenient. Addition of an appropriate plasticizer to the dispersion minimizes the development with time of very slight shrinkage and brittleness in the resulting moulds.

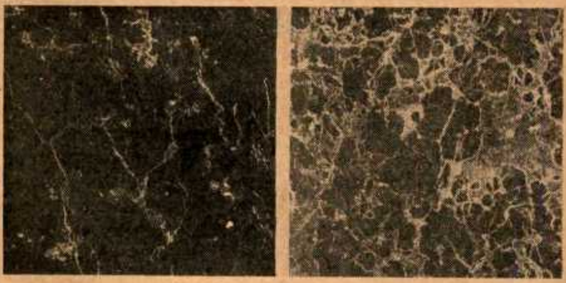

Fig. 1 Fig. 2

PHOTOGRAPHIC ENLARGEMENT (× 5/3) OF DYE-LINES ACCENTUATING 'RIFT' IN THE POLISHED SURFACE OF A GRANITE (FIG. 1) AND IRON OXIDE-AREAS EMPHASIZING CREVICES IN THE CRYSTAL FABRIC OF A POLISHED AND ETCHED IRON ORE (FIG. 2).

Each print was made from a cellulose acetate mould, thickness 0·08 mm., used in an enlarger as a 'negative' and employing Kodak *B.G.*-4 paper exposed to a 60-watt lamp for 15 sec. at *f* 8 for Fig. 1 and *f* 6·3 for Fig. 2.

This pigmentation method, foreshadowed in a previous communication[2], is distinct from the dyed resin impregnation technique of Dr. B. H. Knight. It is suitable for recording such features as rift and grain in granites, cleat in coals, inter-crystal fissures in well-crystallized rocks or metallic ores, and traces of cleavages, glide-planes, twin-boundaries or small shallow etch-pits in the surfaces of individual mineral crystals. Further, it may prove to be useful in studies of crazing on glazed pottery and the crystal fabrics of certain alloys. Experiments suggest the most satisfactory records obtained by this method are derived from crevices or pits varying in width between 1 μ and 10 μ.

The pigment can be a solid dye, such as 'Soluble Blue 3*M*' or lampblack, or a liquid such as Indian ink. If a powdered pigment is used, the etched surface is cleaned and sprinkled with either finely divided dye or lampblack, which is then introduced into the crevices with the ball of the thumb, or a pad of soft cloth. If Indian ink is employed, on the other hand, it is washed over the cleaned surface with a camel-hair brush, and the excess removed, after a moment, with a pad of absorbent cloth ; the use of cotton-wool is inadvisable as it tends to sweep cotton fibres into some of the surface crevices. Whether solid or liquid pigment is used initially, a careful rotary polishing movement with a suitable cloth removes it from the surface, while leaving it undisturbed in the crevices. The surface is then ready to receive the necessary thin layer of dispersion from which a pigmented cellulose acetate mould solidifies.

It is noteworthy that no significant spreading of pigment takes place in the dispersion-layer provided (*a*) the pigment used is not soluble in tetrachloroethane and (*b*) the dispersion-layer is thin. In connexion with (*a*), lampblack is a convenient pigment, apart from its relative chemical stability and its opacity in thin layers.

'Automatic' pigmentation of polished and etched surfaces of certain iron ores and iron-bearing meteorites[2] can be developed by exposing them to moist air for such a time that they become covered with thin films of hydrated iron oxides which can then be stripped from these surfaces in cellulose acetate moulds. By this means the forms and distributions of narrow fissures in the surfaces are recorded either as unpigmented bands, or as dark red-brown lines cutting the lighter brown limonite-bearing areas of the moulds (Fig. 2). Equivalent pigmentation can be obtained by developing thin films of copper carbonates on the polished and etched surfaces of some copper ores.

Finally, direct comparisons can be made between any pair of pigment patterns by superposing the necessary cellulose acetate moulds on an illuminated tracing desk, or by projecting them in a lantern or epidiascope, while photographic prints of any of the patterns can be made with ease by using the corresponding mould in the role of a photographic negative.

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[1] Dollar, A. T. J., *Geol. Mag.*, **79**, No. 4, 253 (1942).

[2] Dollar, A. T. J., *Nature*, **152**, 248 (1943).

Photometric Measurement of Specific Surface

In the course of measurements of the light transmission of dispersions of fine alumina powder in aqueous media, it has been found in these Laboratories that the effective projected area per unit weight of the powder gives a fairly good straight line of negative slope when plotted against the fourth power of the wave-length of the incident light. The projected areas were calculated from the usual formula :

$$A = \frac{\log_e I_0/I}{KCt},$$

where A is effective projected area ; I_0 is intensity of incident light ; I is intensity of emergent light ; K is opacity factor of powder ; C is concentration of powder by weight per unit volume ; and t is path-length.

The measurements were made over the visible range with a photo-electric apparatus having a very low angle of acceptance (about 0·0001 ster radian), the opacity factor of the powder being assumed equal to unity. Extrapolation of the graph of A against wave-length to cut the axis of A yields a value of the projected area, A_0, for which the wave-length is very small compared with the particle size. In such cases it has been shown by Sinclair[1] that the effective projected area is equal to twice the geometric projected area A_G owing to diffraction and scattering.

The specific surface of particles in random motion is usually considered to be equal to $4A_G$, 4 being the ratio of surface to projected area for a sphere. However, the crystals of calcined alpha-alumina may to a first approximation be considered as flat rectangular plates, and hydrated alumina crystals are roughly cubical. It can be shown that the ratio of surface to projected area for a rectangular parallelopiped in random motion is $18\pi/(8 + \pi)$ independent of the relative lengths of the axes, that is, whether the particle is flat, cubical or elongated. If this factor is used to compute the specific surface of calcined and hydrated alumina from the values of A_0 ($= 2A_G$) found by graphical extrapolation, very good agreement over a wide range of samples is obtained with other estimates of the specific surface from air-permeability, sedimentation, and microscope data, if allowance is made for the flat shape of the calcined alumina crystals in the last two instances.

It thus appears that this method, which is rapid and economical of sample material, is capable of giving a good estimate of the specific surface of alumina powders over a wide range of values (1,000–40,000 cm.^{2}/gm.), and may find application to other transparent crystalline materials. The extrapolation method of evaluating A_0 seems to overcome the difficulty due to unknown variations in opacity factor with particle size.

If the Hilger Spekker absorptiometer, having a relatively large angle of acceptance, is employed for the measurement, the value of the specific surface has been found to be approximately $4A_0$, instead of $2{\cdot}55A_0$. This result is no doubt fortuitous, and may be ascribed to the fact that some of the light refracted or scattered out of the parallel beam by the particles is still capable of striking the sensitive surface of the photocell, thereby reducing the estimate of A_0.

It is hoped to publish a more detailed account of this work at a later date.

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[1] *J. Opt. Soc. Amer.*, 37, (6), 475 (1947).

Luminescence Efficiency Changes in Zinc Sulphide Phosphors Below Room Temperature

At temperatures below those at which thermal quenching of luminescence occurs in zinc sulphide phosphors (as shown by the higher temperature forms of the curves of Fig. 1), there is often a slow temperature variation of the luminescence efficiency. The sign of the temperature coefficient of this variation may be positive or negative, being dependent on the wave-length of the exciting radiation. Typical efficiency temperature curves for a self-activated zinc sulphide phosphor are given in Fig. 1 for different excitation wave-lengths. This behaviour has been previously observed by Schön[1], and recently Williams and Eyring[2] have attempted to explain it in terms of the intrinsic luminescence centre configurations. Their treatment gives a slow rise in efficiency with temperature, of an exponential form for longer wave-length excitation; but it cannot explain the fall in efficiency with temperature at shorter wave-lengths.

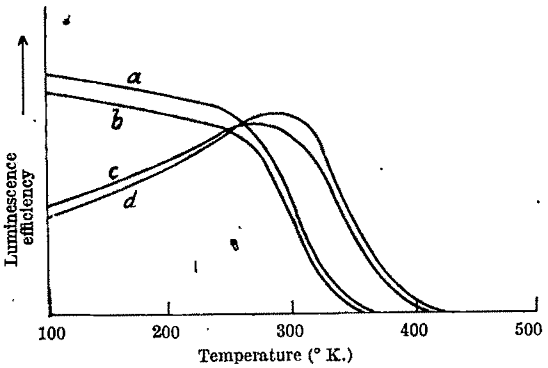

Fig. 1. LUMINESCENCE EFFICIENCY *vs.* TEMPERATURE VARIATION FOR ZnS–Zn PHOSPHOR. λ_{exc} FOR THE FOUR CURVES ARE: (*a*) 2537 A.; (*b*) 3132 A.; (*c*) 3653 A.; (*d*) 4043 A.

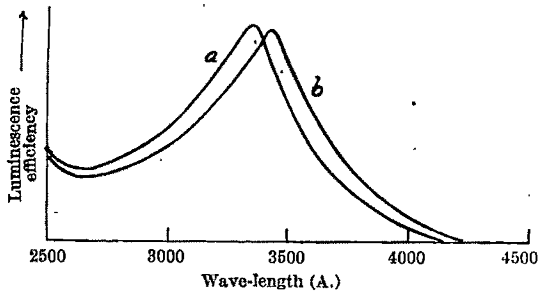

Fig. 2. EXCITATION SPECTRUM OF ZnS–Zn PHOSPHOR AT (*a*) 90° K., (*b*) 230° K.

We have made measurements of the excitation spectra, that is, the variation of efficiency of luminescence excitation with wave-length of the exciting radiation, of various specimens of zinc sulphide phosphors. In particular, studies of the change in these spectra with temperature have been made. Spectra measured at two different temperatures for a typical self-activated zinc sulphide phosphor are shown in Fig. 2. By comparison of the curves of Figs. 1 and 2, it is found that the temperature shift of the excitation spectra (Fig. 2) can account for the slow rise or fall of luminescence efficiency over the same temperature range at various wave-lengths (Fig. 1). We have measured the temperature shift in A./° K. of the excitation spectra of typical phosphors and find that it is the same as the temperature coefficient for the absorption edge shift in these phosphor types as measured by Gisolf[3]. A theoretical study due to Möglich and Rompe[4] has shown that the absorption edge shift with temperature agrees with that expected from the known thermal expansion of the phosphor crystal lattice.

The accompanying table gives a comparison of values for temperature coefficients of the absorption edge shift measured by Gisolf, and the shift of the excitation spectra from our measurements between 90° K. and 290° K.

		Temperature coefficients.
Phosphor	Absorption edge shift (Gisolf)	Excitation spectrum shift (our measurements)
ZnS–Cu	0·425 A./° K.	0·5 ± 0·05 A./° K.
ZnS–Ag	0·45 A./° K.	0·5 ± 0·05 A./° K.
ZnS–Zn	—	0·5 ± 0·05 A./° K.

It is concluded from the above experimental studies that the thermal expansion of the phosphor crystal lattice and its effect on the impurity centres responsible for emission, which are dispersed in the lattice, can cause the above efficiency versus temperature variations and their changes with wave-length of exciting radiation.

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[2] Williams, F. E., and Eyring, H., *J. Chem. Phys.*, 15, 289 (1947).

[3] Gisolf, J. H., unpublished work (1938) quoted in ref. 4.

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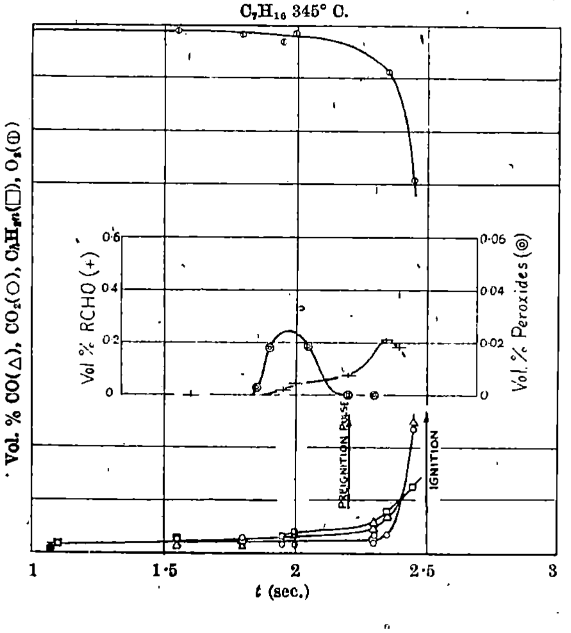
'Low-Temperature' Oxidation of Higher Hydrocarbons at Atmospheric Pressure

RECENTLY, we carried out ignition experiments in a Moore-type apparatus. Working between 300° and 500° C. at atmospheric pressure, we investigated the behaviour of *n*-heptane and an *n*-heptane–benzene mixture (50/50 by vol.).

With *n*-heptane, ignition was found to be preceded by a 'pre-ignition pulse'. The pulse could be observed by the expulsion of vapours from the apparatus or registered on a manometer connected to the apparatus. Three temperature regions could be distinguished. (1) Above 400° C., the delay between pulse and ignition was too short to be measured, so that ignition occurred apparently by a single-stage mechanism. (2) Between 316° and 400° C., the pre-ignition pulse was followed after a measurable time-interval by ignition. We measured both the time interval, τ_1, between the start of the reaction and the pre-ignition pulse, and the time interval, τ_2, between the pulse and ignition. In agreement with the observation of Sokolik and Jantovski[1], τ_1 decreased continuously with increasing temperature, while τ_2 passed first through a minimum and then through a maximum. (3) Below 316° C., no ignition could be observed, yet the pulse still occurred, down to a temperature of about 300° C., τ_1 increasing with decreasing temperature.

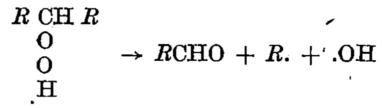
With the *n*-heptane–benzene mixture, again three temperature regions were observed: (1) above 425° C., ignition occurred apparently by a single-stage mechanism; (2) between 370° and 425° C. only slow oxidation occurred, without any physical manifestation such as a pressure pulse or ignition; (3) between 305° and 370° C. the pressure pulse occurred, without being followed by ignition. Only at 340° C. and pressures slightly higher than atmospheric was the pulse followed by ignition.

We collected gas samples corresponding to different stages of the reaction. The samples were analysed for oxygen, carbon monoxide and dioxide, unsaturated hydrocarbons, peroxides, aldehydes and oxides of nitrogen. The peroxides were determined with acid potassium iodide, sensitized with ammonium molybdate. Ferrous sulphate was ineffective as sensitizer. This leads us to the conclusion that the peroxides determined were of the alkyl hydrogen type[2], and probably secondary alkyl hydrogen peroxides. The concentration of oxides of nitrogen found was about 1 per cent of the concentration of peroxides, so that the measured value of the latter could be only slightly affected by the amount of nitrogen dioxide present.



A typical set of results, obtained for *n*-heptane at 345° C., is reproduced in the accompanying graph. Generally, we found that a peroxide maximum was followed by an aldehyde maximum, thus establishing the fact that aldehydes are products of the decomposition of peroxides. We found, further, that the pre-ignition pulse coincided with a decline of the concentration of peroxides.

We examined the experimental material in the light of existing theories. In agreement with the views expressed by Walsh[3], we concluded that initiation occurred through the formation of secondary alkyl radicals, leading to secondary alkyl hydrogen peroxide radicals and to secondary alkyl hydrogen peroxides. Decomposition of the latter according to



$$\begin{array}{c} R\,\mathrm{CH}\,R \\ \mathrm{O} \\ \mathrm{O} \\ \mathrm{H} \end{array} \rightarrow R\mathrm{CHO} + R. + .\mathrm{OH} \qquad (1)$$

seems to agree with the magnitude of the pressure pulse registered on the manometer.

The mechanism of the chain reactions following the pressure pulse is still a matter of conjecture, since no intermediate products have so far been isolated. We concluded that a combination of the reaction schemes proposed by Lewis and von Elbe[4] and by Ubbelohde[5] may present a reasonable explanation. At high temperatures, degradation reactions may prevail, RCHO decomposing according to the scheme proposed by Lewis and von Elbe, and $R^{\cdot}$, after peroxide formation, according to the scheme proposed by Ubbelohde. At lower temperatures, oxydialkyl peroxides may be formed, the decomposition of which leads to a branching reaction[4]. The tendency to follow slower degradation reactions at higher temperatures, as opposed to branching reactions at lower temperatures, would thus be responsible for the negative temperature coefficient of the overall reaction in the 'low-temperature' region.

Recently, Walsh[6] severely criticized the reaction schemes proposed by Lewis and von Elbe. The decomposition of secondary alkyl hydrogen peroxides is said to be responsible for the branching reaction, while the instability of the peroxide radical explains the negative temperature coefficient of the reaction. The evidence which we obtained during our experiments does not support this theory. At 316° C. with *n*-heptane we found a secondary alkyl hydrogen peroxide maximum, the decline of which was associated with a pressure pulse, yet no ignition (that is, a branching reaction) occurred at this temperature. We also found, for example, that the addition of tetraethyl lead to *n*-heptane did not suppress the formation of secondary alkyl hydrogen peroxides and the pressure pulses, but prevented ignition at temperatures at which it would normally occur with pure *n*-heptane.

It seems, therefore, that the chain reactions which follow the decomposition of the secondary alkyl hydrogen peroxides in the 'low-temperature' region still await a reasonable explanation.

A full account of our work will be published elsewhere.

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[1] Sokolik, A., and Jantovski, S., *Acta Phys. chim. U.S.S.R.*, 19, 329 (1944).

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[3] Walsh, A. D., *Trans. Farad. Soc.*, 42, 269 (1946).

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Economy in Cell Counts

It is often necessary in clinical work to determine the relative abundance of two or more species of cells. Examples are counts of the percentage of atypical cells, such as reticulocytes, siderocytes or punctate basophilia, in the blood erythrocytes. In these cases the required result, F, is a fraction. If P and Q are the numbers counted of the two types of cell, $F = P/(P + Q)$. In other estimations, such as the 'platelet ratio', or the proportion of megakaryocytes to nucleated white cells in a marrow smear, the required result is a ratio, $R = P/Q$. F cannot exceed unity, while R may have any numerical value.

The frequencies of the two species of cells are often widely different, making it necessary to count thousands of the common type to include a moderate number of the rarer. The questions arise, Can one save time and labour by counting the abundant cells in a fraction $1/a$ of the area sampled for the rarer type? What would be the precision of a value of F or R so obtained? And what are the best values of P and Q to secure a desired precision with a minimum amount of counting?

There are various algebraically equivalent formulæ for the standard deviation of a ratio or a fraction. The forms most useful for the present purpose are

$$\frac{\text{Standard deviation of } R}{R} = \sqrt{\frac{1}{P} + \frac{1}{Q}} \quad . \quad (1)$$

$$\frac{\text{Standard deviation of } F}{F\,(1 - F)} = \sqrt{\frac{1}{P} + \frac{1}{Q}} \quad . \quad (2)$$

Now it can be shown that when P and Q are sampled on different scales, so that $R = P/aQ$ or aP/Q, and $F = P/(P + aQ)$ or $aP/(aP + Q)$, formulæ 1 and 2 are still true and applicable. It can further be proved that, for any given value of the standard deviation, the number of cells required to be counted is a minimum when $P = Q$. Hence the simple practical rule: choose that value of $1/a$ which will make the counts of the two kinds of cell as near equality as possible.

It is easy to see the commonsense justification of this rule. There is no point in laboriously measuring Q to an accuracy of 1 in 1,000 when P is accurate only to within 1 in 10.

When there is a big disparity in the frequencies of the two kinds of cell, the time saved by this method of 'balanced sampling' is very great. For example, in blood containing 2 siderocytes per 1,000 red corpuscles, a count of 80 cells by balanced sampling will give an answer as precise as a direct count of 10,000 cells. In general, if a is chosen to make $P = Q$, the total number of cells to be counted in balanced sampling is the fraction $4a/(a + 1)^2$ of the number needed in a direct count, for the same precision of estimate.

This method has the further advantage that a count of a given size always yields an estimate with approximately the same relative precision. One can therefore work out once and for all the numbers to be counted for any desired limits of significance, and choose the appropriate size of count for each particular purpose. There will then be no need to calculate standard deviations and significances of differences separately for each estimate.

I am publishing elsewhere a full account, giving details of the practical use of the method in cell counting. It is obvious that balanced sampling has many other uses. The technique here described is a special application of a general theory of weighted and stratified sampling, to be published elsewhere.

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Empirical Data on Hilbert's Inequality

It is known that

$$\sum_{1}^{\infty}\sum_{1}^{\infty} \frac{a_r a_s}{r + s - 1} \leqslant \pi \sum_{1}^{\infty} a_r^2,$$

π being the best possible constant, and it has recently been shown by H. Frazer[1] that

$$\sum_{1}^{N}\sum_{1}^{N} \frac{a_r a_s}{r + s - 1} \leqslant \left(N \sin \frac{\pi}{N}\right) \sum_{1}^{N} a_r^2.$$

Frazer's result, however, is not the best possible, as may be seen from the numerical data below, in which λ is the maximum value of

$$\sum_{1}^{N}\sum_{1}^{N} \frac{a_r a_s}{r + s - 1}$$

for a normalized vector a_r. We are indebted to the Royal Aircraft Establishment, Farnborough, and to Mr. Fairthorne for the computation of these data.

N	λ		
1	1		
2	1·267	591	879
3	1·408	318	927
4	1·500	214	280
5	1·567	050	691
10	1·751	919	657
20	1·907	134	681

Approximate relations of the form

$$\frac{1}{\pi - \lambda} = a \log (N + b) + c$$

can be obtained to fit these data, with errors at the most of 0·001 up to $N = 10$, but an error of 0·005 for $N = 20$. It is evident from the behaviour of the errors that the formula is incomplete.

The values of λ for all values from 1 to 20 are at present being calculated for us at the National Physical Laboratory. The results will be published as soon as available.

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[1] *J. Lond. Math. Soc.*, 21 (1946).

EARLY HISTORY OF THE ROYAL BOTANIC GARDEN, CALCUTTA

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c/o Royal Botanic Gardens, Kew

A GENERAL account of the Royal Botanic Garden, Calcutta, has been given by Biswas[1], and some of the detailed incidents connected with the formation of the Garden are also available in the published papers by Anderson[2] and King[3]. The Calcutta Garden is perhaps one of the oldest gardens in Asia, and it is not generally realized that it was established by the Honourable East India Company as early as 1787, essentially for the purpose of increasing the commercial riches of the Company, and *not* for the advancement of botanical knowledge in India and elsewhere. It was cleverly planned by an army officer, and the proposal was so attractive to the directors of the Company that they readily agreed to the establishment of such a garden. The detailed correspondence on the subject is preserved among the old records of the East India Company. This was made available to me through the courtesy of the Keeper of Records, India Office, London. Some of these letters have been published both by Anderson[2] and King[3], and it is not intended, therefore, to re-publish them here. The remainder of the letters afford other valuable and interesting information, and the purpose of this note is to reveal some of the lesser known facts regarding the origin and development of this garden.

Unfortunately the exact date on which the Garden was started is not clearly known. Carey[4] says that it was started in March 1786—a statement which seems to be wrong from an examination of the correspondence, and which has been corrected by Anderson. Prior to the official sanction by the East India Company, part of the Garden existed around the country house of Lieut.-Colonel Robert Kyd. This plot of land formed the eastern part of the Botanic Garden after its formation and has been referred by Roxburgh[5] in connexion with a tree—*Garcinia cornea* Willd. The actual proposal for the establishment of a botanical garden near Calcutta was submitted to the then Governor-General (Sir John Macpherson) at Calcutta by Lieut.-Colonel Kyd on June 1, 1786[6]. It was clearly stated in this letter that the idea of establishing a botanic garden is "not for the purpose of collecting rare plants as things of mere curiosity, but for establishing a stock for disseminating such articles as may prove beneficial to the inhabitants as well as to the natives of Great Britain, and which ultimately may tend to the extension of the national commerce and riches". It was suggested that the proposed garden would grow teak for ship-building, various spices (such as cinnamon, cardamon, clove, black and white pepper and nutmeg) for sale in Europe, and other articles of commerce (such as cotton, tobacco, indigo, coffee, camphor, gum-yielding plants and tea). The proposal was duly supported by the Governor-General, who wrote by way of recommendation to the Directors of the East India Company, "the garden may be formed as a general plantation or nursery where the cultivation of the cinnamon and the different articles mentioned by Col. Kyd may be attempted". The cost of maintaining this garden was suggested by Kyd at the low figure of Rs. 150–200 per month[7].

Kyd derived this inspiration, which led to the suggestion of forming a botanic garden, possibly from two sources: (1) in the garden of the previous Governor-General (Warren Hastings), he found some flourishing cardamon trees growing, and also some natural seedlings which promised a "rising plantation"; (2) Kyd himself was a keen gardener and at that time collected and grew, in the compound of his country house at Salimar, many foreign plants of economic and horticultural value. He used to secure these plants from the captains of the Company's ships returning from voyages to the Far East. Hence, his own experience had convinced him that some of the spices of the East Indies could be grown in India. If this could be achieved, it would have a further advantage, namely, the Dutch monopoly of the highly prized cinnamon and other spices would be broken.

The Court of Directors, too, as clever business heads of a commercial organisation, were alive to the benefits of this scheme. In their letter of approval, dated July 31, 1787, they duly stressed among other things the cultivation of cinnamon. This portion of their letter runs, "The experiment respecting the cinnamon tree in particular must be made in different parts and soils of those extensive provinces in order to ascertain with certainty whether this spice can be produced in Bengal equal to that which grows on the island of Ceylon[8]. We are aware that by extending your experiment too far, the expenses may increase to an amount of which you may not at present have any idea. But so sensible are we of the vast importance of the objects in view, that it is by no means our intention to restrict you in point of expense in the pursuit of it. In the cultivation of cinnamon tree in particular, we foresee a great source of wealth to the Company and of population and opulence to the provinces under your administration. Most earnestly therefore do we recommend it to you to proceed in your endeavours to propagate this spice in different places, and that you avail yourselves of the abilities and zeal of Lieutenant-Colonel Kyd herein."

The next step was the selection of a site and the acquisition of the land. This presented some difficulties. In his letter dated August 10, 1786, Kyd said that he, in company with a Mr. Hay, examined a plot of ground on the western bank of the river in the vicinity of Calcutta. One area which seemed suitable was not available, as on inquiry from Mr. Jonathan Duncan, the revenue officer, Kyd learnt that the ground had been allotted to the followers of Tishore Lama of Tibet, and had been consecrated for religious purposes. Kyd had of necessity to forgo this plot and chose a second area where the fort of Muggah Tannah and the barracks of the Moorish garrison formerly stood. This fort fell to the British under the leadership of Clive at the time of recapture of Calcutta. It was then demolished by mining. The condition of part of this ground was stated to be "perfect wild, overgrown with brush wood and subject to the overflow of the tide". This ground was adjacent to a plot of land which Kyd already possessed, and where he had his country house with his garden. A portion of this area fell within the limits of the Burdwan district (the extended limit of that time), and the Burdwan land was acquired from the Zamindar by exchanging an equivalent portion of East India Company's land elsewhere. Other lands of the Company, measuring 148 *bighas*-9 *cottahs*, were given to the residents of the ground, to induce them to leave the area, and the amount of compensation granted to them for their huts and personal effects was Rs. 3,166/4/0.

Having obtained the ground, Kyd with 109 labourers started to dig a ditch round the plot of land and also erected a fence. The fence was necessary to exclude wild buffaloes, which frequently visited the area. The monthly cost of this work, excluding the bamboo fencing, amounted to Rs. 384/0/0, and the work must have taken several months, for we read in a letter of the Treasury Officer (Buxey), dated May 1, 1787, that Kyd has drawn "one thousand sicca rupees" for this purpose. This amount appears to be only an instalment.

Those readers who have visited the Royal Botanic Garden, Sibpur, Calcutta, will recall that the ditch made by Kyd still exists, and is fairly continuous around the Garden, even now. A part of the ditch, that is, the ditch which now separates the Bengal Engineering College from the Botanic Garden, existed earlier, as this ditch formed part of the boundary of the old fort of Muggah Tannah. The portion of land, east of this ditch, that is, part of the present area of the Bengal Engineering College, was Kyd's personal land. This was given (at least, the major part of it) to the Botanic Garden at the time of its formation (1786–87), and remained so until 1820. In that year the same portion was given to the Lord Bishop of Calcutta for the establishment of a College. It appears that this old ditch of Muggah Tannah thus formed a ditch of convenience at the time of handing away a part of the garden land for the purpose of Bishop College, and the same holds good as a good demarcating line even now. The original ground of Kyd's garden house was known under various names, such as Kyd's Garden, Royd's Garden, Barwell's Garden, and in 1819 as Metcalf's Garden.

The next stage was to lay out the Garden and to start the commercial plantation of cinnamon and other spices. In this, Kyd was unusually ambitious but he was never a botanist. These two facts led to the complete failure of the enterprise after a few years of experiment. His ambitious aspect is evident from the fact that he wanted to grow every desirable economic plant of every country in his Garden. By a voluminous correspondence with British agents in different parts of Asia, he secured an amazing variety of plants, such as Persian dates, Persian tobacco, Chinese tea, oranges, English apples, cherries, apricots, sandalwood from the Malabar coast, and other plants like black pepper, bread-fruit, and a number of gum-producing plants. All these were duly planted out; but, as was to be expected, most of them perished in the uncongenial climate and soil of Calcutta. The cultivation of teak was also abandoned for the same reason in later years[11].

Kyd's term of honorary superintendentship of the Company's Botanic Garden was not a long one. His failure to grow so many commercial and economic plants should not be regretted by the present botanists of India, as his success (if it could have happened) might have altogether changed the destiny of the Garden. It appears to me that by his failure he paved the way to a botanic garden, which in the hands of his able successor played a very important part in the advancement of Indian botany. The name of Kyd should, however, be remembered with reverence as the founder of the Calcutta Garden which was destined to become a botanic garden and not a cinnamon plantation of the tea-garden type, on which so much stress was laid from the beginning, and at every stage.

Kyd died on March 26, 1793, and was buried in the South Park Street Cemetery in Calcutta. Two years later a memorial was erected in the Botanic Garden and a marble urn was placed on it. The site for this memorial was selected by Roxburgh[9], and the inscription on the urn says, "To the honour of Robert Kyd, an officer of the army and founder of this garden; placed by A. K. 1795" ("Roberto Kyd, *mil. trib. horti foundatori posuit A. K.*, MDCCXCV"). The initials A. K. refer to his relation, Alexander Kyd, who was then a major in the Bengal Engineers, and who later constructed the Kidderpore docks.

Kyd was succeeded by Dr. William Roxburgh, who on November 29, 1793, was appointed the first salaried superintendent of the East India Company's Botanic Garden. It was Roxburgh who got a sanction of Rs. 15,000 to build quarters for the Superintendent. This house was completed after 1795, and Roxburgh's request for a further sum of Rs. 5,000 (presumably over-spent in building the house) was refused by the Company. This house is a three-storied building on the river-bank and is still occupied by the Superintendent of the Garden.

During and since Roxburgh's tenure of office, the Botanic Garden near Calcutta has attracted the attention of the scientific world, and the scientific study of Indian plants dates from his time. (A few years prior to Roxburgh, Dr. Koenig was in India. Roxburgh regarded him as an intimate friend and also his preceptor. Koenig was essentially a plant collector who sent his plants to Linnæus (father and son) and Retzius.) Roxburgh has been, therefore, rightly called the 'father of Indian botany'.

It will be easily understood that, under the direction of a man of science such as Roxburgh, devoted to the scientific study of Indian plants, the original aims of the Garden as emphasized by the directors of the Company were not followed. Much about the same time the East India Company was being gradually eclipsed by the British Government. This was being done through the provisions of Pitt's India Act, and as such the control over Roxburgh became less and less effective. This allowed him to carry on as he liked.

For official purposes, the date of actual sanction to the proposal of establishing a botanic garden by the court of directors of the East India Company (that is, July 31, 1787) should be regarded as the beginning of the Garden. Prior to this date only a part of the Garden existed around Kyd's country house, which was included later within the botanical garden compound in 1787. On the basis of this date, the Royal Botanic Garden, Calcutta (as it is now known), completed its 150th year on July 30, 1937, and this was celebrated in a fitting manner on January 6, 1938. The latter date was apparently fixed for the sake of convenience only, as many British and foreign men of science, including the Director of the Royal Botanic Gardens, Kew, happened to be present in India at that time.

The East India Company during the years 1786–87 governed the country, collected the revenue, and administered law and order. Yet constitutionally its position was like that of landlord under the Nawab of Bengal. The Company at that time was still a private trading company, and could not be regarded as a part of the British Government. Robert[10] says, "the constitutional relation between the Nawab of Bengal and the East India Company at that time was indeed complicated. The Company secured the administration of military power and criminal justice (*Nizamat*) from the Nawab, and the power to collect revenue and administer civil justice (*Diwani*) from the Moghul Emperor." The above statement clearly shows that the East India Company was actually ruling the country under the shadow of the Nawab of Bengal. The Nawab was relieved of this heavy responsibility, as he got annually more than 40 lacs of rupees from the Company as lease-money. This position was cleverly stated by Clive thus, "the Nawab had only the name and shadow of authority, yet this name . . . this shadow, it is indispensably necessary that we should venerate".

This relationship should be clearly understood, as this represented the last days of the Moghul period, a dark period of the East India Company, and the formative phase of the British rule. Unless this is understood, one is liable to assume that the East India Company really represented the British Government at that time.

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[1] Biswas, K., "150th Anniversary Volume of the Royal Botanic Garden, Calcutta", 2–12 (1942).

[2] Anderson, T., *J. Agric. Hort. Soc. India*, N.S., 1, 169 (1869).

[3] King, G., *Ann. Roy. Bot. Gard., Calcutta*, 4, Pt. 1, i–xi (1893).

[4] Roxburgh, W., "Hortus Bengalensis", 2 (1814).

[5] Roxburgh, W., "Flora Indica", 2, 629 (1832).

[6] This date is given as January 1, 1786, by Biswas (*l.c.* 2). This is probably a printer's error.

[7] An idea of the present-day cost can be formed from the amount spent in 1944–45, which was Rs. 1,20,928.

[8] At that time Ceylon was under the Dutch Government.

[9] Biswas' statement on this point is contradictory (*l.c.* 2). King says (*l.c.* 3) that this site was selected by Roxburgh and not by Kyd himself, as stated by Biswas.

[10] Robert, P. E., "Historical Geography of the British Dependencies", 7, India, Pt. 1 (1916).

[11] King, *l.c.*, iii.

TRACE ELEMENTS IN PLANT PHYSIOLOGY

UNDER the auspices of the International Union of Biological Sciences, a symposium on "Trace Elements in Plant Physiology" was held at Rothamsted Experimental Station, Harpenden, under the chairmanship of Prof. B. Nemec, of Prague, during November 5 and 6, 1947. Representatives from many countries attended.

The symposium was conducted in four sessions, at which fourteen short papers were read to introduce the subjects for discussion. The work in progress on trace elements under Drs. Winifred Brenchley and Katherine Warington at the Rothamsted Station was inspected at the end of the meetings.

On the evening of November 6 the members of the conference were entertained at an after-dinner function at the Rothamsted Laboratories by the Director, Dr. W. G. Ogg, and the staff of the Station, when the delegates met senior members of Rothamsted concerned with trace-element investigations.

The subjects presented in the papers for discussion covered a wide field and included items of current scientific interest and practical importance, and demonstrated the immense value of plant physiological studies in investigating problems of crop production and animal husbandry.

Prof. Nemec, in his opening address, outlined the development of methods of research on trace elements, referring in particular to the early water culture experiments of Sachs and the influence of Prof. Stoeckard, of Tharandt Forestry School, Saxony, on this pioneer work. He exhibited a sample of gold obtained from the ash of plants of *Equisetum palustre* grown on volcanic soils in Bohemia, and referred to the concentration of droplets of metallic mercury in the seed capsules of *Holosteum umbellatum* on some soils.

Prof. T. Wallace and Dr. E. J. Hewitt (Great Britain) outlined methods in use in trace-element research at Long Ashton. It was shown how visual methods can be applied to problems of deficiencies, excesses and relationships of trace elements in plant nutrition studies, and how the method can be applied to analyse the injurious effects of soil acidity. Dr. Hewitt described his technique for large-scale sand cultures by means of which he has been able to study problems relating to deficiencies of iron, manganese, boron and molybdenum. The various points of these two papers were illustrated by a comprehensive exhibit of photographs.

Prof. J. Lavollay (France) outlined his method for the determination of the coefficient of action of mineral nutrients and illustrated the application of the method to problems concerning magnesium nutrition, showing how yield is related not only to the supply of magnesium in the nutrient, but also to the total concentration of salts in the medium. He demonstrated the beneficial effect of phosphorus on the action of magnesium and the antagonism which exists between magnesium and potassium; also the similarity of action of potassium and rubidium.

Dr. D. I. Arnon's (U.S.A.) contribution concerned the criteria of essentiality for micro-nutrients, and he illustrated his points by reference to his investigations in California on the essential role of molybdenum in plant nutrition. He suggested as the three criteria of essentiality of any element: (1) the life-cycle of the plant cannot be completed if the element is omitted; (2) the action of the element must be specific; (3) the effect on the plant must be direct. The paper and the discussion revealed the great practical difficulties of establishing 'essentiality' for elements required only in traces; but nevertheless it was thought that refinements of methods might disclose the essential nature of further elements.

Points of special interest in trace element nutrition were discussed in papers by Dr. E. G. Mulder (Holland), Dr. J. Erkama (Finland), and Prof. H. Burström (Sweden). Dr. Mulder described experiments concerning the functions of copper and molybdenum in the metabolism of higher plants and micro-organisms, and also referred to the application of his results to field crops in the Netherlands. Copper is regarded as a catalyst of oxidation processes, and molybdenum has been shown to be necessary for the reduction of nitrate nitrogen in higher plants and for the fixation of nitrogen by *Azotobacter*.

Dr. Erkama in his studies has regarded the three elements iron, manganese and copper as comprising one unit, and has endeavoured to determine their relationships. Manganese seems to be antagonistic to both copper and iron, and reactions with manganese seem to take place mainly in the vacuole sap. Copper, it is suggested, is able to remove iron from the vacuole sap and to oxidize it in protoplasm.

Prof. Burström reported results on the action of manganese in roots. Manganese appears to catalyse nitrate reduction in roots, and in this respect it may have a similar function to molybdenum in some plants. His results show that in roots, nitrogen increases the length of cells, phosphorus is concerned with cell multiplication, while manganese appears not to affect the ultimate length of the root. Manganese may shorten the meristem region, and while increasing the rate of root elongation it also shortens the 'grand period' of growth. Manganese thus seems to have effects apart from those concerned with nitrogen. Arising from this paper, the differential effects of NH_4 and NO_3 with *Aspergillus*, excised roots and attached roots were discussed in relation to redox systems.

The practical application of trace element investigations to crop-producing problems was discussed in the contributions of Dr. L. Gisiger (Switzerland), Prof. F. Steenbjerg (Denmark), Dr. Marie P. Löhnis (Holland), Prof. E. A. Jamalainen (Finland), and Dr. D. Mulder (Wilhelminadorp; this last being communicated by Dr. Löhnis).

Dr. Gisiger described investigations relating to crop failures in Switzerland during the War resulting from over-liming associated with deficiencies of boron and manganese. From his experiments he concludes that the damage from excess liming is due to the hydrating action of the $OH^{\cdot}$ anion. Boron tends to counteract this effect by dehydrating action, this being an alternative hypothesis to the fixation of boron by lime action. The $OH^{\cdot}$ ion is regarded as causing the unavailability of manganese over an intermediate range of pH, availability increasing at low and high pH values. The range of low availability is similar to that shown by Quastel *et al.*, at which soil organisms are active in the oxidation of soil manganese.

Prof. Steenbjerg outlined the main problems of trace elements investigated in Danish agriculture. Iron and manganese deficiencies are common in horticultural crops and copper deficiency occurs in crops on the sandy soils of Jutland. Cobalt deficiency in cattle has also been recognized. Investigations have largely concerned deficiencies of manganese and copper. With manganese the problems differ for sands and clays, and soil methods have been devised for advisory purposes. Organic matter is an important cause of copper deficiency, and the availability is greatly influenced by preceding crops. Grass is regarded as important in mobilizing soil copper. The copper content of plants has been shown not to be an infallible guide in the diagnosis of copper deficiency, since when growth is severely stunted the total copper content of the plant material (as percentage dry matter) may not be unduly low. A characteristic S-shaped curve is obtained relating dry matter production and total copper content. Deficiency values occur up to the point of inflexion.

Discussion of this paper showed that many problems concerned in availability of manganese and its relations to other elements in plants, for example, Mn/N, require further study.

Dr. Löhnis described her researches on the toxicity of manganese to crops in acid soils in the Netherlands. *Phaseolus vulgaris* and *Vicia sativa* were found to be highly susceptible, whereas oats and strawberries were resistant to damage. Resistance to excess manganese and susceptibility to manganese deficiency (as shown by oats) cannot be explained on the simple basis of 'ease of absorption of manganese' from the soil, since some crops are susceptible (for example, *Phaseolus*) and others resistant (for example, strawberry) to both excess and deficiency of the element.

Prof. Jamalainen gave an account of the occurrence of deficiencies of boron, copper and manganese in crops of Finland. Boron deficiency is prevalent in sugar beet, swedes and apples, and occurs even on strongly acid soils, though the deficiency is accentuated by liming. Other crops affected are clover, celery, turnips and white mustard.

Copper deficiency is also an important problem, particularly on peats, but also on sands. Clay soils are less affected. Cereals, hay crops, potatoes and root crops have all responded to copper dressings.

As the soils of Finland are mainly acid, manganese deficiency is rare, though marsh spot of peas has been noted in Aland. The deficiency may occur on over-limed soils.

The contribution sent by Dr. D. Mulder concerned the occurrence of zinc deficiency in fruit trees in Europe and referred in particular to apples, pears and cherries in the Zeeland province of the Netherlands and to reported instances in apples in Hungary, Denmark and Switzerland. The Dutch examples occur on highly calcareous sands, and the deficiency can be cured by winter or summer sprays of zinc sulphate.

A novel paper of the symposium was contributed by Prof. L. Seekles (Holland), in that it referred to trace-element problems in farm stock. The contribution showed clearly the similarity in plants and animals of many of the fundamental problems concerned with trace elements. Thus in both there appear to be direct and induced (or 'conditioned') deficiencies, and relationships between elements may be of great importance. Moreover, as Prof. Seekles pointed out, trace elements are concerned with many linked series of enzyme reactions in plants and animals, and the breaking of these series at different points from different deficiencies may result in varied or similar pathological conditions.

At the conclusion of the conference, Dr. D. I. Arnon proposed that an endeavour should be made to adopt a term for universal use to replace the numerous current expressions used by different workers, namely, 'trace elements', 'trace nutrients', 'minor elements', 'oligo elements', 'spuren-elements'. He was prepared to suggest the term 'micro nutrient elements' as a basis for discussion and agreed to prepare a memorandum on the subject.

NEW ZEALAND DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANNUAL REPORT FOR 1946–47

THE twenty-first annual report of the Department of Scientific and Industrial Research, New Zealand (Wellington: Gov. Printer. 1*s.* 9*d.*), includes the Minister's statement, the secretary's report for the year 1946–47, reports of the various research committees and of the Cawthron Institute, as well as reports from branches and on research work at Canterbury and Massey Agricultural Colleges. The three main new activities noted by the secretary are the establishment of a Fuel Efficiency Service in an effort to reduce the consumption of coal in industry; the extension of the Information Bureau to deal more systematically with the exchange of information for scientific workers of the Department and the Dominion generally, and its dissemination among interested Departments and the public; and a start on the use of radioactive tracer elements in certain biological and chemical problems associated with soil processes. Building research included investigations on lightweight concrete and pumice concrete and the testing of properties of new materials, while the Plant Diseases Division examined the toxicity of wood preservatives and the treatment of infested buildings, as well as the testing of preservatives against fungi. The

Dominion Physical Laboratory undertook measurements of thermal transmittance on two types of concrete construction and also on a weatherboard house.

The work of the Dairy Research Institute was focused upon further improvement in the quality of New Zealand dairy products for export, reducing losses in manufacture, utilizing skim milk to the best advantage in feeding calves in New Zealand, and the influence of the plane of nutrition of the dairy cow during its normal dry period on the quality and quantity of milk produced in the subsequent lactation. The finding that cress-taint does not appear in the butter if cream from cows that have consumed cress is pasteurized below 180° F. was confirmed. Attempts were made to determine the relative influences of fat and casein on the moisture-holding properties of cheese-curd, while the Fats Research Laboratory established on April 1, 1946, initiated research on the nature of fats, particularly those occurring in dairy products.

Fruit cold-storage research covered the influence of root-stock and intermediate scion on core-flush in Granny Smith apples and the effect of a pre-harvest, fruit-fixing spray or superficial scald. Trials with 'Pliofilm' wraps in the shipment of oranges indicated that the percentage of sound fruit was substantially increased, but the high cost of the material outweighed the saving; use of paper wraps impregnated with diphenyl proved highly economic in reducing losses from fungous rots. Fruit research included manurial investigations and root-stock trials on apples, variety trials on apples, peaches and citrus fruit, investigations on codling moth control, tests on new products such as 'Gammexane', 'Dittane', 'Fermate' and 'Phygon', magnesium deficiency investigations, studies of the effect of penicillin on fruit fungi and of the control of black-spot of apples and pears with 'Elgetol' spray, raspberry investigations and a disease survey of orchards.

The Industrial Psychology Division made a survey of eye-strain in two clothing factories, and commenced an investigation into the adjustment of youth in industry as well as carrying out many vocational examinations. The Leather Research Association's studies of the quality of sole leather indicated that the wear life of a sole bears a definite relation to the amount of hide substance per unit area. Some of the fundamental properties of water-pigment finishes in use were examined, as well as difficulties experienced in curing and storing calf-skins. The Shoe Research Association commenced an investigation on the types of leather most suitable for insoles, and continued its work on the effect of perspiration on leather. The Fertilizer Manufacturers' Research Association drew up a programme of work and was selecting a site for its laboratory. The Pottery and Ceramic Research Association carried out preliminary work on the differential thermal analysis of New Zealand clays and completed preliminary work on a similar method, for determining free quartz in clays. The Woollen Mills Research Association continued its control work on unshrinkable finishes, as well as further trials of 'Gammexane' against carpet beetles, and completed the mill tests on the manufacturing trial of hairy wool and the combing trial of exported scoured wool.

Under the Tobacco Research Committee, fertilizer experiments led to a general increase in yield, magnesium having a beneficial effect on both yield and quality. Surveys were made of both mosaic disease and black root-rot in the seedling beds of many growers, and experiments to control collar-ro continued, while the Cawthron Institute continue soil mapping of tobacco lands. Other work at th Cawthron Institute related to land utilization, so analysis and investigations on tomatoes, includin the treatment of soil with steam, formalin an chloropicrin, the effect of cocoa-bean husks, compos etc., on yield, tomato 'cloud' and 'hard-core'.

Research work at Canterbury Agricultural Colleg included sheep-dipping trials with *D.D.T.* an 'Gammexane', studies in copper deficiencies, o insect pests of wheat crops and on subterranean clove as well as farm-machinery research, microbiologic investigations of ear blight and frost damage, eyespo disease, the efficiency of commercial seed-whe dusting and the seed disinfection of peas. At Masse Agricultural College studies on hairy sheep (N typ added to our understanding of the fleeces of bot hairy and non-hairy sheep. Other work was concerne with the propagation of cuttings, drainage and th internal parasites of sheep, while the Biochemistr Department studied the wear of sheep's teeth an the milk supply of Romney ewes.

Since the reversion of the control of the geophysic work at the Apia Observatory to the Departmen efforts have been made to provide modern buildin suitable for tropical conditions, modern equipmen adequate scientific staff and congenial living condition

The Auckland Industrial Development Labor tories report an increase in the number, variety an complexity of the industrial problems in whic assistance has been sought, while the first annu report of the Biometric Section indicates that, i addition to facilitating basic statistical and biometric control of agricultural trials, the Section was con cerned mainly with the collection of an adequa library of technical literature, the recruitment an training of staff, the exploration of methods, such a the punched card technique, of handling extensiv collections of data, as well as research and consultativ work.

At the Dominion Observatory the method of con trolling the standard clocks was unchanged, and th time-service arrangements were continued as pr viously, except for special time signals which had bee sent out for war purposes up to January 31. Th chief seismic event was the disturbance in the Lal Coleridge region on June 26; but 306 earthquak were felt during the year in some part of New Zealan 87 in the North Island and 219 in the South Islan

Lack of accommodation is still a great hindran to the work of the Dominion Laboratory where, i addition to the examination of 25,103 sample research was carried out on New Zealand woods, an special coatings were applied to experimental box in an effort to overcome the tainting of butter b boxes made of *Pinus radiata* timber. Much spectr graphic examination of metals was carried out f industry, and the Coal Survey Laboratory co-operate with the field staffs of the Geological Survey and th Mines Department in a continuation of the physic and chemical survey of the coal resources of th Dominion. Equipment on a pilot-plant scale for th production of penicillin and other antibiotics wa designed for installation at the Plant Chemistr Laboratory, and an experimental tray dryer was al designed and installed. A complete survey of a certified plant therapeutic compounds on the mark was also undertaken.

The Dominion Physical Laboratory has assiste many New Zealand manufacturing firms with tes on materials and equipment, the design and supply of special measuring apparatus, replacement parts for machinery and small precision tools, and about half the time of the Laboratory has been spent on similar work for Government Departments. Major investigations during the year included vacuum-pressure impregnation of timber with synthetic resins, the moulding of plywood, the thermal efficiency of open-hearth fires and the design and construction of micro-wave meteorological radar. In addition to its butter-fat investigations, the Fats Research Laboratory has used a molecular still of novel design for the preparation of fish liver-oil concentrates. In addition to vitamin analyses, the Plant Chemistry Laboratory has conducted a successful trial of new hormone weed-killers. Work under the Plant Research Bureau included an extensive breeding programme for garden peas and field peas, as well as for barley and other field crops. A vegetable research section was established, and the Botany Division made further surveys of vegetation and extended its collections of agar seaweed and of carrageen (Irish moss). The Grasslands Division carried out further work on pedigree strains of pasture species, blind-seed disease of rye-grass and soil conservation, while in addition to therapeutic testing the Plant Diseases Division studied tree-tomato mosaic, lettuce mosaic, halo-blight of beans, and soil disinfection. An investigation was also commenced on boron and its relation to the incidence of yellow leaf.

PHOTO-ELASTIC INVESTIGATION OF INTERNAL STRESSES IN SILVER CHLORIDE CAUSED BY PLASTIC DEFORMATION

By J. F. NYE
Cavendish Laboratory, Cambridge

INTERNAL stresses in cold-worked metals cannot be investigated fully by means of X-ray diffraction because in most cases the stresses vary considerably in distances comparable with the cross-section of the X-ray beam. For this reason, X-ray methods can indicate only the presence and magnitude of internal stresses, but not their distribution in space. A more powerful and direct method of approach is provided by the photo-elastic effect in transparent crystals. Cubic crystals are particularly suitable, since they are optically isotropic when unstressed; the magnitude and orientation of their birefringence, and its distribution over the crystals, thus give a direct picture of the distribution of internal stress. There is no reason at present for supposing that the plastic deformation of transparent crystals differs fundamentally from that of other crystalline substances, and one may reasonably expect that results derived from experiments on such materials will also be applicable to metals.

Since December 1946 a series of observations has been made on polycrystalline silver chloride, a material that is transparent, cubic in structure, and also very ductile. Rolled sheets, of thicknesses from 0·3 to 1 mm., supplied by the Harshaw Chemical Company of Cleveland, Ohio, showed patches of birefringence when placed between crossed nicols. These patches disappeared when strips cut from the sheets were recrystallized by heating for two hours at 400° C. and cooled slowly. (The melting point of silver chloride is 455° C.). Subsequent plastic deformation of such flat strips gave patterns of birefringence of which an example is shown in Fig. 1. This photograph was taken in white light between the crossed nicols of a polarizing microscope after unloading the strip; the polarization directions of the nicols are horizontal and vertical. Light areas indicate residual stresses. The pattern is not coloured because, with sheets of this thickness, the path differences due to the stress birefringence are smaller than the wave-length of light. The average width of the grains is large compared with the thickness of the sheet. Most of the grains are crossed by one, or sometimes two, sets of light and dark bands, similar to those observed in transparent single crystals by Brewster[1], by Reusch[2], and by Obreimow and Schubnikoff[3]. They appear to be the result of deformation by glide or by kinking[4]. Other interesting points are visible: for example, plastic distortion in grain *A* has evidently contributed to the stress pattern seen in the neighbouring grain *B*. When an external stress is applied to the strip the grains lighten and the progress of further plastic deformation can be watched. (I gave a demonstration of these phenomena at a conversazione held by the Royal Society on May 29, 1947.) A small portion of another strip is illustrated in Fig. 2, also photographed between crossed nicols; several intersecting sets of bands are shown. In Fig. 3 a grain boundary *XX* separates two grains, each of which is crossed by a particularly sharp set of birefringent bands, produced in this case by bending. The polarization directions of the nicols are again horizontal and vertical. If the nicols are turned through 45° the light stripes become dark and the contrast of the pattern is much reduced. Such observations combined with the use of a compensator make it possible to calculate the distribution of stress within the bands.

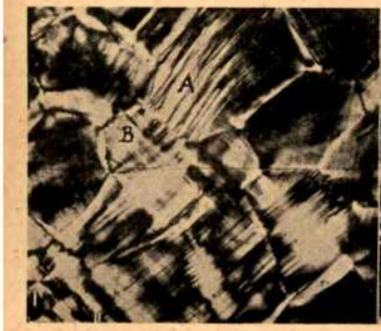

Fig. 1. × 13

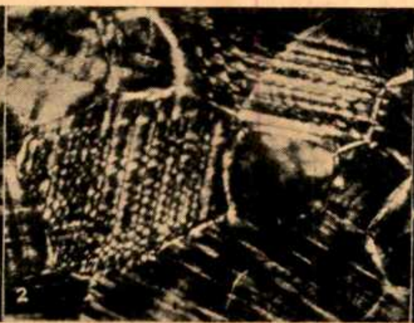

Fig. 2. × 25.

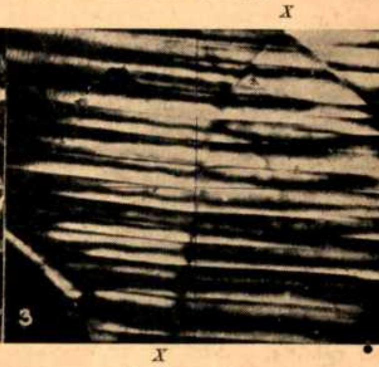

Fig. 3. × 41

Bands of a very similar nature have been reported in diamond by Raman and Rendall[5], and investigated in detail by Ramachandran[6]. These authors attribute the bands to the stresses set up in alternate layers of diamond having two different lattice spacings. It would be interesting to know whether they are not really the consequence of plastic deformation.

Examination of a plastically deformed strip of silver chloride that was annealed in stages shows that heating near the melting point causes a gradual reduction of the intensity of the picture, but leaves the pattern unaltered. We may conclude that, during annealing, there occur no large-scale migrations of dislocations, but only localized processes of atomic rearrangement.

Although they are optically isotropic when unstressed, cubic crystals under stress behave differently from glass and the usual plastics used in photo-elastic tests. The crystal classes T_d, O, O_h require not two but three constants to describe their photo-elastic behaviour, and, as has recently been pointed out[7,8], the T and T_h classes (also in the cubic system) require four. This fact makes the full interpretation of the stress birefringence pattern dependent upon a knowledge not only of certain combinations of these constants, but also of the crystallographic orientation of the grains concerned. It also leads to a striking phenomenon observed in the elastic stress range: when a bending moment is applied to an annealed strip, viewed either between crossed nicols or in a circular polariscope, the grain boundaries are seen to flash out brightly. The effect is completely reversible; if the load is removed the light regions return to their original dark state. The explanation seems to be that, when the bending moment is applied, the light passing through a grain traverses a layer of tension on one side of the strip and a layer of compression on the other side. The birefringence of the two layers cancels out, and the total path-difference between the two oppositely polarized rays will be zero. However, grains with different crystallographic orientations will have different stress-optical constants; consequently, whenever a grain boundary is not perpendicular to the sheet, rays crossing the boundary will pass through different grains on the tensile and compressive sides, and the total path difference will not vanish. In contrast to the grains themselves, therefore, the grain boundaries will be lightened. A more exact mathematical treatment of the effect is possible and its results are supported by other observations, but the above argument contains the essence of the explanation. Such bending moments cause the lightening seen at some of the grain boundaries in Fig. 1.

A fuller account of these and other photo-elastic experiments on plastically deformed materials, carried out with the financial support of the British Iron and Steel Research Association, will be published elsewhere. I am greatly indebted to Dr. E. Orowan for suggesting the possibility of using transparent, polycrystalline materials in the way described and for discussion of the results.

[1] Brewster, "A Treatise on Optics", 280, 281 (Longman, Brown Green and Longmans, London. New edit., 1853).

[2] Reusch, E., *Ann. Phys.*, [V], **132**, 441 (1867).

[3] Obreimow, I. W., and Schubnikoff, L. W., *Z. Phys.*, **41**, 907 (1927).

[4] Orowan, E., *Nature*, **149**, 643 (1942).

[5] Raman, Sir C. V., and Rendall, G. R., *Proc. Ind. Acad. Sci.*, **19** A, 265 (1944).

[6] Ramachandran, G. N., *Proc. Ind. Acad. Sci.*, **24** A, 65 (1946).

[7] Bhagavantam, S., *Proc. Ind. Acad. Sci.*, **16** A, 359 (1942).

[8] Bhagavantam, S., and Suryanarayana, D., *Proc. Ind. Acad. Sci.*, **26**, 97 (1947); *Nature*, **160**, 750 (1947).

SCIENTIFIC RESEARCH AND INDUSTRY

SIR EDWARD APPLETON'S address to the Scottish Council (Development and Industry) at Glasgow on February 13 on "Science and the Progress of Industry" will increase the impatience with which the scientific and industrial world awaits the resumption of publication of the annual reports of the Department of Scientific and Industrial Research. Indeed, it could well be held that here again, as in the recent speech at Letchworth of the Lord President of the Council (see *Nature*, February 7, p. 214), by using a speech to a sectional or limited audience, which even in normal times could only be imperfectly reported in the Press, as the occasion for important announcements of policy or disclosure of developments, the Government is showing lack of courtesy to the scientific man and to the industrialist. Such statements should be put on permanent record in a proper fashion. Whatever may be the rights and wrongs of any policy—for example, the present dispute between the Government and the medical profession—it is to be hoped that the Government will learn that it is wiser to court than to flout the expert and professional experience upon the co-operation of which the smooth running of so many Departments of State depends. As Burke once remarked in another connexion, magnanimity in politics is not seldom the truest wisdom, and little minds go ill with a great State department or with a great Empire.

After a tribute to the work of Scottish men of science in the past, Sir Edward suggested that for an overall picture of the pattern of the scientific effort in Great Britain, it is useful to think of its three great sections—research in universities and technical colleges, Government research and research in industry itself—as being situated at the three corners of a triangle and thus linked directly together. He believes that the first task is to foster fundamental research in universities and technical colleges, where the really revolutionary industrial advances usually have their origin. Such fundamental research knows no national frontiers, but Sir Edward paid here a further tribute to the Scottish contribution, before referring more specifically to the essential contribution of the geologist to those problems of making the best use of familiar materials and of developing in the national interest materials so far regarded as economically useless. The Scottish Branch of the Geological Survey was always ready to help, but the problems of application involved belong to other branches of science. If the inquiries now being carried out by the Scottish Council revealed gaps in the facilities available for research, the Department of Scientific and Industrial Research would always be ready to consult with the Council as to how they could best be filled.

Before dealing with the work of the Department itself, Sir Edward indicated a few of the special grants made to workers in the Scottish universities; for example, to Prof. P. I. Dee in Glasgow and Prof. N. Feather in Edinburgh for work on nuclear physics, to Dr. C. Horrex at St. Andrews for work on the relative speeds of the decomposition of certain organic compounds, to Prof. G. D. Preston at Dundee for work on the development and use of the electron microscope, and to Prof. R. N. Arnold at Edinburgh for work on the cutting of metals at high speeds.

Emphasizing then the national character of the thirteen research stations of the Department, Sir Edward admitted that while, for example, the work which is being done in developing the science of building is equally applicable north and south of the Tweed, in considering the application of such science to particular problems, there may be considerable difference between the problems of the south of England and those of Scotland. For this reason, it has been decided to establish at East Kilbride branches of the Road Research Laboratory, the Building Research Station and the Fuel Research Station.

Sir Edward said that in co-operation with the County Surveyor of Lanarkshire and the Ministry of Transport, full-scale experimental surfacings are already under observation in that county. Two of these are duplicates of experiments on the Colnbrook Bypass near London, one being concerned with long-life asphalt and the other with tar- and bitumen carpets. The object of both these experiments is to ascertain how far conclusions, valid in the south of England, are also valid in Scotland, where the weather tends to be wetter and cooler. Another experiment in Lanarkshire is concerned with the use of wetting agents to improve the adhesion of bituminous binders to a local stone. The County Surveyor of Ayrshire is co-operating in experiments in the use of quarry waste in bituminous surfaces; the County Surveyor of Wigtownshire in the use of local sands, and the County Surveyor of Dumfriesshire in experiments on the use of chemicals for removing ice from roads.

Again, the Building Research Station has carried out work in conjunction with the Scottish Department of Agriculture on building materials composed of peat and cement, and investigations have been made into the suitability of clays from north-east Scotland for brick manufacture. There is already close association between the Fuel Research Station and the manufacturers and others interested in fuel problems in Scotland; but co-operation will be further strengthened by the establishment at East Kilbride of a sub-station of the Fuel Research Organisation. This sub-station will, in the first place, be occupied mainly in testing domestic heating appliances, but it will also serve as a liaison establishment in dealing with other local fuel problems and will ensure full appreciation at Greenwich of Scottish conditions and preferences.

The new laboratory for research into mechanical engineering science of the Department of Scientific and Industrial Research is also to be erected at East Kilbride. Sir Edward said that when, after the War, the Advisory Council for Scientific and Industrial Research came to review the research needs of Great Britain, certain gaps were evident in the facilities for research in this field. The most important of these were in hydraulic machinery, pumps and so forth, in heat transfer problems, in applied thermodynamics, and in kinetics and mechanisms. It will be part of the job of the new establishment to fill in these gaps; but its main task will be basic research in mechanical engineering science, which will have general application in due course throughout the whole of the industry. The work has been divided into groups which are, in fact, the underlying subjects of general application in many branches of mechanical engineering; in addition to those already mentioned, the properties of metals, problems of vibration, of lubrication, of noise, and of the mechanics of the formation and machine-shaping of metals are included.

Speaking of the research associations, Sir Edward made two interesting comments. Thirty-five industries now possess active research associations, some, such as the Iron and Steel, and the Electrical Research Associations with incomes of the order of £250,000 a year, and all with incomes permitting the prosecution of research on a substantial scale, possibly three or four times the pre-war scale. This increase in the scale of working, he suggested, largely disposes of the basis of previous criticism of co-operative research. Secondly, he referred to the use by certain associations, such as the Cotton, the Refractories and the Iron and Steel Research Associations, of the technique of what was called during the War 'operational research'. In industry this means obtaining a quantitative estimate of the dependence of the efficiency of industrial operations on various factors, and studies already made in some branches of industry have indicated immediate steps which could be taken to increase output by as much as twenty per cent. Statistical studies of a different kind made by the Boot and Shoe Research Association have shown that it is possible to increase the chance of being able to fit any customer and to reduce materially the number of sizes to be manufactured and stocked.

Of research by individual firms, Sir Edward remarked that the ultimate decision on how far new ideas springing from science are to be applied in industry rests with industry itself, and the manner of that application is a problem to be determined by the management. Nor is any generalization possible as to the necessity for, or type of, research department in an individual firm: there are industries which can safely rely on research carried out for them in outside organisations, provided they have the technical staff capable of interpreting the results of the work and applying and developing it to meet their particular requirements. No firm can afford to neglect such development, and Sir Edward insisted that Britain can only remain a great industrial nation if the industrial scene is kept under view and opportunities watched for applying science. This is work that the Scottish Council is well equipped to do for Scotland, and the office which the Department of Scientific and Industrial Research has established in Edinburgh is intended to assist the Council in such work. A main task of this new office is to assist the utilization of existing knowledge by putting the man with the problem into direct touch with the man who can solve it.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 8

INSTITUTE OF PETROLEUM, NORTHERN BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6 p.m.—Mr. E. Thornton: "The Fighting of Oil Fires".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at Woolwich Polytechnic, Woolwich, London, S.E.18), at 6.45 p.m.—Dr. H. Baines: "Colour Photography".

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 7 p.m.—Dr. B. P. Ridge: "Some Aspects of Synthetic Fibres".

INSTITUTION OF THE RUBBER INDUSTRY, MIDLAND SECTION (at Burton-on-Trent), at 7.15 p.m.—Mr. L. E. Puddefoot: "Rubber Adhesives".

Tuesday, March 9

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. H. E. M. Barlow: "Applications of Micro Waves".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. W. E. Le Gros Clark, F.R.S.: "Recent Discoveries of Fossil Hominoids in Africa".

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir John E. Lennard-Jones, F.R.S.: "Modern Theories of Chemical Valency". (Further Lectures on March 16 and 23.)

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. H. A. Jahn: "Comparison of Atomic and Nuclear Energy Levels".

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. H. Wheeler and Mr. J. E. C. Topps: "Rocket Propulsion, a Restricted Survey".

Institution of Civil Engineers (at Great George Street, London, S.W.1), at 5.30 p.m.—Prof. C. A. Hart and Mr. B. F. J. Bradbeer: "Air Survey and the Road Engineer".

Illuminating Engineering Society (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. H. G. Jenkins and Mr. J. N. Bowtell: "High Voltage Fluorescent Tubes".

Manchester Geographical Society (at the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. John Coatman: "On Musa Ka Musalla".

Wednesday, March 10

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. H. S. Gibson: "The Production of Oil from the Fields of South-West Iran".

British Institution of Radio Engineers, North-Eastern Section (at Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p.m.—Mr. I. A. Harris: "The Calculation of Electrode Temperatures in the Radio Valve".

Society of Chemical Industry, Microbiological Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Annual General Meeting; at 6.30 p.m.—Papers on "The Microbiological Control of Therapeutic Products".

Institution of the Rubber Industry, Southern Section (at the Polygon Hotel, Southampton), at 7.15 p.m.—Mr. A. E. Moulton: "Rubber in Railway Operation".

Institute of Welding, North London Branch (at the Technical College, Acton, London, W.3)—Mr. E. Ryalls: "The Bronze Welding of Cast Iron".

Thursday, March 11

East Malling Research Station (at Bradbourne, East Malling Research Station, East Malling, Kent), at 4 p.m.—Capt. R. Wellington: "Fruit Research—some Thoughts Past and Future".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. D. W. E. Axford and Prof. R. G. W. Norrish, F.R.S.: "Oxidation of Gaseous Formaldehyde"; Sir Alfred Egerton, F.R.S., and Mr. J. Powling: "The Limits of Flame Propagation at Atmospheric Pressure", Parts 1–2.

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—"Survey of the Outer Hebrides". (Dr. James W. Campbell: "Birdlife"; Miss M. S. Campbell: "Plant Collecting".)

Physical Society, Acoustics Group (joint meeting with the British Sound Recording Association, at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 5.45 p.m.—Discussion on "Loudspeakers, with Particular Reference to High-Fidelity Monitoring Reproducers" (to be opened by Dr. D. E. L. Shorter).

Anglo-Austrian Society (at the British Council, 6 Hanover Street, London, W.1), at 6.30 p.m.—Prof. J. R. Marrack: "The World Food Situation".*

Chemical Society (in the Chemistry Department, The University, Manchester), at 6.30 p.m.—Prof. H. L. Riley: "Amorphous Carbon".

Society of Chemical Industry, Food Group (joint meeting with the Nottingham Section of the S.C.I., at the Welbeck Hotel, Nottingham), at 7.15 p.m.—Mr. W. Cunliffe: "Physical Chemistry of Food with particular reference to Bakery Products".

Chemical Society, Society of Chemical Industry, and Royal Institute of Chemistry, Edinburgh and East of Scotland Sections (at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. E. S. Paice: "Practical Aspects of Wetting and Detergency".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Sir Weldon Dalrymple-Champneys, Bart.: "The Work of the Medical Staff of the Ministry of Health".

Pharmaceutical Society, Manchester, Salford and District Branch (in the Council Chamber, Houldsworth Hall, Manchester), at 7.45 p.m.—Papers on "The New British Pharmacopœia".

British Institution of Radio Engineers, North-Western Section (in the Reynolds Hall, College of Technology, Sackville Street, Manchester).—Mr. M. P. Johnson: "Some Aspects of Moderate Precision Temperature Control in Communication Engineering".

Friday, March 12

Biochemical Society (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 2 p.m.—Annual General Meeting; Scientific Papers.

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. H. V. Clay and Mr. V. Watson: "Physico-chemical Studies of Lead Chromes".

Physical Society (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 5 p.m.—Scientific Papers.

Institute of Navigation (at the Royal United Services Institution, Whitehall, London, S.W.1), at 5.30 p.m.—Mr. P. F. Everitt: "Air Sextants"

British Association of Chemists, Birmingham Section (at the University, Edmund Street, Birmingham), at 6.30 p.m.—Prof. W. Wardlaw: "Valency".

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Prof. P. A. Sheppard: "The Physics of Meteorology".

Sheffield Metallurgical Association, Methods of Analysis Group (at 198 West Street, Sheffield), at 7 p.m.—Mr. H. Groom: "Absorptiometric Determination of Manganese".

Chemical Society (in the Chemistry Lecture Theatre, The University, Glasgow), at 7.15 p.m.—Prof. E. L. Hirst, F.R.S.: "Some Problems in the Chemistry of Starch and Glycogen".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. T. E. Allibone: "Lightning and Spark Phenomena".

Saturday, March 13

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10 a.m.—Conference on "Results of Recent Investigations into Nutritional Status in Great Britain".

British Psychological Society (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. J. C. Raven: "The Comparative Assessment of Intellectual Ability".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. M. Fortes: "The Cocoa-Farmers of the Gold Coast".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Chemist in the India Store Department—The Director-General, India Store Department, Blackpool, quoting S.4527/47 (March 8).

Area Supervisors or Assistant Area Supervisors, and a Laboratory Steward, in the West Midland Province—The Provincial Supervisor, National Milk Testing Service, Ministry of Agriculture and Fisheries, Bank House, Newport, Shropshire (March 12).

Lecturer in Agriculture and Farm Bookkeeping, and a Lecturer in Agriculture, Farm Implements, Building Construction, etc., at the Cheshire School of Agriculture, Reaseheath—The Director of Education, County Education Offices, City Road, Chester (March 13).

Agricultural Adviser for the County of Angus—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (March 15).

Assistant Lecturer in Theoretical Physics—The Registrar, The University, Manchester 13 (April 17).

Chief Mining Engineer, Salt Range Division, Khewra, West Punjab—The High Commissioner for Pakistan, 16 Fitzhardinge Street, London, W.1 (March 19).

Physical-Chemist to work on chemical reactions in emulsion systems, a Physicist or Physical-Chemist to work on properties of plastic-elastic materials, and a Chemist with experience of abstracting, etc.—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey (March 27).

Forecasters in the Meteorological Branch, Air Department, New Zealand—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (March 31).

Robert Blair Fellowships in Applied Science and Technology—The Education Officer (H.1/2), London County Council, County Hall, London, S.E.1 (April 1).

Senior Principal Scientific Officer in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2123 (April 7).

Assistant Editor—The General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1 (April 12).

Ramsay Memorial Fellowships for Chemical Research—The Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1 (April 17).

Head of the Department of Surveying and Engineering—The Principal, College of Estate Management, 11 Great George Street, London, S.W.1 (May 1).

Assistant Lecturer (Grade III) in the Department of Biochemistry—The Registrar, The University, Liverpool (May 1).

Dental Research Fellow—The Dean, Medical School, Guy's Hospital, London, S.E.1 (May 31).

Professor of Civil Engineering in the University of Queensland, Brisbane—The Agent-General for Queensland, 409 Strand, London, W.C.2, and The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Brisbane, May 31).

Head of the National College for Heating, Ventilating, Refrigeration and Fan Engineering—The Clerk to the Governors, Borough Polytechnic, Borough Road, London, S.E.1.

Laboratory Technicians with experience in cutting and staining sections—The Dean's Office, St. Thomas's Hospital Medical School, London, S.E.1.

Research Assistants (with Inter.B.Sc.) for work in Organic Chemistry section, in Leatherhead—The Assistant Secretary, British Coal Utilization Research Association, 13 Grosvenor Gardens, London, S.W.1.

Demonstrator in the Division of Chemistry—The Bursar, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1.

Biochemist (male, with B.Sc. chemistry) in charge of routine hospital biochemical laboratory—The Secretary, Ministry of Health Laboratory, Peace Memorial Hospital, Watford.

Demonstrator in the Physiology Department—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

Technicians (2, Grade B)—The Medical Director, Coventry Joint Laboratory, Stoney Stanton Road, Coventry.

NATURE

No. 4089 SATURDAY, MARCH 13, 1948 Vol. 161

CONTENTS

Page
Colonial Development and International Co-operation . . . 371
Early English Naturalists. By Prof. F. J. Cole, F.R.S. . . . 373
Men of Science in Industry and Society. By R. Brightman . . 374
Wireless Direction Finding. By Dr. R. L. Smith-Rose . . . 375
Newton Tercentenary Celebrations 375
Operational Research. By Sir Charles Goodeve, O.B.E., F.R.S. . 377
Progress of Cancer Research. By Dr. I. Hieger 385
Obituary :
  Dr. Bernard S. Dyer. By G. Taylor 386
News and Views 387
Letters to the Editors :
  Liquid Helium II.—Dr. H. S. Green 391
  Theory of Skating.—Dr. A. E. Bell 391
  Chromatic Aberration of Electrostatic Lenses.—W. A. Le Rütte 392
  Absorption Band Spectrum of S_2 in the Schumann Region.—R. Maeder and Prof. E. Miescher 393
  Energy of the Ground-State of Helium-like Atoms.—H. A. S. Eriksson 393
  Theory of the Anomalous Skin Effect in Metals.—G. E. H. Reuter and E. H. Sondheimer 394
  Use of 'Calyx' Burner to Determine Combustion Conditions.—H. Rostron Hindley 395
  A New Sulpha Compound ("6257") and its Use in Human Cholera Infection.—Dr. S. S. Bhatnagar, F. Fernandes, J. de Sa and P. V. Divekar 395
  Bactericidal Activity of Phenols in Aqueous Solutions of Soap.—Prof. H. Berry and H. S. Bean 396
  Calcium-Deficient Media : Their Effect on Phage Action.—H. Williams Smith 397
  Production of Itaconic Acid and Kojic Acid by a Species of *Aspergillus*.—John L. Yuill 397
  Presence of Substances Inhibitory to Acid Phosphatase in Normal Human Urine.—Dr. Alice M. Robinson and Dr. F. L. Warren 397
  Trace Elements and Nitrification.—Dr. Howard Lees and Jane Meiklejohn 398
  Vascular Patterns in the Testis, with Particular Reference to *Macropus*.—Dr. R. G. Harrison 399
  Relationships in the Plumbaginaceæ.—Dr. H. G. Baker . . 400
  Pharmacology of Ch'ang Shan (*Dichroa febrifuga*), a Chinese Antimalarial Herb.—Dr. C. S. Jang, F. Y. Fu, K. C. Huang and C. Y. Wang ; T. S. Work 400
  Annealing of Glass.—S. M. Cox 401
  Determination of Silicate Inclusions in Steel.—Prof. J. Kamecki and A. Kotlinski 402
  Extinction of Petrol Fires by Methyl Iodide.—Dr. Oliver C. de C. Ellis 402
  A Simple Moving-Boundary Apparatus.—E. G. Baxter and Dr. V. Gold 403
  Elminius modestus in the Netherlands.—Prof. H. Boschma . . 403
  What is a Dialysate ?—Eric G. Ball 404
  Operational Research.—Prof. C. H. Waddington, F.R.S. . . 404
A Factor in Heart Muscle Required for the Reduction of Cytochrome *c* by Cytochrome *b*. By E. C. Slater 405
Plant Analysis and Fertilizer Requirements 406
Sociology of Mental Disease 407
Association of British Zoologists 408
Natural Selection of *Drosophila*. By Dr. F. W. Sansome . . . 409
Oribatid Mites and their Economic Importance. By M. Anantaraman 409
The Meson Field and the Equation of Motion of a Spinning Particle. By R. C. Majumdar and Dr. S. Gupta 410

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COLONIAL DEVELOPMENT AND INTERNATIONAL CO-OPERATION

THE increasing tempo of development in Colonial territories, and also the urgent need for integrating their economy with that of Europe as a whole, have given added importance to published studies of Colonial administration. A recent one[*], by Mr. Martin Wight, is the first study made of a Colonial legislative council in action, and has political as well as constitutional significance. Mr. Wight attempts to put the legislative council in its place against the life and society of one of the most progressive British dependencies in Africa. Beginning with a factual study of the history and practice of the legislative council over the twenty years from 1925, it affords a valuable introduction to the appraisal of the new constitution of 1946 in which the legislative council became the legislature for Ashanti as well as for the Gold Coast Colony, and was at the same time transformed into a representative legislature in which the official majority has been replaced by an unofficial, elected, African majority.

Mr. Wight comments on the significance of this first introduction of representative government into Africa outside the colonies of white settlement, in the general context of British Colonial government. His book well indicates how this step is in keeping with the spirit that has inspired British Colonial government since Sir James Stephen's days, and should do something to convince Africans that we share with them both the ultimate vision and something of the ardour and urgency which they are bringing to its realization. In seizing on the legislative council, which has long been the growing point of constitutional development in the Colonies, for the starting point of this series, the Colonial Research Committee appointed by Nuffield College could scarcely have demonstrated better the capacity of such research on contemporary political and economic questions to contribute to an understanding of these problems by both the white and the coloured peoples, and to the effective collaboration which is required for their solution.

A second reason for welcoming this survey of Colonial administration is the value of such a conspectus in relation to the latest approach to international co-operation in this field. The survey has its place in rebutting the uninformed criticism which has sometimes come into discussions related to the trusteeship proposals in the United Nations Organisation; but it is even more pertinent in regard to such developments as those on which the Foreign Secretary just touched in his speech in the House of Commons on January 22. Pointing out that the organisation of Western Europe requires economic support, he emphasized that such support involves the closest possible collaboration between the British Commonwealth and overseas territories, French, Dutch, Belgian and Portuguese as well as British. These overseas territories are large primary producers, with a standard of life which is rising and is capable of great development. They have raw materials, food and resources which can be turned to very great common advantage, and Mr. Bevin suggested that to enable Western Europe to achieve its balance of payments and a world equilibrium, it is essential that those resources should be made available and the exchange between them carried out correctly.

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[*] The Gold Coast Legislative Council. By Martin Wight. (Studies in Colonial Legislatures, Vol. 2: Published under the auspices of Nuffield College.) Pp. 285. (London: Faber and Faber, Ltd., 1947.) 12s. 6d. net.

Mr. Bevin did not pursue this idea into any detail. He affirmed that there is no conflict between the social and economic development of these overseas territories to the advantage of their people, and their development as a source of supplies for Western Europe as a contributor to the balance of payments. He merely indicated the Government's intention, if the Marshall Plan for American aid to Europe is accepted, to develop economic co-operation between Western European countries step by step, to develop the resources of the territories with which we are associated, and to build up a system of priorities which will yield the quickest, most effective and most lasting results for the whole world; it is also hoped that other countries with dependent territories will do the same in association with us.

Mr. Bevin's vision of the tremendous resources stretching through Europe, the Middle East and Africa, to the Far East, being brought together with the object of making the whole world richer and safer, involves economic and social planning on a bolder and more imaginative scale than the world has yet seen. None the less, the opportunity may well be there, and although this imaginative passage in his speech has largely escaped notice, there is already evidence that the European Powers concerned in Colonial administration are drawing closer together. The Royal Institute of International Affairs has recently published* a series of papers on Colonial administration read at King's College, London, in November and December 1946. Contributions from French, Dutch, Belgian and Portuguese administrators, side by side with Lord Hailey's review of British Colonial policy, are brought together, not merely to exchange experience and compare methods, but also to lay down general principles which may assist in the re-orientation of both policy and practice to meet the latest developments and the accelerated urge towards independence in the Colonial territories.

M. le Gouveneur H. Laurentie, in his review of recent developments in French Colonial policy, notes that in spite of frequent differences in method, Great Britain and France, inspired by their common belief in the freedom, the dignity and the reason of man, have set themselves the same goal. Dr. A. M. Joekes likewise concludes a very clear and pertinent exposition of developments in the administration of Indonesia with the hope that the assistance given by Britain in clearing up the situation in Indonesia will be a corner-stone for close and fertile co-operation between Great Britain and the Netherlands in protecting and promoting the well-being of both countries, and Dr. R. Godding's review of principles and methods now being followed in the Belgian Congo is of profound interest for such projects as the East African groundnut scheme. Scientific workers will note with special interest the reference to the National Institute for Agricultural Research in the Belgian Congo, and the emphasis laid on research. The twenty-one research and experimental stations now scattered all over that Colony, covering the various climates, soils and altitudes, have, in fact, something in common with the idea of pilot schemes developed by Dr. E. B. Worthington in his plan for Uganda.

One argument submitted by Dr. Godding in favour of the Belgian method of development is that cultivation of large modern plantations on scientific lines with up-to-date machinery affords much higher yields of produce of better quality, and in consequence a much larger return, to be ploughed back, as it were, in the form of educational, social, medical and material improvements in the native standards of living. Dr. Godding also referred to the formation of an institute of scientific research in the Congo, which would cover such fields as geology, botany, meteorology, sociology and medicine. It was intended to endow this institute with large resources, and it was hoped that it would become a kind of international research station for tropical Africa.

Such developments clearly provide substantial backing for the vigorous defence of Western democratic administration with which Dr. Godding concludes, and he too referred to the inspiration which the Western democracies draw from humanism and Christianity in this task, which, he affirmed, they would perform in a spirit of human solidarity with the coloured races. Dr. José de Almada similarly concluded his survey of Portuguese Colonial administration with the comment that the modern world leaves no room for privilege, economic domination or social injustice, any more than it can tolerate ignorance, disease, malnutrition and extreme poverty.

Lord Hailey's survey was more severely practical, emphasizing first the influences which had gone to form the modern British outlook on the general direction of Colonial policy and the measures taken to give it effect. Here he pointed out that in widening the franchise for the legislatures and extending their legislative powers, we should satisfy ourselves that such institutions are developing so as to secure the interests and confidence of the mass of the people; for this is the real measure of their success. Similarly, in admitting the native peoples to the State services and such administrative institutions as executive councils, there is the difficulty and danger of accepting those of doubtful competence or character. Again, Lord Hailey emphasized that for all the educative influence of the method of indirect rule it has its limitations, and we have not yet succeeded in making it popular with the more educated community or with the middle class or commercial elements.

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* Colonial Administration by European Powers: a Series of Papers read at King's College, London, 14 November to 12 December 1946. By José de Almada, Robert Godding, Lord Hailey, A. M. Joekes and H. Laurentie. Pp. xiii+97. (London and New York: Royal Institute of International Affairs, 1947.) 4s. 6d. net.

These are matters to which due attention will doubtless be given at the conference of unofficial members of the African Legislative Councils which is to be held in London later this year. Two things, however, stand out very clearly from this series of papers: first, the general disposition to examine anew the principles which have shaped the Colonial systems of the Western democracies, and to test the adequacy of the existing structure to meet the demands which the future seems likely to make upon it; and, secondly, the large measure of implicit support in the Colonial territories for the ideas of Colonial co-operation which Mr. Bevin ventilated in the most imaginative passage of his recent speech. The chapter on international relations in the Blue Book on "The Colonial Empire, 1939–1947" (Cmd. 7167) indicates how much has already been done to prepare the way, particularly in co-operation with the French and Belgian Governments. In his speech in the House of Commons on July 29, Mr. Creech Jones particularly stressed the three years programme of conferences in technical matters between these three Governments in Africa which had already been agreed, and his words are strikingly similar to those of Mr. Bevin in regard to the larger issue of Colonial development and European needs.

Scarcely less significant, however, is the emphasis placed by Mr. Creech Jones in this speech, in the Blue Book, and also in the papers just noted, on the importance of the contribution which the scientific worker himself must make in such developments. References to research in the Blue Book and also in Mr. Creech Jones' speech show how ready should be the response of the British Government to the lead which, as Dr. Godding showed, the Belgian Government has given in certain fields. Problems of Colonial welfare and development, in their scientific aspect, were considered by several sections of the British Association at its meeting in Dundee last year, while elsewhere current discussions on game slaughter in Africa in connexion with the control of tsetse fly and trypanosomiasis have emphasized the need for proper research, to which adequate finance is the key, in yet another field, and in particular the linking of research with authoritative administrative co-operation.

There are, indeed, many reasons why scientific men should take an increasing interest in Colonial affairs generally. For the solution of a wide range of Colonial problems their co-operation is essential, and frequently those same problems are linked to scientific problems of fundamental importance. Further, as citizens, they cannot be indifferent to the wider implications, in the material and economic field, and in the greater task of building those Colonial and international institutions which may best serve the highest cultural and moral needs of men. In seeking thus to provide the means of safeguarding both human welfare in its physical and material sense, and the great heritage of freedom and creative achievement which Western civilization has given to the world, we shall simultaneously further the nurture and advance of science itself.

EARLY ENGLISH NATURALISTS

English Naturalists from Neckam to Ray

A Study of the Making of the Modern World. By the Rev. Charles E. Raven. Pp. x+379. (Cambridge: At the University Press, 1947.) 30*s*. net.

Dr. C. E. Raven has followed up his remarkable work on John Ray by another, equally learned, on the early English naturalists. His purpose in the latter "began as a series of biographies. But very soon it became clear that the succession of 'lives' not only formed a very definite pattern, but that this illustrated and illuminated the progressive change in Western civilization from the medieval to the modern world." Again, "in Man's attitude to living nature the process of a gradual overcoming of superstition and fabulous tradition, and the development of the modern scientific spirit as a result, is significant and may be followed from man to man. . . . Little by little nonsense was recognized, fables were exploded, superstitions were unmasked; and the world outlook built up out of these elements fell to pieces." The thesis is not a new one, nor is it one that admits of serious dispute, but Dr. Raven has brought to bear upon it a wealth of new matter, the result of prolonged and detailed critical research. These notable additions to our knowledge have been exhumed often from little-known and unpromising sources, and they enrich and distinguish the author's bio-biographies of such naturalists as William Turner, John Caius, Thomas Penny, Thomas Mouffet, John Gerard, Edward Topsell, John Parkinson and Thomas Johnson. Dr. Raven's method, however, has one drawback. It complicates what is known as documentation, and a text frequently halted by the intercalation of bibliographical detail is apt to be tedious to follow. It is better to preserve the flow of the narrative even if it involves some sacrifice of meticulosity. In a future edition we hope to see the author's sources collected and printed in alphabetical order at the end of the text. But however this may be, historians of biology must welcome so scholarly an addition to their studies and literature.

The history and emergence of the modern outlook on science has been to many workers an attractive and fruitful field of research. The preceding or medieval period, based as it was on scholasticism, symbolism and the ingenuous acceptance of attractive but flagrant fables, was not only incapable of producing an integrated body of science, but would have been even hostile to it. As Dr. Raven remarks, the contest between an untenable tradition and the induction of the men who loved and lived by the world of plants and animals unhappily resulted in giving "for a time to the ancient writings an authority, indeed an infallibility, very damaging to progress. So long as Aristotle and Galen, or for that matter Genesis and the Apocalypse, were accepted and imposed as inerrant, it was difficult to encourage the investigation of the facts with which any real advance must begin. This delayed, though it could not prevent, the coming of the new outlook." Such is Dr. Raven's theme, and his scrutiny of the works of the early naturalists provides us with a convincing and orderly exposition of it. His most successful biography is that of William Turner, but much new light is thrown upon the works of Penny, Mouffet, Parkinson and Merrett. The book learning of Wotton, the author of a beautifully printed zoological treatise dated 1552, is rescued from undeserved obscurity, but Gerard's "Herbal" is severely, if justly, handled. Dr.

Raven, however, gives us an admirable analysis of the second edition of this famous book which had been competently revised and amended by Thomas Johnson. There are some omissions, such as Thomas Hill and Charles Butler—the latter one misses particularly, since he represents a type that Dr. Raven delights to reanimate.

Here are a few minor addenda and corrigenda. P. 58: Gaza's Latin translations of the biological works of Aristotle and Theophrastus were first printed at Venice, 1476, and Treviso, 1483. P. 145: Caius' "maculo" was evidently one of the Serranid fishes, some of which attain a length of 10 ft. The length given, 60 ft., is clearly an error, possibly for 6 ft. Caius' "ceruchus" could not be a sturgeon, but was undoubtedly the angler *Lophius*, as first pointed out by Jonathan Couch in 1862. The name is derived from the Greek and refers to the horn-like lures of the fish. Belon's "true picture of the dolphin" was first published in 1551 and only later in the "De Aquatilibus" of 1553. Hence Caius was not necessarily acquainted with the latter work. P. 180: Mouffet's unpublished engraved title-page was first described and reproduced by Mullens in 1911. P. 188: A comparison of Mouffet's woodcuts with the drawings of the original MS. is necessary in assessing the accuracy of the author. P. 220: The Su, which receives only a bare mention, is one of the most remarkable figures in Topsell, and he copied it from Gesner, who in his turn took it from Thevet of 1558. The description of this animal fits in with no known species, but it cannot be doubted that the figure was inspired by the sight of an American opossum carrying its young on its back. P. 221: The history of Dürer's rhinoceros in zoological literature is curiously relevant to the soundness of Dr. Raven's theme. P. 230: The commonly accepted biographical details relating to Leonard Mascall were shown to be inaccurate by Sir Frederick Smith in 1919. Nothing certain is known of Mascall's career. P. 235 *passim* and index: Jan Jonston's name is wrongly spelt. P. 337: The inexact quotation from Sir Thomas Browne is apparently taken from Wilkin, who was not always an accurate transcriber of Browne's manuscript, and "Turn" was understood to be Turner by Southwell in 1902. F. J. COLE

MEN OF SCIENCE IN INDUSTRY AND SOCIETY

The Engineer in Society

By John Mills. Pp. xix+196. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1946.) 14*s*. net.

THE right relation of knowledge and power—the means by which we can best secure that action in political and social no less than in industrial problems is determined after full regard to the scientific and technical factors as well as to the other elements in a situation—remains one of the central problems of our time. There are signs that appreciation of the importance of this problem has led to new attempts to find a solution. These attempts have clearly been on three lines: the provision of more effective administrative organisation by which the scientific worker can make his contribution; improvement of the training of the administrator; and the improvement of the training of the scientific man; while it has not been altogether overlooked that in a democracy the education of the ordinary citizen himself is also an important factor.

Mr. Mills in this book addresses himself squarely to the question why the scientific man, and more especially the engineer, does not occupy in society the position which his technical achievements and the part they have played in the radical transformation of the conditions of living would seem to warrant. He seeks to lay bare the reasons for his failure to do so, and to indicate by what steps he can take a more effective place in the control of the forces which his discoveries and inventions have released. But once again we find the physician surer at diagnosis than at prescription, and while there is much sound advice to the young industrial scientific worker, albeit frequently couched in jargon, or at least rather uncouth writing, Mr. Mills' contribution to the fundamental problem of how the man of science is to take a more effective place in the life of society is slight indeed. In that Mr. Mills concludes with half a dozen chapters on exposition in which the first essential to persuasive writing—clear thinking—is well brought out, and one chapter on "Reader Consciousness" indicates that Mr. Mills, at least in theory, is alive to the importance in either spoken or written exposition of considering first the needs and limitations of the audience or reader, he is at least open to the indictment that his practice is rather short of the standards he holds out for attainment.

What Mr. Mills has really given us in this book is something in the lineage of Samuel Smiles and "Sanford and Merton". It is a cautionary book for the scientific man or engineer contemplating or embarking on an industrial career. It abounds in suggestions, but few are pursued to any length; and indeed it is so discursive that adequate treatment of the themes raised would have made the book intolerably long, even had many of the irrelevancies been rigorously pruned. The author has something to say about the qualities which should determine the choice of research appointments as well as about the selection of men for the research—and the social waste when scientific talent of conspicuous ability is drawn off into administrative positions as soon as its full powers in research have been developed. On motives, incentives and salaries he is refreshingly forthright, sometimes provocative but usually stimulating, as further exemplified in some remarks on creative thinking in a chapter "The Art of Thought".

Mr. Mills comes nearest to his title theme in writing of professional associations, and his comments on the characteristic weaknesses of such bodies are just as pertinent to British organisations as to their American opposites. Nevertheless, he believes that scientific workers in industry should organise for their own protection and advancement, but even more for the great opportunities of social service which such organisation makes possible. In urging this he points out that this does not mean that scientific workers should be organised: his comment elsewhere on the tendency in present industrial conditions for the creative scientific man to lose his professional attitude deserves to be pondered when we are reviewing our whole organisation for scientific and industrial research. The problem which such professional bodies should examine is an engineering study of their class relationship to society. Commencing with a study of remuneration and of other incentives, he suggests that such a study might lead to others which will bring the engineer and scientific man into fruitful contact with the major problems of our time. If the project is attacked objectively by the scientific method, it should lead to results of social importance; and the core of the book really lies in Mr. Mills' plea for all scientific men of good will to join in an intelligent attack upon the social, economic and political problems of the day by an evolutionary application of the methods of science. Primarily that means a study of the problems of organisation, for the scientific method is to-day so little employed outside physical problems and, as Mr. Mills shows, is so diametrically opposed to the interests of particular classes, that its use in open attack may be impracticable. None the less, he believes its use is the last hope of our civilization, and his dignified plea for the engineer and scientific man to apply the objective method of science to the things directly affecting their lives and national surroundings without regard to inbred or subjective attitudes goes far to redeem his blemishes of style.

R. Brightman

WIRELESS DIRECTION FINDING

Wireless Direction Finding

By R. Keen. Fourth edition. Pp. xii+1059. (London: Iliffe and Sons, Ltd., 1947.) 45*s*. net.

THE appearance of the fourth edition of this book will do much to dispel the impression, prevalent in some quarters, that the technique of radio direction finding has been rendered obsolete by the introduction and development of radar in recent years. As the author explains in his introductory chapter, there are several fields in which direction finding will still have commitments for many years to come. The relative simplicity of the equipment required to give guidance to ships and aircraft, and particularly to those in distress, makes it an invaluable aid to navigation; in another field, the network of direction finders provides the only means so far available of locating radio transmitting stations, and such information is frequently required under peacetime conditions as well as in time of war.

In spite of the fact that the present book excludes a discussion of radar technique as such, it is a considerable enlargement on the previous edition, which was reprinted four times during the War. The only new chapter added describes the recently developed radio navigation systems such as 'Gee', 'Loran', 'Decca' and 'Consol', some of which use pulse modulation and some continuous-wave technique. The remaining chapters have been suitably expanded to include material descriptive of advances and developments; much of this material has only recently become available for publication.

Two of the most important additions are the sections on the calibration of direction-finding systems of various types, and on the classification of observed bearings. On both these subjects there has been much confused thinking in the past, and their detailed study has resulted in considerable improvement in the accuracy with which radio bearings can be observed and interpreted. The subject of radio wave propagation at both high and very high frequencies is treated somewhat more fully, since a detailed knowledge of this is fundamental to the successful exploitation of direction finding.

The book has been brought up to date also by the addition of details of new equipment developed both in Great Britain and in the United States, and including blind approach and landing systems for aircraft, improved forms of the Adcock and spaced-loop aerial systems, and various types of cathode-ray tube presentation devices. The bibliography is, as in previous editions, an important feature of this book. With more than four hundred references, it forms a very useful guide to the literature of the subject, and it includes the titles of some papers still in course of publication.

As a comprehensive, practical manual on the various aspects of radio direction finding, the book can still be confidently recommended to students, engineers and other workers in this field.

R. L. Smith-Rose

NEWTON TERCENTENARY CELEBRATIONS

Royal Society

Newton Tercentenary Celebrations, 15–19 July 1946. Pp. xv+92+6 plates. (Cambridge: At the University Press, 1947.) 10*s*. 6*d*. net.

THE tercentenary of the birth of Sir Isaac Newton occurred in 1943. The Royal Society arranged at that time a commemorative meeting, and it was decided that more complete celebrations of an international character should be held after the War. These celebrations were held in July 1946, and invitations to send delegates were extended to the national academies of the world; in spite of the difficulties of travel, more than thirty countries were represented.

During the course of the commemorations, a number of addresses on various aspects of Newton's life and work were given, which were of considerable interest. These are all printed in the present volume, together with the list of delegates and the programme of the celebrations. It is well that they should be published in this way and so made available to a larger audience. The principal address, on "Newton", by Prof. E. N. da C. Andrade, gave a brilliant account of the life and achievements of Newton; in a very effective manner he called on the great men of science, from Newton's to the present time, to pay their tributes to Newton's genius. Among the other addresses of special interest were those on "Newton and the Atomic Theory" by Academician Vavilov; on "Newton: the Algebraist and Geometer", by Prof. H. W. Turnbull; and on "Newton, the Man", by the late Lord Keynes, which was read by his brother, Mr. Geoffrey Keynes.

At the opening address to the delegates, the president of the Royal Society announced that the Chancellor of the Exchequer had agreed to ask Parliament to vote a sum of money sufficient to provide an Isaac Newton Observatory, to house a reflector of 100-in. diameter, as a fitting national memorial to commemorate the tercentenary of the birth of the greatest British man of science. The design of this telescope is now under consideration by a special board of management which has been constituted.

The volume is illustrated with three portraits of Newton, an old engraving showing Newton's rooms at Trinity College, Cambridge, a drawing of Woolsthorpe Manor by Mr. Hanslip Fletcher, and a reproduction of a letter from Newton to Halley.

Plato's Theory of Education

By Prof. R. C. Lodge. With an Appendix on The Education of Women According to Plato, by Rabbi Solomon Frank. (International Library of Sociology and Social Reconstruction.) Pp. viii+322. (London: Kegan Paul and Co., Ltd., 1947.) 18*s.* net.

THE aim of this important book, by Prof. R. C. Lodge, of the University of Manitoba, is to meet the needs of students of educational theory, "of those who are interested in Plato as thinker and who find in him a standing challenge to their own powers of thought, and of that wider group who are seeking to enlarge their own vision". The author considers Plato as writer, teacher, and thinker who believed that in the balanced philosophic life is to be found the solution of all human problems. Prof. Lodge fulfils his promise in twelve admirably written chapters. Turn where you will in these chapters, and you are struck by their freshness, clearness and vitality. He writes as a scholar, but not for scholars only.

As to the bibliography, a British reader naturally expects to find certain names, and he does find the names of Nettleship and A. E. Taylor. But he wonders why no mention is made of Bernard Bosanquet, the distinguished author of "A Companion to Plato's Republic" and of "The Education of the Young in the Republic of Plato", published in 1900. There was good reason for omitting R. H. S. Crossman's "Plato Today" (1937), which is too exclusively British in its outlook to attract an American writer. Some of the British books mentioned by Prof. Lodge, though important in their own way, contain only bare references to Plato. For this there may be good reasons; but their inclusion looks rather odd.

Mechanics

By Prof. John C. Slater and Prof. Nathaniel H. Frank. (International Series in Pure and Applied Physics.) Pp. xiii + 297. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 20*s.*

THE word 'mechanics', although derived from μηχανη, a machine or contrivance, is often used to describe the general treatment of natural philosophy by mathematical methods, and it is in this sense that the authors here employ it. This particular work is the first of several, which are intended to replace their "Introduction to Theoretical Physics", published in 1933, and is presumably to be followed by others on electromagnetism and quantum theory. In this dissection, it is believed that a better treatment of each field can be provided, at the same time preserving the general unity essential both to teacher and student.

The main emphasis here is on dynamics and the theory of vibrations, and the first seven chapters are devoted to the classical development of this theory. After the enunciation of Newton's laws of motion the fundamental principles of particle and rigid dynamics are deduced, to be followed by the methods of Euler, Lagrange and, finally, Hamilton. Special vibration problems are then considered, such as those of a string, a membrane, and an elastic solid, and the last chapter is concerned with the elements of irrotational fluid flow. A number of appendixes are also provided to elucidate the properties of complex numbers, vectors, tensors, Fourier series and Bessel functions, which have been previously utilized in the main text.

The whole work is beautifully bound and clearly printed on good quality paper, and should prove a useful book of reference. J. H. PEARCE

Die Bluteiweisskörper des Menschen

Untersuchungsmethoden und deren klinisch-praktische Bedeutung. Von Dr. F. Wuhrmann und Dr. Ch. Wunderly. Pp. 354. (Basel: Benno Schwabe und Co., 1947.) 36 Swiss francs.

THIS book is divided into three parts, of which the first deals with the general physico-chemical properties of serum proteins. The second chapter considers methods used in the study of serum proteins: electrophoresis, ultracentrifugation, colour tests such as the Millon reaction, and finally a series of empirical clinical methods such as the Takata reaction, among them some not in use in Britain. In the third part an account is given of the changes occurring in diseases as revealed by the methods described previously. The fourth chapter groups diseases according to the serum fraction mainly affected by them. The concluding chapters sketch the formation of blood proteins (13 pages) and the therapeutic application of serum fractions (17 pages).

A work such as this, written by five authors, will necessarily show some unevenness; but by more severe editing, some repetitions might have been prevented. In the pathological sections, English literature is not sufficiently taken into account. In the chapter on nephrosis, for example (p. 281), out of fifty references, only one is to an American publication, and there is not one to a British journal. In spite of these shortcomings, the book contains much valuable information and will enable workers in this field to get an insight into the trends of research in Switzerland.

Recent Advances in Endocrinology

By Prof. A. T. Cameron. Sixth edition. Pp. vii+443. (London: J. and A. Churchill, Ltd., 1947.) 21*s.*

IN form, this sixth edition does not differ from its predecessor, which was published in 1945, and the revisions it incorporates are in general only slight. The more important additions are paragraphs on the treatment of hyperthyroidism with thiouracil, and on the iodoproteins; further information about the effects of adrenalectomy and the treatment of Addison's disease; and some interesting new facts about the parathyroids. The book is a very useful summary of the whole field of hormone studies, and it is bound to enjoy the success of previous editions.

Exploring Our National Parks and Monuments

By Devereux Butcher. (Published under the auspices of the National Parks Association.) Pp. 160. (New York and London: Oxford University Press, 1947.) 15*s.* net.

THE United States have long given a lead to the world in the matter of national parks. Although the Yellowstone Park is world-famous, it is but one of their many Nature reserves, embracing some twelve million acres of land, lake and forest. There are reserves from Maine to California and from Alaska to Florida. This book by the executive secretary and editor of the National Parks Association of America is a guide to their twenty-four national parks and thirty-eight Nature monuments. It gives a description of each reserve, its scenery and fauna; also how to reach it and the accommodation available for visitors. The many photographic illustrations are excellent and more than tantalizing for the English reader, whose travel opportunities are now so restricted. The book is well produced and admirably fulfils its object. FRANCES PITT

OPERATIONAL RESEARCH

By SIR CHARLES GOODEVE, O.B.E., F.R.S.

DEFINITION AND USE IN WAR

THE term 'operational research' came into prominence during the War to describe what to the Services was a new type of thinking process used to arrive at answers to questions arising out of the operations of war. This thinking process has, however, already to some extent been used in industry under other names. It has been applied to market problems, cost accounting, quality control and works efficiency; in other words, to the operations of industry[1]. It has also been applied to agriculture and medicine. Its successful application during the War is already stimulating and extending its peace-time application.

Operational research has been defined in various ways. I commonly call it "quantitative commonsense"; but more specifically, *operational research is a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control.* This definition is based on that put forward by Kittel[2] and is preferable to the more complicated and limited one put forward by Watson-Watt[3]. According to the scientific method reliance is placed only on controlled experiments or on experiences, the observations of which can be analysed. From the analysis, conclusions are deduced, using the rigorous logic of mathematics and statistics.

The applied nature of operational research is shown by its association with executive decisions, and it follows that workers in this field must be closely in touch with, if not part of, executive departments.

The field of operational research depends on the interpretation of the word 'operations' in the definition. This paper attempts such an interpretation by means of illustrations. In war, operational research was applied to the use of weapons, to tactics, and to strategy. In the peace-time application of operational research, studies are directed, for example, to the use of equipment and man-power, to operating procedures, and to the solution of those many problems faced by management in operating or controlling factories or public utilities, or by Government authorities in planning. The field of operational research is very wide; but it will be seen that it is quite distinct from the field of most applied scientific research, the latter being concerned with new or improved processes, equipment, materials, etc.

Let us first look at some of the examples from the Second World War. Operational research was really born out of the 'Battle of Britain'. As is well known, we had in 1940 relatively few fighter aircraft compared with the number that would have been required to defend our shores against an air invader. We had very good fighter pilots and very good aircraft; but, with the equipment and methods used prior to 1940, it would have been impossible to obtain sufficient interceptions to defend our shores. The most important new feature that came in was, of course, radar. This equipment, by giving ample warning, permitted the retention of aircraft on the ground until needed, and then, by plotting the positions of the enemy and defending aircraft, enabled a 'ground control' to direct the aircraft to a position where the enemy could be sighted visually. The planning of this sequence of operations involved careful analysis of training and of operational experiences, and involved also a full analysis of the technical possibilities of the equipment. But the process of combining these factors required mathematical calculations beyond the experiences of the ordinary commanding officer. Accordingly, a small party of half a dozen scientists was attached to Fighter Command, to study and refine the deployment and the operational orders. These scientists learnt how to estimate which were the bad targets and which were the good, and to determine where and how our limited effort could best be expended. Their analyses formed the basis for the operation of the whole defence organisation of Britain. It is estimated that radar itself increased the probability of interception by a factor of about 10; but that, in addition, this small operational research team increased the probability by a further factor of about 2, which together meant that the Air Force was made twenty times more powerful. The operational research contribution, a doubling, was out of all proportion to the amount of effort spent on the research.

An even more startling case was the introduction of Coastal Command to the Battle of the Atlantic. While Coastal Command had a number of successes in the early days of the War, these fell far short of what was needed when the U-boat campaign was renewed with increased intensity during the winter of 1941–42. Prof. P. M. S. Blackett[4], whose name will go down in the history of operational research as outstanding, came into the picture to see what could be done. He built up a small team of scientists at Coastal Command to study all aspects of the problem of air attack on U-boats. Of particular importance was the work of the late Prof. E. J. Williams, who, in the spring of 1941, analysed the previous attacks on U-boats by Coastal Command aircraft. This analysis led to the conclusion that, instead of the depth-charges or bombs being dropped more or less on and about the centre of the targets, there was a serious and not obvious fault in the tactics adopted. Indeed, it later came out that the chances of a successful kill were something like one in a thousand.

The tactics accepted at that time were based on a belief that the best setting for a depth-charge to explode was 100 ft., where the charge would be well 'tamped' by the water. It was also known that when a U-boat dived, it increased its depth at the rate of about 2 ft. a second, and that accordingly it should have been submerged for at least 40 sec. before the depth-charge exploded. (The lethal range of a depth-charge is about 20 ft.) Allowing for the speed of descent of the depth-charge and the forward movement of the submarine, the best time and place to drop the depth-charge could be calculated, using as a point of reference the swirl left by the submerging U-boat. To carry out the attack properly, it would commonly be necessary for the aircraft to frighten the U-boat into submerging and then attack at the appropriate number of seconds later. (In fact, of course, most aircraft went straight into the attack.)

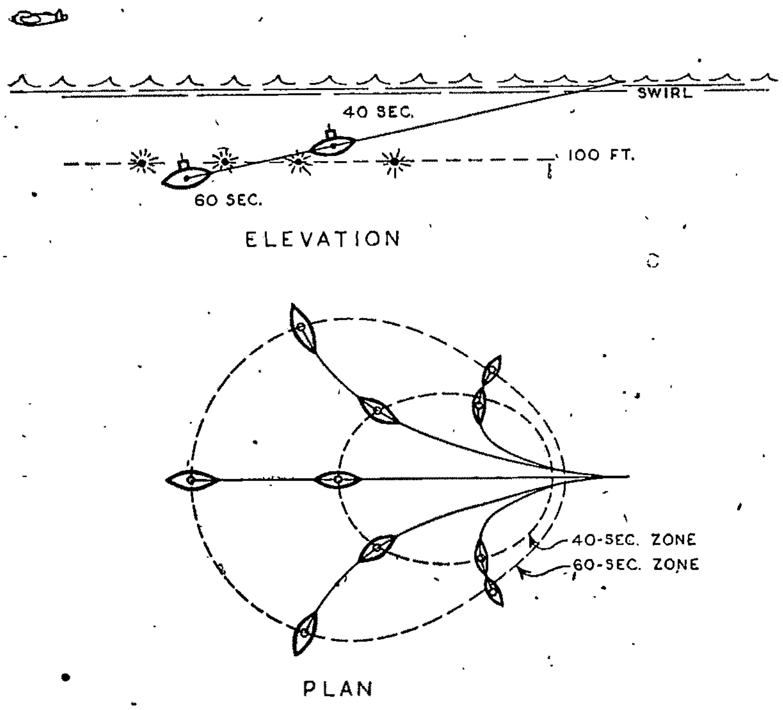
Prof. Williams' analysis showed, among other things, the following statistics (see ref. 4) for the number of U-boats visible and having submerged for different times at the moment of attack:

Condition of U-boat	Percentage of all attacks
U-boats visible	34
Submerged up to 15 sec.	27
,, 15 to 30 ,,	15
,, 30 to 60 ,,	12
,, more than 60 sec.	11

From this it is seen that only about one-tenth of the U-boats could be in the depth-range of the exploding depth-charge, when set to explode at 100 ft. The analysis further showed that the volume of the 'probability zone' in which the submarine lay increased very rapidly, indeed, according to the third or fourth power, with the time of submergence. (See accompanying diagram.) This three-dimensional probability zone is that inside which it is almost certain (that is, 97 per cent probable) that the submarine will be found and is calculated by allowing for all possible movements of the submarine inside the limits of its estimated course and speed, turning circle, etc. The inaccuracy with which the depth-charges were dropped also increased very rapidly with the time of submergence, largely due to the disappearance of the swirl. Taking the two together, it was found that, of the one-tenth of the U-boats which were within the lethal range for depth, fewer than one in a hundred were within the lethal range for plan. By setting our depth-charges at 100 ft. we were failing to engage the targets which could be attacked most accurately and which were by far the most frequent, that is, U-boats visible or submerged up to 15 sec., simply to gain the small increase in lethal range of a depth-charge at 100 ft. This is probably as serious an example as we could have of the concentration on bad targets and the disregarding of good. It is difficult to appreciate how it can have arisen until one realizes how ingrained and over-emphasized certain technical facts on underwater explosions had become. In fact, the change to the shallowest possible depth setting was opposed by a number of technical people, until they were shown the full analysis giving the other aspects of the problem. (This case also showed up a good lesson in research management. In accordance with the procedure at that time still prevailing in this section of the Admiralty organisation, orders were passed to the research station concerned to make the necessary alterations in design. The delay which followed led to a visit of inquiry which elucidated the situation described above. When the research people concerned were finally convinced, the 'unsurmountable' difficulties were resolved in a week.)

To conclude this story, within a very short time of the change being made, first to 35 ft. and later to 20 ft. depth setting, one U-boat was sunk and another captured and brought into port, the only enemy submarine captured during the War. The sinkings went up steadily until a year later they reached twenty a month. The Germans within the first month announced to their Navy that we had introduced a new and much more powerful depth-charge. This change brought Coastal Command effectively into the War, and their aircraft, together with the sea-borne forces, with which they were closely integrated, averted defeat in the most critical period of the U-boat war.

My third story has a somewhat amusing side. During the latter phase of the U-boat war, the enemy U-boats in the Bay of Biscay were countering our radar with some success by listening to the transmissions from our aircraft, and diving at the appropriate moment before we could pick up the radar echo. We countered this by special technical devices and managed to maintain a certain low rate of successes against the enemy. The operational research team of Coastal Command showed, by careful statistical analysis followed by model exercises on a games board, that a saturation technique was possible which would take advantage of the fact that the U-boats' storage batteries would not permit submergence for more than four hours, during which time they would move a certain maximum distance. With the required number of aircraft working in accordance with a definite plan of patrol, there would always be an aircraft inside the critical listening range when the U-boat surfaced, and the latter would be forced to submerge before it could properly recharge its batteries. We would thus exhaust our opponent and he would be forced to stay on the surface. Our sightings would increase to about twenty per week, and as we were getting about one kill in every ten sightings, this would mean about two kills a week. The required number of aircraft was twenty-five more than were available for this patrol force, and a considerable argument with Bomber Command followed a request for the additional aircraft. In this argument, a senior Bomber Command officer inquired whether this War was to be fought with slide-rules or weapons. However, a three weeks trial of the full operation was ordered by the Prime Minister, resulting in sixty-seven sightings and six kills. An extraordinary coincidence perhaps; but the 'slide-rule' had won!



METHODS OF OPERATIONAL RESEARCH

Statistical Analysis

The foregoing examples are obviously very important ones, but they are rather too complex to illustrate methods of operational research. For this purpose a different approach is necessary. In most problems, there are a number of variables to be considered. Our first object is to find the correlation between these variables, our second to test the stability of this correlation by finding the causal link lying behind it, and our final object is to estimate the likely consequences of any particular change that may be imposed upon the system. We thus provide ourselves with a quantitative basis for any decision to be made regarding the change. For example, how does the number of ships sunk in a convoy depend upon the speed of the convoy ? Is the speed the direct cause of the effect ? How many ships are likely to be saved if the speed is increased ? What will be the cost resulting from the elimination or re-routeing of slow ships, etc. ?

Unfortunately, most problems have many variables, which are varying in apparently quite unco-ordinated ways. In addition, there are often superimposed completely random fluctuations, which tend to obscure the correlations. One generally attacks a problem first by a study of past experiences ; if one is lucky, it might be possible later to organise an experiment to test some particular point. The data from these experiences are subjected to a statistical analysis to determine the *intensity* of the correlation between any pair of variables. Are the higher sinkings more frequently found to occur with slow speeds of convoys than with fast ? (The answer, during the War, was found to be 'Yes'.) The intensity of this correlation is expressed quantitatively by the 'correlation coefficient' determined from the statistical analysis.

If a correlation is found, the next step is to find the form of the relation between the two variables. Statisticians call this the 'regression' of one variable on the other. More specifically here we want to know the partial differential coefficient relating the change in sinkings to a change in speed, the other factors, such as size of convoy, air and sea protection, route, etc., being constant or accounted for.

The causal link is best determined from theoretical or other independent grounds. The speed of the convoy is clearly an independent variable, but it may be that the correlated rate of sinkings really depends on some other variable itself accidentally intensely correlated to the speed. For example, the ships might make smoke when steaming at slower speeds and thus be detected by a U-boat at a longer range. However, a study of the performance of the enemy's submarines and of his tactics showed clearly a direct causal link. It was possible to go further and predict approximately the relation between sinkings and speed, and this relation was found to agree satisfactorily with the operational data. It could, therefore, be predicted that, if it was decided to make a certain increase in the speed of convoys, a certain increased safety was to be expected. The loss due to various dislocations of convoy routine was separately calculated and set against the gain, and the net result formed the basis for decisions to increase speed in many important convoys.

Models and Experiments

As will be seen from many of the examples in this article, one of the commonest methods of operational research involves setting up one or more possible imaginary models, studying their expected characteristics and seeing which fits the data best. This is exactly the technique used in the determination of crystal structure by means of X-rays. It is impossible to deduce the structure from the data on X-ray diffraction—the mathematical equations cannot be solved in that direction. One can, however, very accurately calculate the diffraction angles and intensities for a given model or series of models derived from other considerations and be satisfied that only the correct model will lead to data which fit the observations.

Similarly, one can make use of analogies, particularly electrical analogies, as is done so commonly in various branches of physics and engineering.

The use of direct experiments to test a particular point is, needless to say, of the greatest value, but experiments often involve considerable cost. As operational research becomes more accepted, experimental operations will become more common, which in turn will add to the strength of this branch of science.

Sampling and Significance

Full technical details of this important subject can be found in standard text-books such as that by Davies[5]. The relative advantages and weaknesses of different methods of sampling are well known and the reliability or significance of a conclusion from a particular group of data can be determined by standard statistical methods. If certain returns show variations from week to week, a statistical analysis can show what is the chance that differences, equal to or greater than those actually observed, could have arisen from random fluctuations. If the odds against are high, it can reasonably be assumed that some extraneous factor is present; highest odds being necessary where a wrong decision would involve serious consequences.

The significance of a conclusion is greater (that is, the odds are higher) the greater the number of data in relation to the number of variables. The experiences of the War, however, have shown that one should not be deterred from attacking a problem even with only very limited data, particularly when the problem is an urgent one; that is, the risks of delay may be greater than the risk of a decision based on low significance. Very often parts of the picture can be filled in by theoretical deductions and thus one might narrow down the apparent fluctuations and thus effectively increase the significance. In this way, operational research or applied statistics, whichever one cares to call it, departs from or goes beyond the more rigid field of pure statistics.

For example, supposing that over a period of time and in a given area or business there is an average of 500 events per week. If each one of these events were completely independent of one another and of any common factor (that is, they occurred at random, such as is nearly the case with births, accidents, placing of orders, etc), then the odds are fifty-fifty that any particular week would show less than 485 or more than 515 events. In other words, if a week showed, say, 484 events, it does not really mean that the 'orders have fallen' or the 'accidents have fallen', as one commonly sees reported. It *may* be true, but no decision should be based in any way on an isolated fact of this kind.

On the other hand, in a case where the events are the completion of operations in a production line, and where the time of beginning one operation depends primarily only on the end of the previous operation, a weekly return of less than 485 events would be of great significance and extraneous factors should be sought. The significance, therefore, depends not only on the statistical data, size of sample, etc., but also on the expectations of the 'standard deviation' based on an analysis of the technical characteristics of the processes involved.

This question of significance of observations is one of the most important to executive decisions. Probably more wrong decisions arise from an over-emphasis being placed on chance happenings than from any other cause.

Soundness of Data

Before going on to further methods of operational research, some remarks on data are necessary. It is obvious that the soundness of data should be thoroughly tested before the data are used. Hearsay evidence is extremely dangerous. Two examples will illustrate the mistakes that might arise.

In 1940, we were asked at the Admiralty to re-design a certain weapon to enable it to fire vertically. When interrogated, crews of ships attacked by enemy dive-bombers were almost unanimous in saying that the dive-bombers came down vertically. By placing an inconspicuous grid on the wall of the interrogation room and asking the witness to point his hand in the direction of the aircraft, it was soon found that 'vertical' to a man being attacked was between 45° and 75°. This research saved us the task of overcoming very difficult design problems to produce a weapon which would have been of little value.

A similar incident took place with regard to the depth setting of ship-borne depth-charges. Reports from ships at sea continually stated that the enemy submarines went deep and below the deepest setting on the depth-charge. In fact, figures were quoted to support the claim. The statement was suspect because there is a natural tendency in a man, who has carried out an attack accurately so far as he can see, to blame the one factor he could not control, in this case the depth below the deepest setting. Fortunately, it was possible to get an approximate idea of the depth of the enemy submarine by the range at which the asdic beam lost contact, the angle of the lower edge of the beam being known very approximately. This gave a fairly reliable knowledge of the depths of submarines during attacks and showed that very few, if any, were going anywhere near the depths alleged.

The remainder of this story tells of a failure to apply operational research results. The myth that enemy submarines went deep, based at first on human weakness but kept up by intelligence reports from German sources, resulted in an extensive wastage of depth-charges and the escape of many German submarines.

Probability Calculations

The example of the gun just quoted is an interesting one to illustrate a common type of problem. A gun with its sights can be designed to be at its best at a certain angle of fire, its effectiveness falling away on either side of this angle. The usual requirements ask for a gun to have the maximum probability of shooting down enemy aircraft and at the same time to be able to engage an aircraft no matter at what angle it may be. A study of this problem shows that the two requirements are conflicting, and one must choose between the two or compromise. From an analysis of attacks carried out both by enemy aircraft and our own, it was fairly easy to determine the approximate shape of the curve relating the probability, $Q_t d\alpha$, of finding a target at a given angle α (that is, between α and $\alpha + d\alpha$) above the horizontal as a function of that angle. In a similar way, one can determine the probability of hitting, P_h, as a function of the angle. One can determine the overall probability by integrating the product:

$$P = \int_{\alpha}^{\pi/2} Q_t P_h d\alpha.$$

The integral will have its highest value under the conditions where the highest values of P_h coincide with the highest values of Q_t; the contribution to the integral of a region where P_h might be high and Q_t low would be negligible. In other words, the gun should be designed to be most effective at those angles where targets are most probably to be found, and other angles should take second place or be ignored. In this example, Q_t is very low at 90° elevation and so, indeed, in almost any design of gun, is P_h. The complications of designing to cover 90° elevation, particularly as this would lead to reduced effectiveness of the gun at other angles, would reduce the value of the weapon. (In this example, the effects of range, enemy speed, etc., would be roughly included in Q_t and P_h, but in more precise work double or triple integration would be required.)

This is a common problem where coincidences are required. In general, where the requirement is to get the maximum number of hits, we want the integral of the products of the various probabilities to be a maximum, and for this we want the maximum amount of overlapping of the probability curves. We have already seen an important but more complicated example, that of depth-charges used by Coastal Command aircraft. Here, however, the mathematics by the integration method would be too complex and it is necessary to use more approximate methods, in which the submarine is assumed to lie with uniform probability inside a circular or oval-shaped zone. The size of the zone is, of course, a marked function of time; if it is a three-dimensional zone its volume may go up as the fourth or fifth power of the time.

A further example of this type was found in the case of Coastal Forces' counter-attacks on raiding enemy E-boats. The E-boats were first spotted and plotted by radar and the motor gun boats were sent out to attack. As in the case of Fighter Command, the gun-boats were controlled as near as possible to the position of the enemy and if a sighting occurred the enemy was attacked. Most of the E-boat sorties took place in weather of low visibility, which, of course, made our counter-offensive much more difficult.

There was, however, a marked difference between the percentages of sightings obtained by the flotillas of two separate Commands, and a study was made by the naval officers concerned to find the cause. It was appreciated that up-to-the-minute information was important, but it was found that the average time between the obtaining of the position of the enemy and the passing and re-plotting of this position on the charts of the gun-boat was the same for the two Commands. In other words, there appeared to be no statistical difference between the times of the two flotillas. However, the average taken was a linear average, whereas the probability of interception is a function of the inverse third or fourth power of the time. Therefore, the average taken should have been of the times raised to the third or fourth power rather than to the first. When this was done, there was a marked difference found in the averages of the two flotillas, quite sufficient to account for the difference in success.

In other words, there were big fluctuations in the times of transmission. In the successful flotilla, there were fortunately quite frequently a number of short times of transmission and these were responsible for most of the interceptions. In the other flotilla, while the average time was the same, there were fewer exceptionally short times. This fact was not obvious in view of the large random factor involved in the interception problems.

These are examples in which common sense, by applying the scientific method, has been turned into quantitative common sense.

Causal Links

A discussion of causal links is liable to lead one into the realms of philosophy or at least into difficulties as to the meaning of cause and effect. However, there are many branches of science in which there is no ambiguity and in these one can predict with a high degree of certainty that if certain things are done, a known effect will follow; for example, a force can *cause* a movement. As one of the primary objects of operational research is to predict the future, it is necessary to find some assurance that a particular relation between two variables is a stable one. If the data go back some time and have consistently supported the relation, then stability can probably be safely assumed, but the best basis for security lies in an accurate knowledge of the causal link behind the empirical relation. With such a knowledge, it is possible to use data collected over a shorter time and to make all conclusions of much wider and more general application.

It has already been emphasized that statistical correlation between two variables gives no indication of a causal link. Indeed, the history of applied statistics is full of examples where inexperienced people have jumped to conclusions in this connexion. For example, during the War a graphical correlation between the numbers of pilots having various degrees of 'night vision' and the successes of pilots in intercepting enemy aircraft at night was taken to prove the importance of 'night vision' (the tests actually included intelligence and quickness of response as well). A closer scrutiny of the results, however, showed that the predominant factor was the distribution of pilots over the various degrees of night vision, and the coincidence of the maxima of the two curves at 'degree 22' merely showed that the successful night fighters had the same *average* night vision as the bulk of the pilots.

It is well accepted in the iron-making industry that the output of a blast furnace falls if the conditions are changed to produce iron with a higher silicon content. This, indeed, can be proved very clearly from statistical data. The real cause here, however, lies first in the fact that higher silicon iron requires a higher temperature to shift the equilibrium towards the reduction of silicon dioxide, and the blast furnace would require more coke and more air in relation to the iron produced. Blast furnaces are designed, however, to operate with a more or less fixed maximum quantity of air and, therefore, the output falls, simply because in practice the furnace cannot get more air. There is thus no direct causal link between output and silicon content. A furnace to give a fixed through-put of iron could be built, but it would require a different design.

Organisation of Operational Research

Operational research may be carried out in two ways: either as part of ordinary research work or in a separate section set up for the purpose. Each of these has its protagonists. Clearly, a man who undertakes the research and development leading to a new piece of equipment or a new process should learn for himself the many operational problems concerned therewith. He should also follow up his new equipment or process by studying its behaviour in actual use. This might or might not be called 'operational research' according to the use made of the methods outlined in this paper.

On the other hand, there are severe limitations on this latter type of organisation, limitations which can largely be overcome by the setting up of a separate section. If operational research is to provide executive departments or managers with a quantitative basis for decisions, the men carrying out the research must be in the closest possible contact with the men who make the decisions; the value of their advice will be directly related to the extent to which they can see the overall picture of the problem under consideration.

A second advantage of a separate section is that it frees the operational research workers from executive responsibility. They are thus able to initiate studies with greater freedom and are limited only by the confidence that can be built up between themselves and their colleagues. Executive responsibility, whether in a normal research department or in management, has not been found conducive to the best operational research, and most of the successes of this work have been associated with 'free lance' teams. On the other hand, operational research teams should, of course, have a good sense of responsibility towards their task and their employers; but, as 'common sense' is one of the first qualifications of an operational research worker, no difficulty should be found in practice. A full discussion of the organisation of operational research must, however, await further peace-time experience.

PRESENT AND FUTURE OF OPERATIONAL RESEARCH

Application to Traffic Problems

The extension of operational research in peace-time activities is already in full swing, particularly in certain specific branches. Some of the most interesting recent applications have been in the fields of railway and road traffic. Both fields give a promise of useful results on the application of the scientific method.

One of the principal railways of Britain, the former L.M.S., has set up a special research unit attached to the operational side of the railway, and this unit has already completed thorough studies of some parts of the communications system, on which the effective running of a railway so much depends. These investigations have shown quantitatively where delays more commonly occur and have also predicted the likely improvement and saving that would result from certain possible changes in organisation and equipment. Those changes which show good returns are now being made. Needless to say, studies are also being made in the delays in the operation of the trains.

The road problem has two sides, the reduction of accidents and the improvement in flow. Losses due to accidents or delays on the roads to-day represent a serious loss to our national income or productivity. The Road Research Board of the Department of Scientific and Industrial Research has set up a strong team to study the problems involved. A wide range of the tools of modern science are at their disposal, a major one being the statistical method.

There are many problems in this field. For example, studies are being made of the factors affecting the usefulness of a typical road junction as controlled, say, by traffic lights. From a flow aspect, the main object is to get through the maximum number of vehicles and pedestrians with the shortest delay for each. From a road safety point of view, the object is to reduce the probability of an accident, and particularly of a serious accident, to the lowest possible value. These two objectives are to some extent conflicting, but the extent of the conflict may be very considerably reduced by studying all the factors associated with the junction and with its use. In other words, it should be possible to increase the flow-rate and reduce the danger of accidents at the same time. The way to do this can best be found by a close study of the operations of the various factors involved. A statistical study can be made of a number of road junctions of the same type and loading. However, there are severe limitations here because of the wide variations in type and loading, etc., and because of the fact that the frequency of accidents at each junction is low. It is necessary to deduce the relation between any two parameters from first principles, testing these relations where possible against such reliable statistics as may exist. These first principles are derived from studies of human reaction time, of the braking and manœuvring power of vehicles, of the conditions of the surfaces and the lay-out of the roads, of the timing and other characteristics of controlling lights, etc. Studies of this kind have, indeed, gone on for many years. As a result, London, for example, has one of the most highly developed and successful traffic signalling systems in the world. However, the development of this system is far from complete, but having been carried so far, much more powerful methods are now required to make further progress.

Most of the data in this field of traffic flow and accidents have been collected from studies of daily operations, with their associated mixture of variables, or by taking advantage of some change brought about for other reasons. In this field, however, changes introduced primarily to help disentangle data, that is, 'experimental operations', hold out great promise and, indeed, are already being tried.

There is one general point of technique worth referring to in connexion with this field. For example, it may be required to test experimentally the effect on a dependent variable, such as traffic flow rate, of increasing a given parameter, such as the width of a road section. The cost of increasing the width experimentally would be prohibitive, but a good approximation to the value of the partial differential coefficient in the neighbourhood of that particular road width can sometimes be obtained by experimentally *decreasing* the width of that section. This technique is based solely on the assumption, frequently a reasonable one, that the curve showing the relation between the two variables is a smooth one. The function need not be linear, but there should be no marked discontinuity or excessive curvature in the region considered.

There are also similar traffic problems more directly in industry. For example, the cost of transporting the fuel and raw materials and the products of the furnaces in an iron and steel works amounts to a large item in the cost of steel. This arises not only from the direct cost of traffic but also from hold-ups of parts of the plant awaiting materials, etc., or from more subtle points such as the need for close schedules. A full operational research into the details of this problem is now being made as a necessary preliminary to the engineering lay-out and design problems involved in improvements.

Application to Productivity and Output

Time and motion studies of operators of machines or of workers making repetitive operations have for long been one of the main research methods of the production engineer and the 'industrial consultant'. This method is steadily being improved and strengthened, recently by the exchange of lessons between this and other methods of operational research.

Extensive studies of productivity and of its reciprocal, O.H.P. (operator hours per unit of production) have been made by Tippett[6]. The factors governing O.H.P. in the factories of the cotton industry have, to a large extent, been resolved from a mass of data collected over a number of years. Decisions concerned with productivity by the management of individual firms, or policy decisions by Government Departments, are generally made with the results of these studies as a basis.

Similar studies have also been made of the processes occurring in chemical plant; but it is doubtful whether this should be called 'operational research'. It is probably better to consider this work as part of the normal type of research required to develop or improve existing processes.

Application to Inspection and Maintenance

Inspection has long been a field for the successful application of statistics; 'quality control' is now accepted practice with many large manufacturers. As an interesting example of a rather special type, an inquiry has recently been made into the distribution of the inspection effort in a steel works. In accordance with common practice, the inspection was made on a certain finished article at the end of a series of operations starting with the raw steel billet. Rejects at this final stage were, however, costly and the question arose: Could the faults leading to rejects be reliably detected at an earlier stage? A close statistical analysis, coupled with certain trial runs, showed that this was possible for several of the major types of faults, and the cost of the rejects has now been reduced to less than half without in any way lowering the standard. Furthermore, it was found possible to eliminate certain of the final inspection tests as they were now covered by the earlier tests, and hence the total inspection effort was not increased. The research here led to no new equipment or process, but merely to a re-deployment of inspection effort.

Good examples of operational research applied to maintenance problems in industry are not known to me and therefore I am tempted to return to one of the most striking examples of the War, the studies made by Dr. C. Gordon, in 1942–43, on the maintenance of aircraft, some details of which are given in "Science at War" (p. 104)[7]. These studies of the occurrence of faults in aircraft as a function of maintenance showed that it was possible to increase the flying hours at the expense of the hours an aircraft spent undergoing maintenance without any appreciable increase in the number of faults. As a result, the rigid schedules of maintenance were altered, with a very substantial increase in our fighting strength.

An obvious example where operational research is needed to-day lies in the maintenance of road traffic signals. It appears that the cost to the community of faulty signals and of maintenance is wrongly balanced. In the aircraft example, maintenance was overdone, whereas in this example, it appears to be underdone. It seems likely that operational research methods can be of great use to the maintenance engineer.

Application to Technical Progress

The change in public attitude to science in recent years has led to the question: Why is there such a long interval between the discovery of a new scientific fact and its application to the benefit of mankind? The answer to this would in itself require a lengthy research, but one factor is of obvious importance. A decision to try an idea out, when made reasonably, is based on a weighing of the pros and cons, many of which concern costs in money, coal or man-power. If it is not possible to weigh these sufficiently accurately to see which is the greater, a decision is naturally postponed or made on a 'hunch'. If operational research is successful in providing a quantitative basis for decisions, it should be able to shorten the interval between discovery and application.

There is, however, a danger here that operational research will be diverted to the routine task of 'vetting' inventions which arise through the initiative of individuals driven by parental interest. Operational research workers should be able to take a wider view of a problem, study its economics and its technicalities as a whole and, as a result, see how a proposed change or invention would affect the problem.

In certain research associations, such as that for iron and steel, operational research is already playing a major part in the formulation of programmes of applied or objective research by providing a logical basis for deciding what is worth while developing through its later stages.

Operational research is also playing a part in following up technical progress. The Ministry of Agriculture analyses regularly how far the knowledge of scientific research is being applied by farmers and thus obtains a basis for part of its educational and control schemes.

Future Trends

While there were certain technical developments in regard to the methods of operational research during the War, it is likely that these methods will be developed very much further. The application of the statistical tool is still on the increase, but there is no need or likelihood of the tool itself being developed further. There are many other tools in science, however, which will be tried, and some of which we hope will be successful.

One of the most important of these is the general concept of forces, potentials and equilibria in relation to the Second Law of Thermodynamics. This Law may be expressed in a general form as follows: If there is any 'tendency' for a certain thing to happen, or if a process is potentially able to take place in a certain direction, it should be possible to harness that process to produce external work, the amount of which per unit of process is a measure of the 'tendency'. In certain cases the tendency may be realized as a force.

The generalized Second Law of Thermodynamics should be capable of wider application despite the fact that one cannot take advantage of the rigorous relation between force and work found in the physical sciences. One of the most important forces in sociological systems is that of incentive. If an individual or a group of individuals does something in a certain direction, then there must be a force or incentive, the net value of which determines that direction. If we can elucidate and estimate the various components of that force, we can predict the behaviour of groups of people in given circumstances.

The concept of equilibrium is also capable of wide application, particularly as it can be shown that a system showing an equilibrium position can change only in a direction towards that equilibrium (except under external influence). Furthermore, the amount of the external influence required to keep a system away from its equilibrium rises rapidly with the extent to which it is kept away. For example, the cost of food subsidies rises rapidly as the equilibrium (free economic or supply-and-demand price) departs from the actual fixed price.

We can look forward to the day when the *science* of economics will be sufficiently developed to enable man to gain better control over his circumstances. I believe this science will only grow by the methods of operational research and more specifically by developing its own versions of the First and Second Laws of Thermodynamics, the First being the law of conservation of equivalence, the Second the law of direction of changes as governed by (economic) forces and of the associated conditions of equilibria.

Self-compensating and Self-aggravating Systems

This last point about equilibria leads to a further point. Practically all processes occurring in physical or natural science can be divided up into two categories, those which are self-compensating and those which are self-aggravating. The first are those described by the well-known theorem of Le Chatelier. 'If a change is imposed on a physical system in equilibrium, there are automatically generated other changes which tend to offset the effect of the first change.' This theorem follows from the Second Law of Thermodynamics and is of general application.

In contrast, self-aggravating systems are those in which a small change leads to a further change which *enhances* the effect. In the extreme cases, the result is catastrophic. In others, the enhancement proceeds until other self-compensating or attenuating factors present bring the situation under control and possibly reverse the direction of the change. Such systems generally lead to vigorous oscillation.

There are many examples of each type of system in the ordinary operations concerned with our daily life. Of the first type, there is the example of the reduction of the blindness of a blind corner. Such a change should normally result in a reduction of the number of accidents at that corner, or at least the danger of an accident. As, however, it would be followed by an automatic increase in speed of the cars taking that corner (as a consequence of the greater security felt by the drivers), the net reduction of the danger will be less than would otherwise be expected. This simply means that danger and speed are in equilibrium.

A good example of the self-aggravating type concerns the movement of buses. Consider a system in which buses depart at regular two-minute intervals from a depot and pass along a route through a large town to another depot. Under normal loading and with no special obstacles, the two-minute interval can be retained fairly accurately throughout the entire schedule. If, however, a small delay takes place with one bus when the load is near the maximum designed value, this bus will then find itself faced with the problem of picking up a larger number of accumulated passengers than it would otherwise have had to do. This immediately adds further delays which further aggravate the loading on this particular bus. This, of course, is the basic cause of the 'convoys' of buses which form rather frequently in large towns such as London.

A very similar problem is found in connexion with the supply and demand of scarcity goods. On first thought, it might be assumed that a system, in which there was an even flow of cigarettes from the manufacturers to the shops and an even rate of smoking, would be one of stability. Indeed, in normal conditions when there is no thought of scarcity, it is. The stocks held in retailers' shops provide a reserve or buffer for fluctuations in demand. The ordinary person becomes used to the fact that he can buy cigarettes on demand and therefore it is not necessary for him to maintain a large stock of his own.

Under conditions of scarcity, however, the stocks of a retailer are considerably reduced and the stocks of the consumer are increased because of his bitter experiences in being refused. The situation fluctuates widely because should there be, by some initial fluctuation, a small deterioration in the supply position, a consumer's reaction is immediately further to build up his own stocks. This in turn aggravates the retailers' stock position and induces other consumers to take corresponding self-protective action. Thus a small decrease in the available supplies in shops can quickly lead to a complete emptying of the shops; a rumour can become a reality.

I once had the opportunity of studying a similar self-contained system. The supply of chemical apparatus from a college 'loan store' would collapse annually at a certain time due to a self-aggravating factor of this type. The collapse was preceded by a sudden falling off of returns of apparatus after use, the falling off in turn being due to the beginnings of non-availability of certain items. There are numerous other examples, such as a run on a bank or the locking of a traffic roundabout due to some small initial fluctuation when it is near its maximum loading point. The economic trade cycles are presumably kept in oscillation by self-aggravating factors of this type.

The method of combating self-aggravating systems by the damping effects of controls and reserves is also well known. This method is parallel to the use of resistances and condensers in electric circuits. Operational research can lead to more exact knowledge of these systems to enable a better balance between reserves and flow and a better phasing or timing of actions intended to damp down or offset an impending change. One of the greatest problems for the Government administration has been to obtain 'early warning' of a particular situation and thus to avoid the more drastic compensating action required if the problem is left until it has built itself up to a serious state.

Conclusion

The arguments in this paper are based partly on the experiences of War and partly on those of two and a half years of peace. There are obviously many differences between the two conditions. War leads to a great degree of centralization of control and consequently a lack of flexibility. This is a situation in which operational research is potentially able to produce enormous improvements, partly because in certain respects it is a situation full of weaknesses to start with. On the other hand, an industry consists of a number of units or firms each evolving its own methods and working independently. Accordingly, variations of working methods occur, if only by chance. In normal economic conditions, the variations of positive value will have a greater chance of survival than those of negative value. In other words, 'natural selection' can operate in the uncentralized systems, providing there is a freely competitive economic system operating. As a result, it might be argued that operational research would be less likely to make such startling improvements in peace as it did in war. However, the same is true for applied science in general: the results in war are much more startling than in peace-time.

History has shown that results in war are followed by extended application in peace-time, and the case of operational research is so far no exception. This technique is becoming a new tool for executives, alongside their older tool, accountancy. It is a tool that the executive man can readily understand; it is not wrapt in the 'mysteries of science'. For him, his business life is becoming more and more complex as the repercussions of any one act or decision become wider. As a result, the waste of time in arguing with 'half-truths' becomes more serious. We are entering an age of statistics collected with great consumption of man-power. The new methods of operational research are needed if these statistics are not simply to add to the half-truths but to play their proper part in the more highly developed thinking processes now required.

[1] See, for example, Pickard, R. H., *J. Roy. Stat. Soc.*, Supplement 1934.

[2] Kittel, Charles, *Science*, **105** (Feb. 7, 1947).

[3] *Nature*, **160**, 660 (1947). Summary of a discussion held by the British Association.

[4] The first general paper on this subject, entitled "The Methodology of Operational Research", was prepared by Blackett in 1943 and has been distributed privately since then.

[5] Davies, Owen L., "Statistical Methods in Research and Production" (Messrs. Oliver and Boyd, 1947).

[6] Tippett, L. H. C., British Cotton Industry Research Association, Shirley Institute Bulletin (1947).

[7] Crowther, J. G., and Whiddington, R., "Science at War". Pp. vi+185+51 plates. (London: H.M. Stationery Office, 1948.) 2*s*. 6*d*. net.

PROGRESS OF CANCER RESEARCH

By Dr. I. HIEGER
Chester Beatty Research Institute, Royal Cancer Hospital, London

THE composition of the twenty-fourth annual report of the British Empire Cancer Campaign (11 Grosvenor Crescent, London, S.W.1) shows that more research is being carried out on radiation therapy and theory, on carcinogenesis and on the biochemistry of cancer, than on any other branch of investigation pursued in the different centres of research supported by the Campaign.

It is of interest to see to what extent the subjects of study are representative of cancer research in other parts of the world by a comparison with the papers presented at the Fourth International Cancer Congress held at St. Louis last September. More than 75 per cent of the 260 odd papers given at the Congress were by scientific men from the United States, and it should be noted that their papers tended to be finished products, whereas the Campaign's report is rather more a statement of progress. Any such comparison is certainly liable to errors, for a number of reasons; nevertheless, the accompanying table will probably give an approximate idea of the relative precedence of the different lines of research with which the cancer problem is attacked.

	4th International Cancer Congress, 1947	B.E.C.C. Report, 1947
Radiation therapy and theory; use of radio-isotopes	35	18
Biochemistry of tumours and tumour bearers; nutrition; enzymes; nucleoproteins	33	12
Carcinogens, carcinogenesis	32	13
Chemotherapy	32	7
Pathology and diagnosis	25	5
Hormones in cancer	20	2
Advances, clinical and surgical	13	5
Organisation (research and clinical)	12	—
Cytology and cytochemistry	11	1
Genetics and mutation	9	2
Comparative oncology	9	—
Tissue culture	8	2
Experimental pathology	8	6
Milk factor	8	1
Virus tumours	5	6
Social, racial and industrial cancer	5	1

Only a few of the interesting investigations described in the Campaign's report can be referred to in this review and some important work will unfortunately receive no mention.

It need scarcely be stated that much essential clinical investigation has been carried out at all medical centres, and an elaborate report of the Clinical Cancer Research Committee analyses nine hundred cases of cancer of the colon from every etiological, pathological and clinical angle.

The increasing prominence of physics in cancer research is chiefly due to developments in the technique and theory of radiotherapy, in the use of radioactive isotopes, in the field of microscopy and in the application of physical chemistry to the study of carcinogens. The electronic characteristics and structural properties of carcinogens are now being used to explain why some compounds are carcinogenic and others not.

Haddow, at the Royal Cancer Hospital, recently arranged a meeting which Dr. Pullman from Paris was invited to address on a theory of electronic characteristics and carcinogenic activity of hydrocarbons. At this discussion, Dickens neatly hit the nail on the head by pointing out that the proof of any such theory would be its capacity to predict the structural requirements for a 'super-carcinogen'.

If the emphasis at the present time is favouring the physicist, the organic chemist has found at least one sphere for new synthetic work, that of chemotherapy, for another class of compounds has been introduced, the nitrogen mustards (for example, methyl-*bis*-(β-chloroethyl) amine). The large number of papers on chemotherapy presented at the International Congress shows how intense is the search for some drug which will selectively destroy cancer cells. The interest in chemotherapy would probably be greater than that suggested by the table if the hormone investigations directed to hormone therapy were included.

Unfortunately, the extreme caution with which therapists are compelled to state their results has a decidedly chilling effect on the reader: for example, they are apt to speak of "some degree of amelioration, although the response is usually transient", or "every case of Hodgkin's disease has shown a good although temporary response to the drug", or "it is doubtful whether any retarding influence has been present in our cases". Research, or rather experimentation, in this field is still highly empirical, dare one say, haphazard; this is inevitable, for we still have very little knowledge of the vulnerability of cancer tissue.

Passey and his collaborators in Leeds are working with the transmissible milk factor for mouse mammary carcinoma, and have elegantly demonstrated by the electron microscope the presence of macromolecular particles of definite size only in those tissues and secretions where the factor has been detected by the biological method. The further progress of these experiments will be awaited with much interest.

The mode of action of carcinogens is claiming more attention, to the satisfaction of those who see little purpose in the continued multiplication of new synthetic carcinogens. Selbie, at the Middlesex Hospital, and also the Edinburgh workers, have studied carcinogenesis by urethane on the lung of the mouse. They suggest that some tissue is stimulated to proliferation at a rate disturbing to tissue equilibrium, and that the urethane poisons a defence mechanism, allowing some other agent, perhaps a virus, to attack the cells and bring about malignancy. It may perhaps be objected that such an explanation scarcely does more than move the difficulties one step farther back.

Orr, at Leeds, comes to somewhat similar conclusions, namely, that the lung adenomata evoked by urethane supervene on an inflammatory process, and that mice, the lungs of which are particularly liable to pneumonic conditions when treated with urethane, are also more liable to lung tumours.

Dickens has succeeded in showing that saturated compounds can be dehydrogenated to the aromatic state by rabbit blood and by slices of muscle, kidney and spleen. The interest of this reaction lies in its bearing on a popular theory of cancer: that polycyclic saturated compounds in the body (cholesterol, sex hormones, bile acids) can by some error of metabolism be dehydrogenated to polycyclic aromatic carcinogens. Similar studies are being made by Shoppee at the Royal Cancer Hospital on the possibility of the conversion of 17 α-methyl-*D*-homoandrostane to carcinogenic methylchrysenes.

Berenblum has been working on the mechanism of the carcinogenic process with the aid of co-carcinogens, and also on the nature of the cancer-producing factors in addition to benzpyrene which are present in tar. This work, and the experiments of Woodhouse at Birmingham on petroleum, might give valuable information if an attempt were made on the part of a government inspectorate to assess the risks of using certain petroleum products. However, any such tests and recommendations would have little effect so long as industrial substances which are carcinogenic are not handled entirely by mechanized processes.

Glücksmann, at Cambridge, has treated mouse tissue with X- and γ-rays in combination with co-carcinogens to see if the same synergistic effect can be observed as with chemical carcinogens. No such effect was detected, and histological examination showed profound differences between the papillomas induced by radiations and those induced by benzpyrene. Also at the Strangeways Laboratory, Lasnitzki has found that when an adenocarcinoma in mice is irradiated with X-rays, two-thirds of the injurious effect on the tumour is indirect and is brought about by changes in the still normal tissue surrounding the tumour. Thus the conclusions of Koller, arrived at by studies on irradiated tumours in human subjects, have been confirmed experimentally.

Peacock, at Glasgow, has investigated the co-carcinogenic action of croton oil added to overheated (365°) edible oil in feeding experiments on mice. He found that cancerous changes were brought about in the alimentary tract, although the proportion of positive results was much smaller than in experiments with carcinogenic hydrocarbons on skin or connective tissues. Similar tests on mice mutants produced by methylcholanthrene (Strong) which are particularly liable to gastric cancer might show facilitation of the effect of feeble carcinogens in the diet.

Pybus and Miller, at Newcastle, and also Carr, at Edinburgh, have been studying gene mutation produced by the administration of carcinogenic hydrocarbons to mice. The mutation theory has had an eventful career in cancer research. One of the first to propose that cancer cells are mutant forms of normal cells was Boveri, in 1912. X-rays and radium had long been known to be carcinogenic, when Muller in 1928 discovered that X-rays greatly increased the spontaneous mutation-rate in *Drosophila*. During the War, Auerbach *et al.* found mustard gas to be a potent mutagen; but unfortunately for the theory, Berenblum had shown that it prevents carcinogenesis by the hydrocarbons. Strong's discoveries have now been followed by a report from Demerec that benzpyrene and other carcinogenic compounds bring about mutations in *Drosophila*. He finds about 84 per cent correspondence between carcinogenic and mutagenic potentiality in a number of compounds given to the fruit fly in the form of a fine mist.

Sir Ernest Kennaway and Lady Kennaway are continuing their statistical work on the Registrar General's returns, and point out that in eighteen years the deaths from cancer of the lung in England and Wales have increased 16½ times in men (nearly 6,000 in 1945) and 8 times in women, although diagnosis must have been doubtful in some cases.

One of the most interesting conclusions in this investigation runs: "Cancer of the lung differs from that of the upper alimentary tract, larynx and skin in showing no inverse relation to ascent in the social scale (Stevenson, 1923). This suggests an airborne factor, as owing to the mixing action of the wind, there is less difference in the outdoor air breathed by different classes than in other social conditions such as food and cleanliness."

Hieger, in experiments on endogenic carcinogens, finds that these substances are concentrated in the cholesterol-rich fraction of tissues, not only from cancerous and non-cancerous human subjects, but also in commercial cholesterol obtained from cattle brain and spinal cord or from fish livers. Some recent results were described in this journal ("Carcinogenic Activity of Preparations Rich in Cholesterol", *Nature*, **160**, 270; 1947).

OBITUARIES

Dr. Bernard S. Dyer

The death of Dr. Bernard Shirley Dyer on February 12, in his ninety-second year, marks the passing of one of the very few remaining pioneers of agricultural chemistry of the late nineties.

Born in London on February 25, 1856, the son of J. A. Dyer, a well-known London journalist, Bernard Dyer was educated at the City of London School. On leaving school at the age of seventeen he became a pupil assistant in the laboratory of Dr. Augustus Voelcker, consulting chemist to the Royal Agricultural Society, spending three years there and later taking the University of London degree of B.Sc. In 1877, at the early age of twenty-one, he established his laboratory at 17 Great Tower Street, London, where he remained until the laboratory was destroyed in the 'blitz' of May 1941. Here, while engaged in building up a practice in agricultural and food chemistry, he devoted much time in his earlier years to the publication of a series of agricultural articles in the scientific and lay Press, and also undertook a very considerable amount of lecturing throughout the country. About this period he was appointed consulting chemist to the Devon Agricultural Society, and later to the Essex and Leicestershire Societies.

There can be little doubt that Bernard Dyer's training with Voelcker had led to a specialization in agricultural chemistry which determined his future trend and the major interest in his life. Year after year, papers were published dealing with field investigation work, and, in particular, with the use and application of fertilizers and the necessity for far larger amounts than was then customary in Britain. Then came some years of work on the vexed question of soil analysis as a means of indicating the availability of the mineral constituents of the soil. The suggestion had already been made by Sachs that plants extracted their mineral food from the soil by the solvent action of the root sap exuded from their root hairs, and Tollens and Stutzer had suggested the use of a 1 per cent solution of citric acid for the assessment of the relative 'availability' of phosphatic fertilizers. Bernard Dyer attacked the problem from this new angle. He first determined in his laboratory the root acidity of about a hundred plants, and found the average figure to be the equivalent of 0·9 per cent citric acid—a figure substantially that suggested by Tollens and Stutzer. He then, in 1889, systematically analysed soil samples from twenty-two plots of Hoos Field, Rothamsted. The outcome of this work was the elaboration of the now well-known method of soil extraction using a 1 per cent citric acid solution. This was published in the *Journal of the Chemical Society* in 1894, and for this investigation the

University of London granted him the degree of D.Sc.

The next years were devoted to the larger task of examining the soils of the historic Broadbalk wheat field, including plots manured and unmanured for fifty years. The results of this work were recorded in 1901 in the *Philosophical Transactions of the Royal Society* in a paper entitled "A Chemical Study of the Phosphoric Acid and Potash Contents of the Wheat Soils of Broadbalk Field, Rothamsted". The paper was published shortly after the death of Sir John Lawes, to whom the inspiration of this particular investigation had been due. Shortly before this, in 1900, Dyer delivered the triennial course of Rothamsted American Lectures at Newhaven, U.S.A., afterwards published by the United States Department of Agriculture under the title of "Results of Investigations of the Rothamsted Soils". In 1893 he published a little book, "Fertilizers and Feeding Stuffs"; and in 1924 a book on "The Manuring of Market Garden Crops", this latter being a record of the results obtained from more than twenty years of field experimental work in Kent.

Turning to his other great activity, Bernard Dyer became an original member of the Society of Public Analysts in 1875, and to the affairs of this Society he gave much of his time, first as a member of council in 1880, and then as joint honorary secretary during 1883–96, when he was elected president in succession to Sir Thomas Stevenson. He contributed many papers to its journal, *The Analyst*, and, in collaboration with Dr. C. Ainsworth Mitchell, prepared its history, "Fifty Years of the Society of Public Analysts". He was elected an associate of the Institute of Chemistry during the year of its formation (1878) and became a fellow in 1880. He was an original member of the Society of Chemical Industry, and acted as chairman of its London Section during 1923–24. He held official appointments as agricultural analyst, as public analyst, and as official analyst to the London Corn Trade Association.

Dyer married twice, first Alice Collett, and secondly in 1890 Edith Steel, who survives with two of their three daughters.

Dr. Bernard Dyer will be remembered by all his friends for his great personal kindliness and charm. As a member of many societies, he was greatly esteemed by his colleagues and held in the greatest affection by his juniors, who remember his kindly help in their struggling years. As an analyst he was austere in the conception of his duty in seeking the truth.

G. TAYLOR

WE regret to announce the following deaths:

Mr. Griffith Brewer, president during 1940–42 of the Royal Aeronautical Society, and a pioneer of aeronautics in Great Britain, on March 1, aged eighty.

Prof. R. T. Chamberlin, emeritus professor of geology in the University of Chicago, aged sixty-six.

Dr. A. L. Du Toit, F.R.S., lately consulting geologist to the De Beers Consolidated Mines, on February 25, aged sixty-nine.

Mr. G. S. W. Marlow, secretary of the Faraday Society, on March 5.

Sir Charles Grant Robertson, C.V.O., principal and vice-chancellor of the University of Birmingham, on February 28, aged seventy-eight.

NEWS and VIEWS

Radio Research in Great Britain:

Dr. R. L. Smith-Rose

IN 1920 the Department of Scientific and Industrial Research, guided by a newly formed Radio Research Board, started research in radio, which had grown in importance during the First World War. Most of the work was done at a field station at Slough under R. A. (now Sir Robert) Watson-Watt, and at the start attention was mainly devoted to investigations on atmospherics, direction-finding and the propagation of waves over the ground. When, in 1924, Appleton and Barnett demonstrated the reflexion of radio waves from the ionosphere, they asked the co-operation of Slough in fundamental experiments which laid the foundations of our present knowledge of the subject. Later, much of this experimental work was transferred to Slough, still under Appleton's guidance, while he continued his own work at Cambridge. In this way there grew up at Slough a team skilled in the use of pulses for the determination of distance by radio methods, which was able to turn its energies to the development of radar when the time came. In 1933 Slough and other radio research stations under the Department of Scientific and Industrial Research had been formed into a Radio Division of the National Physical Laboratory, with Watson-Watt as superintendent. In 1935 he took away a small team of experts to start a secret radar establishment, and Dr. R. L. Smith-Rose succeeded him. Just before, and during, the War, the ionospheric investigations at Slough developed so as to provide a world-wide organisation for the forecasting of propagational conditions on different wave-lengths, and there has, in addition, been considerable work on direction-finding, the propagation of ultra-short waves through the troposphere, the development of *radio sonde*, and the measurement of the electrical properties of soil and water at radio frequencies.

A new arrangement has recently been announced by which it is intended to combine the work at the National Physical Laboratory and Slough and to transfer it to a new establishment under Dr. Smith-Rose as director of radio research. The new establishment will, by this arrangement, have a director who has been personally active in several lines of research. In the early days at Slough he was engaged, with Barfield, in investigations of the propagation of waves over the surface of the earth and in problems of direction-finding. The study of propagation led him to work on the electrical properties of soil and water, and to investigate the forward tilt of waves travelling over the ground; the work on direction-finding led to a clear understanding of the part which the wave deviated by the ionosphere can play in producing errors in a loop direction-finder, and to an explanation of the errors produced by conducting bodies near the loop, the so-called site-errors. He has published papers on the propagation of waves through the troposphere and on improved methods of direction-finding, particularly on very high frequencies. He has been chairman of the Radio Section of the Institution of Electrical Engineers, and was decorated with the United States Medal of Freedom with Silver Palm for his work in radio during the

War. Under Sir Edward Appleton's able guidance, Britain has established a lead in the scientific applications of radio, which the country will look to the new Radio Research Establishment to improve. With the present team under Dr. Smith-Rose, and with Sir Edward at the head of the Department, they are not likely to be disappointed.

Deputy Scientific Adviser to Army Council: Prof. F. J. M. Stratton, O.B.E., F.R.S.

The appointment of Prof. F. J. M. Stratton to the post of deputy scientific adviser to the Army Council has been announced. Prof. Stratton's retirement from the chair of astrophysics at Cambridge last October was announced in *Nature* (**159**, 463; 1947), and the record of his scientific work was noted. His was a retirement dictated by the rules of superannuation, and not by any loss of activity; so that his choice for and acceptance of this further post will be no more a surprise to his friends than his own preference for further service to merited retirement. The War Office is fortunate in securing the services of so able a man of science, particularly one who has given proof, through ten years service in the Army in two wars and a long association with the Cambridge O.T.C. and the Territorial Army, of his aptitude and interest in military affairs. While his appointment will be a temporary one for a limited period, the acquisition to the Scientific Civil Service, even for a short time, of such men as Prof. Stratton will be a source of strength to the Service, and the experience and leadership he can give to some of the younger men of science employed by the Army, in operational research and other tasks, will obviously be of the greatest value to them.

Willard Gibbs Medal: Prof. Carl F. Cori

Prof. Carl F. Cori, professor of biochemistry in the Washington University School of Medicine, has been awarded the 1948 Willard Gibbs Medal of the Chicago Section of the American Chemical Society. This medal, one of America's highest scientific honours, goes to Dr. Cori for his achievements in research on the processes by which the body converts sugar into energy. He has been a leading worker in the difficult field of biological carbohydrate transformations for many years. His contributions have been of widespread importance involving adrenal, cortical, pituitary, and pancreatic roles in carbohydrate utilization as well as carbohydrate metabolism in tumours. A recent outstanding contribution is at least a partial solution of the problem of how insulin functions. He and his wife, Dr. Gerty T. Cori, who is also a professor of biochemistry in Washington University, received the Nobel Prize for Medicine for 1947 (see *Nature*, **160**, 599; 1947) for determining the process by which the body stores sugar in the liver as glycogen, or animal starch, and then reconverts the glycogen to sugar as it is needed.

Library of the Royal Society: Mr. H. W. Robinson

On March 31 Mr. H. W. Robinson retires from the office of librarian of the Royal Society. He joined the staff of the Society in 1902, when as a boy of fourteen he assisted both the chief clerk and the librarian. His work soon became exclusively associated with the Society's Library; in 1930 he was raised from assistant to the post of assistant librarian and five years later to the position which he now holds. This forty-six years service to the Society has been twice broken by war. In the First World War Mr. Robinson served in the army with distinction; in the Second World War there was a period of service on the Central Register, which came between the strenuous work which he performed in seeing the Society's manuscripts and early printed books safely to Wales and his recall to the Society's service in 1943. Since then he has had the exacting but pleasant task of seeing the Library's books brought back from Oxford, where they had been stored by the Bodleian Library, and arranged in their places with a minimum of inconvenience and disturbance.

Mr. Robinson has a unique knowledge of the Society's Library and in particular of its extensive and priceless archives, a knowledge which he has always been delighted to put at the disposal of the scholars, from many countries, to whom his learning is well known. His intimate acquaintance with the Society's traditions and records has found expression in his services to the history of science. He is, for example, an authority on Robert Hooke, having edited, in conjunction with Mr. Walter Adams, the Diary in the possession of the Guildhall Library and having identified as another Diary of Robert Hooke the manuscript in the British Museum previously attributed to James Petiver. With Prof. Harcourt Brown and Dr. D. McKie he founded the *Annals of Science*, and he was actively associated with the foundation of the British Society for the History of Science, of which he is honorary treasurer. He has an intimate knowledge of many aspects of the bibliography of Isaac Newton, in particular of his manuscripts, and it has been arranged that after his retirement his services shall still be available to the Society, to assist Prof. H. W. Turnbull in editing the Newton letters. It is to be hoped that for many years to come Mr. Robinson's familiar figure will be seen about the Royal Society Library, working among the manuscripts that he loves so well.

Reports on German War-time Industry and Science

Reports of war-time scientific and industrial activities in Germany have been available to interested parties for some time. These reports were prepared by B.I.O.S. (British Intelligence Objectives Sub-Committee), its American counterpart, F.I.A.T. (Field Information Agency, Technical), and the combined Anglo-American Agency, C.I.O.S. (Combined Intelligence Objectives Sub-Committee) which preceded them. Actual investigations in Germany ceased at the end of June 1947. To date, 2,720 reports have been issued. It is stated that more than one million copies have been sold or distributed to the universities, learned societies, trade and research associations and principal public libraries of Britain. The Board of Trade has now arranged for experts in each of the major fields to prepare critical summaries suitable for publication. These reports will be known as "B.I.O.S. Overall Reports" and there will be fifty of them, all of which are expected to be printed by the end of June. The first, on the petroleum and synthetic oil industry of Germany, has been published; the next six reports will be on shipbuilding and marine engineering, the German timber industry, the glass industry, the German road system, agriculture, and the rubber industry. All inquiries about these reports should be addressed directly to the Board of Trade, T.I.D.U., Research Section, 40 Cadogan Square, London, S.W.1.

The Foreign Office announces the publication and distribution of the first volumes of the "FIAT Review of German Science", compiled by German experts under the direction of the British, American and French Field Intelligence Agencies (Technical). The Review is written in German and covers fundamental research in pure science during the years 1939–46. By agreement between the British, American and French agencies, the first printing is a restricted edition for official distribution between the three Allies and U.N.E.S.C.O. The British share of about 250 sets will be issued to Government and other bodies within the Commonwealth, to universities and medical schools and to the libraries of certain learned and professional societies. It is hoped that the edition will be completed within the next six months. The Allied edition of the FIAT Review will be followed by a German edition. The latter, also printed in German, will be published by Dieterich'sche Verlagsbuchhandlung, Wiesbaden, Germany, and will be obtainable through normal trade channels. It is understood that volumes will not be sold separately but only in sets comprising the titles under the headings physics, chemistry, mathematics, medicine, biology and sciences of the earth.

Eclipse Observations for Geodesy

It is now possible to amplify the brief reference in *Nature* of February 7 (p. 196) to the application to geodesy of the times of contact to be observed at different stations on the track of the annular eclipse of May 8–9, 1948. The first suggestion that such observations might provide information as to the earth's shape over areas where geodetic triangulation is impracticable was made by Mr. G. E. Barton (*Mon. Not. Roy. Ast. Soc.*, **64**, 105; 1926). His observations at Benkoelen at the eclipse of January 14, 1926, were spoilt by an unfortunate accident, but the idea was afterwards adopted, and expeditions from a number of countries used improved methods of time determination of such observations at the total eclipses of 1945 and 1947 by parties well separated in longitude. For the annular eclipse of next May, the National Geographic Society of the United States has prepared an elaborate scheme of observations at seven ground stations from Mergui in southern Burma to Kiska in the Aleutians. These will be supplemented by observations from aeroplanes of the U.S. Air Force; photographs of the eclipse will be taken from above the clouds from positions determined by short-range radar navigational methods.

The U.S. Army's Map Service, Engineer and Signal Corps, the U.S. Navy, Air Force, Bureau of Standards, Coast and Geodetic Survey and State Department will co-operate with the National Geographic Society in the scheme. The leaders of the different parties are to be as follows: at Mergin, Mr. E. A. Halbach; at Bangkok, Prof. Charles H. Smiley with Prof. C. W. Miller; at Wu-K'ang, China, Father Francis J. Heyden with Dr. V. C. Chang; at Cho-nan, Korea, Dr. George van Biesbroeck; at Kiska and Adak, Lieut.-Cmdr. Clarence R. Reed and Mr. Clarence A. Shelton; while at the Japanese island of Rebun Jima there will be a Japanese astronomer selected by Prof. Hagihara, of the Tokyo Observatory. This marks a welcome move towards international co-operation in science between Japan and the United States. Measurements of the times of contact will be made by photographing the eclipse on 35-mm. sound motion pictures which will record the ticks of a chronometer on the sound track. The chronometers will be checked and rated from radio time-signals. The techniques which make these observations practicable have been developed to a high degree of efficiency in the last twelve years.

Journal of the Institute of Navigation

The recently founded Institute of Navigation, the headquarters of which for the present are at the Royal Geographical Society, Kensington Gore, London, S.W.7, has issued the first number of its quarterly *Journal* (London: J. Murray. 25*s*. per annum). The object of the Institute is to unite those interested in the science and art of navigation, both by sea and in the air. Fellows are those who are either professional navigators or who have made outstanding contributions to the science of navigation; members are those who are generally interested. The Astronomer Royal is president of the Institute, and he has contributed to the new *Journal* an introductory address on the development of navigation. Other articles are on radio aids to navigation, consol, pressure pattern flying and many other topics. The new ocean weather service also finds a place: its ships, equipment and tasks are explained. The *Journal* promises to be a useful addition to the list of scientific periodicals.

Plant Disease Charts

Plant Protection, Ltd., has recently issued two useful wall charts illustrating common and important crop diseases and pests. Both charts are beautifully produced in colour, depicting parts of the plants diseased and the insects where such are concerned. One is entitled "Some Crop Pests and Diseases" and illustrates and describes the following: tomato blight, celery leaf-spot, celery leaf miner, cabbage white caterpillar, black aphis, potato blight, carrot fly, turnip flea beetle, onion mildew, chocolate spot of broad bean, mole cricket, locust, pea and bean weevil, leatherjacket, wireworm, cutworm. The other, "Pests and Diseases of Apples", deals with brown rot, woolly aphis, sucker, apple and pear scab, winter and March moths, sawfly, capsid bug, codling moth, apple blossom weevil and apple mildew. Methods of prevention or protection are shortly described in each case. These wall charts will be a valuable visual aid for schools and agricultural colleges and institutes, which can obtain copies free of charge from Plant Protection, Ltd., Yalding, Kent.

Biology of Lice

A second edition of the booklet entitled "Lice" by Dr. John Smart, published as Economic Series No. 2A by the British Museum (Natural History) has recently appeared (British Museum (Natural History), London, S.W.7, 1948. 9*d*.). It deals with the incidence, development and habits of lice affecting man and the best methods for controlling these pests. During the six years interval that has elapsed since the appearance of the first edition of this booklet, much new knowledge concerning lice has come to hand, especially relative to control measures acquired during the War. Information on these and other features are incorporated in the new edition.

International Conference on the Physics of Metals

The Netherlands Physical Society is organising an international conference on the physics of metals, to be held at Amsterdam during July 12–18, after the Assembly of the International Union of Pure and Applied Physics. The provisional programme includes general lectures by Dr. R. Kronig (Delft) on the electronic structure of metals; Prof. L. Pauling (Pasadena) on valency in metals; Dr. H. B. G. Casimir (Eindhoven) or Prof. C. J. Gorter (Leyden) on superconductivity; Sir Lawrence Bragg (Cambridge) on slip in metals; Prof. N. F. Mott (Bristol) on work hardening and creep in metals; H. Borelius (Stockholm) on transitions in super-cooled metallic solutions; A. Guinier (Paris) on precipitations in metals; Prof. W. G. Burgers (Delft) on crystal growth; Prof. J. H. van Vleck (Harvard) on fundamentals of ferromagnetism. The reception committee in Amsterdam is prepared to give advice and to make hotel reservations. Particulars of the conference can be obtained from Prof. C. J. Gorter, Kamerlingh Onnes Lab., Nieuwsteeg 18, Leyden.

Summer School in Chemistry at Dublin

A SUMMER SCHOOL IN CHEMISTRY is being arranged by the Irish Chemical Association and will be held in the Department of Chemistry, University College, Dublin, during July 5–9. Four courses of lectures will be given: "Some Recent Advances in Chemotherapy", by Dr. V. C. Barry, of the Medical Research Council of Ireland; "Recent Advances in the Determination of the Structure of Organic Compounds", by Prof. W. Cocker, professor of chemistry, Trinity College, Dublin; "Recent Advances in Biochemistry", by Prof. E. J. Conway, professor of biochemistry and pharmacology, University College, Dublin; "The Electronic Theory in Chemistry", by Prof. T. S. Wheeler, professor of chemistry, University College, Dublin. Particulars of the School can be obtained from the honorary secretary, Irish Chemical Association, The Laboratory, 12 Dawson Street, Dublin, to whom applications to attend must be sent not later than June 26.

British National Committee for Crystallography

THE Royal Society, as the national body adhering to the newly formed International Union of Crystallography, has recently set up a British National Committee for Crystallography under the chairmanship of Sir Lawrence Bragg. The members of the Committee are: Prof. W. T. Astbury, Prof. J. D. Bernal, Mrs. D. C. Hodgkin, Mrs. K. Lonsdale, Sir George Thomson, Prof. C. E. Tilley (all representing the Royal Society), Dr. G. M. Bennett (Chemical Society), Mr. D. A. Oliver (Institute of Metals), Prof. E. G. Cox (Institute of Physics), Dr. C. Sykes (Iron and Steel Institute), Dr. F. A. Bannister (Mineralogical Society), and Dr. H. Wilman (Physical Society). In addition to the above, Prof. P. P. Ewald, Dr. R. C. Evans and Dr. W. H. Taylor as members of the provisional executive committee of the International Union are *ex officio* members of the National Committee. The first General Assembly of the International Union of Crystallography is being held at Harvard University during July 28–August 3.

Royal Society of Edinburgh: New Fellows

THE following have been elected fellows of the Royal Society of Edinburgh: Sir Robert Allan, 41 N. Castle Street, Edinburgh 2; Prof. J. F. Allen, Department of Natural Philosophy, University of St. Andrews; Mr. Alexander Cullen, architect and town planning consultant; Dr. F. J. Elliott, head of the Department of Physiology, Royal (Dick) Veterinary College, Edinburgh; Dr. M. A. Ellison, principal scientific officer, Royal Observatory, Edinburgh; Major M. D. W. Elphinstone, Threeways, Highfield Road, Chislehurst, Kent; Prof. T. H. Fraser, Department of Economics, Fouad I University, Cairo; Sir John Fryer, secretary of the Agricultural Research Council; Prof. T. N. George, Department of Geology, University of Glasgow; Dr. John Morrison Hay, deputy director and head of Engineering Division, Scottish Seaweed Research Association; Dr. J. F. Heggie, senior pathologist, North Middlesex County Hospital; Dr. G. O. T. D. Henderson, officer-in-charge, Oceanographic Laboratory, Leith; Dr. I. G. W. Hill, lecturer in pharmacology, University of Edinburgh; Dr. W. C. O. Hill, lecturer in physical anthropology, University of Edinburgh; Prof. E. L. Hirst, Department of Organic Chemistry, University of Edinburgh; Mr. E. P. Hudson, director, Scottish Agricultural Industries, Ltd., Leith; Prof. W. Q. Kennedy, Department of Geology, University of Leeds; Mr. J. Gibson Kerr, 51 Castle Street, Edinburgh 2; Dr. D. N. Lawley, lecturer in statistics, University of Edinburgh; Dr. T. N. MacGregor, lecturer in gynæcological endocrinology, University of Edinburgh; Dr. A. P. Orr, deputy director (senior principal scientific officer), Millport Laboratory, Scottish Marine Biological Association; Dr. R. Passmore, lecturer in clinical and industrial physiology, Department of Public Health and Social Medicine, University of Edinburgh; Dr. T. R. Tannahill, lecturer in astronomy, University of Glasgow; Dr. S. I. Tomkeieff, lecturer in geology, King's College (University of Durham), Newcastle-upon-Tyne; Prof. C. H. Waddington, Department of Animal Genetics, University of Edinburgh, director of the Genetics Laboratory of the Animal Breeding and Genetics Research Organisation of the Agricultural Research Council.

Announcements

THE James Tait Black Memorial Prize of the University of Edinburgh for 1947, awarded for a biography or work of that character, has been awarded to Dr. C. E. Raven, regius professor of divinity in the University of Cambridge, and master of Christ's College, for his book "English Naturalists from Neckham to Ray" (see this issue of *Nature*, p. 373).

DR. J. E. KEYSTON, formerly assistant director of scientific research, Admiralty, has been awarded the United States Medal of Freedom with Bronze Palm for promoting interchange of scientific and engineering information and collaborating with American research groups during the Second World War. The investiture took place in Salisbury, Southern Rhodesia. Dr. Keyston has recently been appointed research secretary of the Central African Council (see *Nature*, February 14, p. 230).

THE Committee of Privy Council for Medical Research has appointed Prof. H. P. Himsworth, professor of medicine in the University of London, to be a member of the Medical Research Council.

THE Council of the Royal Statistical Society offers the Frances Wood Memorial Prize, value £30, for competition in 1948. The Prize is offered for the best investigation, on statistical lines, of any problem bearing directly or indirectly upon the economic or social conditions of the people. Essays (which must be either printed or typed, and accompanied by copies of all statistical tabulations and diagrams) must be sent to the honorary secretaries of the Royal Statistical Society, 4 Portugal Street, W.C.2, not later than December 31, 1948.

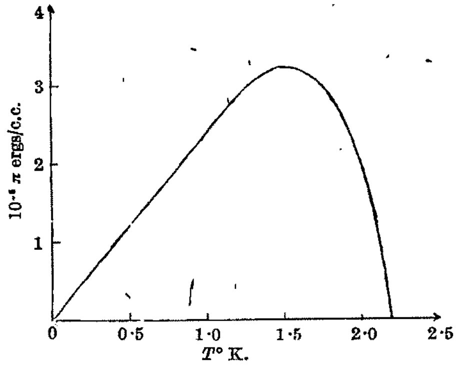
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Liquid Helium II

THE classical theory of liquids[1,2,3], of which a general explanation was given by Prof. Max Born and me in a previous article[4], and the quantization of the theory[5,6] which followed, led to a conception of the nature of viscosity and thermal conduction in liquids which we hoped would contribute towards the understanding not only of normal liquids, but also of 'quantum liquids', of which helium II and the electrons in superconducting metals are known examples.

The detailed application of these results to helium II has now been completed, and it has been found possible, without further assumption, to explain all the well-known properties of this liquid. The essential feature of a quantum liquid, as we observed previously[6], is the distinction between the intensive properties defined thermodynamically and from the point of view of kinetic theory. Of special importance is the distinction between the 'thermodynamic' pressure p, defined in terms of the work done pdV during the displacement of a surface in the liquid, and the 'kinetic' pressure p_1, the gradient of which determines the mean motion of the molecules. It can be shown that the difference π between these two quantities first becomes numerically significant just below the λ-point; it is represented as a function of temperature in the accompanying figure.



π AS A FUNCTION OF TEMPERATURE AT THE SATURATION VAPOUR PRESSURE

The equation of motion of the quantum liquid is

$$\rho\frac{du}{dt} + \frac{\partial p}{\partial x} = -\frac{\partial \pi}{\partial x}, \qquad (1)$$

where ρ is the density and u the macroscopic velocity. It follows rigorously that a reformulation of the first law of thermodynamics is required below the λ-point, of such a kind that it reduces to the usual law

$$dQ = dU + pdV \qquad (2)$$

for the ideal quasi-static process, but has quite a different form

$$dQ = d(U - \pi V) + p_1 dV \qquad (3)$$

for steady motion, such as is observed in the transfer effect (studied in detail by Daunt and Mendelssohn[7]), and yet another form

$$dQ = d(U + \pi V_0 - \pi V) + p_1 dV \qquad (4)$$

for wave motion, V_0 being the rest volume of the liquid. The anomalous specific heat and density of helium II is thus explained by the presence of thermal waves. Similar waves have been observed in ordinary liquids[8], but are strongly damped and have only a small group velocity.

A thermal wave transfers heat energy and the liquid bulk in opposite directions in a ratio depending only on the temperature. Kapitza's experiments[9] on the thermomechanical effect in a narrow slit have a quantitative explanation not, as Landau[10] suggests, in the motion of a superfluid at absolute zero, but in the almost isothermal passage of a thermal wave through the slit. Peshkov's observations[11] of temperature waves in helium II also have a quantitative explanation in terms of the thermal waves.

Earlier theories due to F. London[12,13] and Tisza[14,15] suggest that superfluidity is connected with the condensation which occurs in a Bose gas not far from the λ-point. A serious objection to these theories is the occurrence of entirely analogous phenomena in superconductors, where the electrons obey Fermi statistics. The quantum theory of liquids is, however, equally applicable to superconductivity, and an interesting feature of the theory outlined here is that it can explain also phenomena in superconductors: one requires only to replace the mechanical pressure by the electromagnetic stress tensor and to represent the almost stationary metallic ions by a conservative field of force.

H. S. GREEN

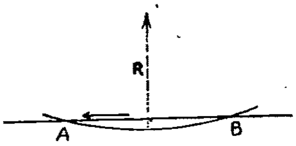
Department of Mathematical Physics,
University, Edinburgh.
Dec. 24.

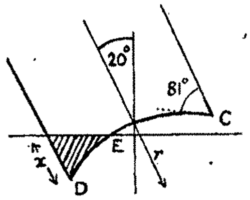
[1] Born, M., and Green, H. S., *Proc. Roy. Soc.*, A, **188**, 10 (1946).
[2] Green, H. S., *Proc. Roy. Soc.*, A, **189**, 103 (1947).
[3] Born, M., and Green, H. S., *Proc. Roy. Soc.*, A, **190**, 455 (1947).
[4] Born, M., and Green, H. S., *Nature*, **159**, 251 (1947).
[5] Born, M., and Green, H. S., *Proc. Roy. Soc.*, A, **191**, 168 (1947).
[6] Born, M., and Green, H. S., *Nature*, **159**, 738 (1947).
[7] Daunt, J. G., and Mendelssohn, K., *Proc. Roy. Soc.*, A, **170**, 423 (1939).
[8] Lucas, R., *J. de Phys.*, (7), **9**, 410 (1937).
[9] Kapitza, P. L., *J. Phys. U.S.S.R.*, **5**, 59 (1941).
[10] Landau, L., *J. Phys. U.S.S.R.*, **5**, 71 (1941).
[11] Peshkov, V., *J. Phys. U.S.S.R.*, **10**, 389 (1946).
[12] London, F., *Phys. Rev.*, **54**, 947 (1938).
[13] London, F., *J. Phys. Chem.*, 43, 49 (1939).
[14] Tisza, L., *C.R. Acad. Sci., Paris*, **207**, 1035, 1186 (1938).
[15] Tisza, L., *J. de Phys.*, (8), **1**, 165, 350.

Theory of Skating

IT is perhaps less common than it was to find the phenomenon of regelation put forward as a complete explanation of skating. Very probably anyone with a scientific education will suspect that plastic flow in the solid ice plays an important part, and the following observations will, if they are accepted, serve to strengthen that opinion.

It is clear at once that regelation as ordinarily understood in this case must require a rapid flow of heat through the skate blade from back to front, and yet the temperature gradient must be an infinitesimal one. Obviously the effect of friction must also be included, and since the publication of Bowden and Hughes' paper[1] in 1939 it has become possible to calculate what this may be. What no one seems to know with any accuracy is the depth of penetration of the skate blade and the amount of ice actually displaced. This is not easy to determine experimentally, and for present purposes the results have been calculated from simple observations using a skate ground to accurately known dimensions. Skates are usually ground to a form decided more or less empirically, the radius of curvature of the blade not being constant along the length. It is therefore important to record that a skate of uniform vertical radius (R) 72 in. and transverse radius (r) 0·5 in. performs admirably and possesses, indeed, some superiority over the ordinary run[2]. The blade has a thickness of 5/32 in. and the angle between the side of the skate and the bottom edge is accordingly 81°. In the calculations, this skate is considered at an angle of 20° to the vertical and is supposed to carry a load of 10 stones weight.





The depth of penetration of the blade is clearly a question which depends on the pressures concerned: the skate will sink in until the area in contact is such that the pressure is insufficient for further sinking. Curiously enough, this matter turns out to be less uncertain than might be expected. Double lines such as would be (and are) formed when the edge C comes in contact with the ice are always avoided in competitions, and the fact that they can be avoided at angles of about 20° (got from photographs) shows that the penetration must have an upper limit which with this particular skate is about 1/32 in. From this it follows that 0·0018 c. in. (or 0·03 gm.) of ice are displaced per length AB: the chord AB being in this case 4·38 in. The heat required to melt this ice is then 2·4 cal.

Friction can account for very little of this. From the equation

$$Q = \frac{Mg\mu_k}{J}L,$$

where M is load and L is AB, we find (using Bowden and Hughes' value for μ_k for *brass* on ice) only 0·363 cal. per length AB (AB = 4·38 in.). The ice melted would therefore be only 0·0045 gm.—about one eighth of the amount estimated to be displaced.

To estimate the regelation effect without reference to the difficulty about heat flow, we may find how deep the skate would sink under the stated load if there is a temperature gradient in the ice of the sort existing in rinks. 10° C. per in. is here quite a common gradient; out of doors the conditions are, of course, very variable; but a surface temperature of 0° C. seems to be the best for skating, and at low temperatures when there is a hard frost skating is more difficult.

The freezing-point lowering being given by

$$t = 0{\cdot}0072\,P,$$

where P is the pressure in atmospheres, it remains to find the area in contact with the ice at a penetration of 1/32 in. The arc DE having a value of 0·0744 in. when $x = 0{\cdot}0313$ in., the area is approximately given by 2·2 (0·0313 + 0·0744), which comes to 0·233 sq. in. From this the freezing point comes out at about − 0·3° C.—or a depth of 0·03 in. below the surface, which is of the correct order.

Nevertheless, this static picture will not do. At 10 m.p.h., heat would have to flow from B to A at some 100 cal. per sec.: an impossible rate having regard to the conductivity of steel, the cross-section area and the temperature difference of only a fraction of a degree centigrade. It looks very much more likely that the skate makes its track in the ice through plastic deformation of the solid rather than that melting plays any great part. The pressures applied to the ice by a moving skate must be of the order of some thousand pounds per square inch, and under such a stress the ice would give way. It is of interest, however, in regard to the question of friction, to note that Bowden and Hughes state that the lowest coefficients of kinetic friction were obtained when a water film of the order of 7×10^{-3} cm. thickness is present. The water formed by friction in the present case would allow of a layer of some 5×10^{-3} cm. thickness, and this might be sufficient for lubrication.

A. E. Bell

Science School,
Clifton College,
Bristol.

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[1] *Proc. Roy. Soc.*, A, 172, 280 (1939).

[2] Private communication from J. E. Sears, T. P. C. Low and C. S. d'E. Stock.

Chromatic Aberration of Electrostatic Lenses

The focal length of a three-aperture electrostatic lens follows from the general paraxial ray equation:

$$4\Phi r'' + 2\Phi' r' + \Phi'' r = 0,$$

where Φ is the potential along the axis ($r = 0$), and Φ_0 is the acceleration voltage.

When the potentials of cathode and intermediate electrode are equal, the chromatic aberration due to $\Delta\Phi_0/\Phi_0$ is zero according to this equation (although Φ_0 must be kept constant within 1 per cent to reduce the influence of external fields of transformers, etc.).

This is not so, however, when the relativity correction is taken into account.

The focal length is influenced by applying an extra constant voltage e between cathode and intermediate electrode. Chromatic aberration is caused by this extra voltage. It has proved possible to compensate the relativity aberration by this second chromatic aberration due to $\Delta\Phi_0/\Phi_0$ by choosing a suitable value of e/Φ_0. So every acceleration voltage determines its specific value of e/Φ_0.

When cathode and intermediate electrode potential of a certain weak electrostatic lens are equal ($e = 0$), the aberration due to relativity correction at 100 kV. is

$$\frac{\Delta A}{A} = -0{\cdot}14\,\frac{\Delta\Phi_0}{\Phi_0}, \qquad (1)$$

$1/A$ being the focal length.

Using a specific value of e/Φ_0 to eliminate this aberration, the constancy of e is determined by the chromatic aberration due to $\Delta e/e$.

$$\frac{\Delta A}{A} = -0{\cdot}16\,\frac{\Delta e}{e}. \qquad (2)$$

The advantage over the $e = 0$ type lenses follows from equations 1 and 2.

As the intermediate electrode is taking no current, stabilization of e causes no difficulties. The difficulty in stabilizing Φ_0 is that emission current is being taken. The advantage over magnetic lenses is clear, chromatic aberration of this type being

$$\frac{\Delta A}{A} = C.\ \frac{\Delta \Phi_0}{\Phi_0},$$

where C is about 0·8.

W. A. LE RÜTTE

Institute for Electron Microscopy,
Delft. Nov. 17.

Absorption Band Spectrum of S_2 in the Schumann Region

WHILE the main band-systems of the molecules O_2, S_2, Se_2 and Te_2 of the sixth periodic group have been the subject of numerous publications, there is little known about the systems of these molecules lying in the far ultra-violet. In all cases such systems have been found in absorption, but they have been analysed only partially for their complex structure. The absorption bands of Te_2 and Se_2 between 2500 and 1950 A. and 1950 and 1750 A. respectively have been photographed by Choong Shin-Piaw[1]. His analysis is incomplete and violates the empirical rule of Mecke–Birge. Choong Shin-Piaw believed all the molecules Te_2, Se_2 and S_2 to show the same peculiarity, and referred to the results published by Wieland, Wehrli and Miescher[2] on S_2. Yet these authors emphasized the provisional character of their interpretation.

We have therefore reinvestigated the S_2-bands between 1600 and 1900 A. by means of a 1-metre vacuum grating spectrograph (dispersion 8 A. per mm.). The continuum was furnished by a Lyman explosive discharge through a quartz capillary. Within the accuracy of measurement, which for most of the sharp bands is better than ± 1 cm.$^{-1}$, all the recorded bands can be arranged in two systems which we will call C and D.

The bands of system C are degraded towards shorter wave-lengths and appear to have several heads up to six, the intensity of which depends strongly from the vibrational quantum number v'. By arranging the strongest head of each band in a scheme, one gets for the wave-numbers of the heads the expression :

$$\nu = 55598{\cdot}2 + 830{\cdot}2\ (v' + \tfrac{1}{2}) - 3{\cdot}75\ (v' + \tfrac{1}{2})^2 - 725{\cdot}1\ (v'' + \tfrac{1}{2}) + 2{\cdot}85\ (v'' + \tfrac{1}{2})^2.$$

The system thus consists chiefly of the two vibrational progressions $v' = 0$ and $v'' = 0$. The vibrational constants of the lower level are in good agreement with the data of the ground-state of S_2 given by Olsson[3] ($\omega_e'' = 725{\cdot}8$, $\omega_e''x_e'' = 2{\cdot}85$). The high intensity of the bands points to a transition between states of like multiplicity. The ground-state being $^3\Sigma_g^-$, the upper state might then be of the $^3\Sigma_u^-$ or $^3\Pi_u$ type. Considering the number of heads and the multiplet separation, which is larger than in the ground-state, $^3\Pi_u$ is perhaps more probable.

System D, situated at shorter wave-lengths, is about of equal intensity, but its aspect is more complex. There are apparently three groups of bands (a, b, c in the accompanying [illegible]ion) which are observed several time[illegible]s formed by three strong heads. Th[illegible]ing arranged in a scheme, the vibrational [illegible]s turn out to be nearly the same for all t[illegible]s. From the strongest heads on the mor[illegible]angible side of each group, the following [illegible]ants are derived :

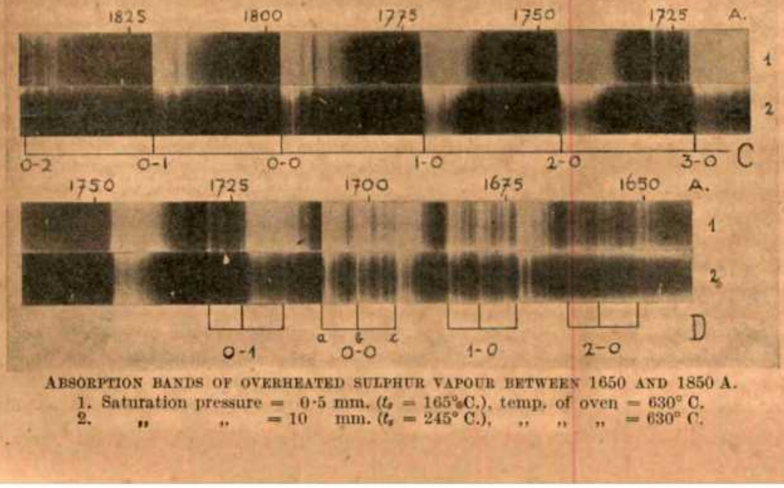
Group [illegible]			Group b			Group c		
ν_e	=	58515·1	ν_e	=	58707·2	ν_e	=	58976·8
ω_e'	=	794·2	ω_e'	=	793·8	ω_e'	=	793·7
$\omega_e'x_e'$	=	4·00	$\omega_e'x_e'$	=	4·00	$\omega_e'x_e'$	=	4·00
ω_e''	=	724·4	ω_e''	=	724·6	ω_e''	=	725·1
$\omega_e''x_e''$	=	2·85	$\omega_e''x_e''$	=	2·85	$\omega_e''x_e''$	=	2·85

Here again the lower level is identical with the ground-state of S_2. As an arrangement of the groups or systems in series of electronic states does not seem possible, no traces of higher series members being recorded, the three groups must be regarded as belonging to one and the same system showing atom-like separations. This analysis of system D departs from the one given earlier. The bands being shaded towards the violet, the vibrational frequency of the lower level is expected to be smaller than that of the upper one. This is actually the case.

The details of this investigation and a fuller discussion of the results will be given in a later paper to appear in the *Helv. Phys. Acta*.

R. MAEDER
E. MIESCHER

Physical Institute,
University of Basle.
Nov. 21.



ABSORPTION BANDS OF OVERHEATED SULPHUR VAPOUR BETWEEN 1650 AND 1850 A.
1. Saturation pressure = 0·5 mm. (t_s = 165° C.), temp. of oven = 630° C.
2. ,, ,, = 10 mm. (t_s = 245° C.), ,, ,, ,, = 630° C.

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[1] Choong Shin-Piaw, Thèse, Paris (1937).

[2] Wieland, K., Wehrli, M., and Miescher, E., *Helv. Phys. Acta*, 7, 843 (1934).

[3] Olsson, E., Thesis, Stockholm (1938).

Energy of the Ground-State of Helium-like Atoms

THE purpose of the present note is to suggest that the discrepancy between the measurements of helium-like spectra made by F. Tyrén and by H. Flemberg[1], on one hand, and the theoretical calculations made by E. Hylleraas (non-relativistic) and by me[2] (relativistic corrections), on the other hand, may possibly be due to the same reason which causes the discrepancy between theory (Dirac's fine-structure formula) and experiment (Lamb and Retherford[3]) in the hydrogenium spectrum.

The possibility of removing this latter discrepancy by taking into account the interaction of the electron with the radiation field has been the subject of discussions at a conference on Shelter Island this year[4], and has inspired calculations by Weisskopf[5] and by Bethe[4].

According to Bethe's calculations, the shift of an *ns* level should become $W' \sim kZ^4/n^3$ cm.$^{-1}$, where the factor k is about 0·26 for $Z = 1$ and $n = 2$ and does not change very rapidly with Z and n. This agrees well with the observed level-shift.

This result can be applied to the ionization energy of helium-like atoms if as a first rough approximation the interaction between the two electrons is neglected. In the accompanying table I have calculated the ratio W'/Z^4, where W' is the difference between the calculated and the experimental ionization energy.

Z	W'	W'/Z^4
2	+ 14	0·88
3	+ 13	0·16
4	+ 84	0·33
5	+ 195	0·31
6	+ 311	0·24
7	+ 537	0·22
8	+ 1080	0·26
9	+ 1844	0·28
12	+ 4861	0·23
13	+ 4966	0·18

The value 0·88 obtained for $Z = 2$ is, of course, very uncertain, since the theoretical value lies within the experimental limits of error.

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Theory of the Anomalous Skin Effect in Metals

Pippard[1] has recently made an experimental and theoretical study of the skin effect in metals at high frequencies, in which he showed that the usual theory of the effect is no longer valid at low temperatures owing to the breakdown of Ohm's law when the free path of the conduction electrons becomes comparable with the penetration depth of the electric field. With the aim of putting Pippard's provisional theory of the anomalous effects on a more rigorous basis, we have reformulated his equations using the methods of the modern electron theory of metals, and we have succeeded in obtaining explicit solutions which make it possible to give a quantitative account of the phenomena to be expected over the whole frequency- and temperature-range.

We consider a semi-infinite metal and assume the electrons to be quasi-free, the energy being proportional to the square of the wave-vector. The relation between the current density and the (unknown) electric field at any point in the metal, for arbitrary values of the frequency ω and the free path l, can then be obtained by the usual statistical methods of the theory of metals based on the Boltzmann equation[2]. On combining this relation with Maxwell's equations, we obtain the following integro-differential equation for the electric field $f(x)$:

$$f''(x) = i\alpha \left\{ p \int_{-\infty}^{\infty} k(x-y)\, f(y)dy + (1-p) \int_{0}^{\infty} k(x-y)\, f(y)dy \right\}, \qquad (1)$$

where

$$k(u) = \int_{1}^{\infty} \left(\frac{1}{s} - \frac{1}{s^3}\right) \exp\{-s(1+i\omega\tau)|u|\}ds,$$

x is the distance into the metal measured in units of l, $\alpha = 3l^2/2\delta^2$ (δ being the classical skin-depth), τ is the time of relaxation of the electrons, and it has been assumed that a fraction p of the electrons is scattered specularly at the surface of the metal while the rest are scattered diffusely. Also, $f(x)$ is to be an even function of x. The basic equation of Pippard's treatment (*loc. cit.*, equation (7)) may be written in a form which differs only in minor detail from equation (1).

Equation (1) has been solved for the two limiting cases $p = 1$ and $p = 0$ by means of the theory of Fourier integrals[3]. The electric field is, in general, a very complicated function of x, but for comparison with experiment it is not necessary to know $f(x)$ explicitly since all observable quantities can be expressed in terms of the surface impedance Z, defined as $4\pi/c$ times the ratio of the electric to the magnetic field strength at the surface of the metal. For $p = 1$ we find that

$$Z = \frac{4\pi\omega l}{ic^2}\,\frac{f(0)}{f'(0)} = \frac{8i\omega l}{c^2(1+i\omega\tau)} \int_0^{\infty} \frac{dt}{t^2 + \dfrac{i\alpha}{(1+i\omega\tau)^3}\varkappa(t)}, \qquad (2)$$

where

$$\varkappa(t) = \frac{2}{t^3}\{(1+t^2)\tan^{-1} t - t\}.$$

The expression for $p = 0$ is more complicated, but the results differ only in detail from those obtained for $p = 1$.

For frequencies which are not too high, we have $\omega\tau \ll 1$, and the integral in (2) is then a function of the single parameter α. In this case equation (2) reduces to the classical expression $Z_{cl} = (\pi\omega l/c^2)\sqrt{(6/\alpha)}\,(1+i)$ when $\alpha \ll 1$, and to

$$Z_\infty = \frac{8\pi^{2/3}\omega l}{3\sqrt{3}\,.\,c^2\alpha^{1/3}}\,(1+\sqrt{3}\,i) \qquad (3)$$

when $\alpha \gg 1$. (For $p = 0$, Z_∞ has 9/8 times the value (3).) For intermediate values of α, Z has been obtained by numerical evaluation of the integral in (2). From the definition of α, it follows that α is proportional to l^3 for a given metal and a given frequency. Hence Z varies as $l^{-1/2}$ in the classical case but is independent of l when $\alpha \gg 1$. This result is in agreement with Pippard's observations of the resistive part of Z at a wave-length of 25 cm., and represents the quantitative refinement of his theoretical interpretation in terms of an 'ineffectiveness concept'[1]. From a detailed comparison of the experimental and theoretical curves, it is possible to estimate the value of α and hence of the free path corresponding to any particular temperature. Thus for Pippard's mercury specimen we find that $\alpha = 1{,}550$ and $l = 8{\cdot}5 \times 10^{-4}$ cm. at $T = 3{\cdot}72°$ K.

Writing $Z = R + iX$, we have $R = X$ in the classical limit, while equation (3) shows that

$R = X/\sqrt{3}$ when $\alpha \gg 1$. X has not been measured directly, but Pippard[4] has obtained some indirect experimental evidence which indicates that X does, in fact, exceed R in the anomalous region.

The expression (2) has further been computed as a function of $\omega\tau$ for several values of the ratio $\alpha/\omega\tau$. ($\alpha/\omega\tau$ is independent of ω and, for a given metal, determines the value of l; the values chosen correspond to several temperatures between room temperature and liquid helium temperatures.) The ratios R/R_{cl} and X/X_{cl} are found to have the classical value unity for sufficiently low, and again for sufficiently high, frequencies (which are, however, well below the frequency for which the metal becomes transparent), and to pass through a maximum value at intermediate frequencies. The anomalous effects become less marked as the temperature increases, and have disappeared almost completely at room temperature. To give some idea of the orders of magnitude involved, choosing values of the parameters which correspond to a very pure specimen of silver at liquid helium temperatures, we find that R/R_{cl} attains a maximum value of 180 at a wave-length of 69 μ, while X/X_{cl} attains a maximum value of 5·3 at a wave-length of 7·6 cm. The absorption coefficient of the metal is increased in the same ratio as R; thus in the above example the theoretical absorption coefficient at 69 μ is $1{\cdot}44 \times 10^{-3}$, whereas the classical value is only 8×10^{-6}. Since the absorption is so small even in the anomalous case, an experimental verification of these predictions is likely to be very difficult.

A full account of the theory is to be published elsewhere.

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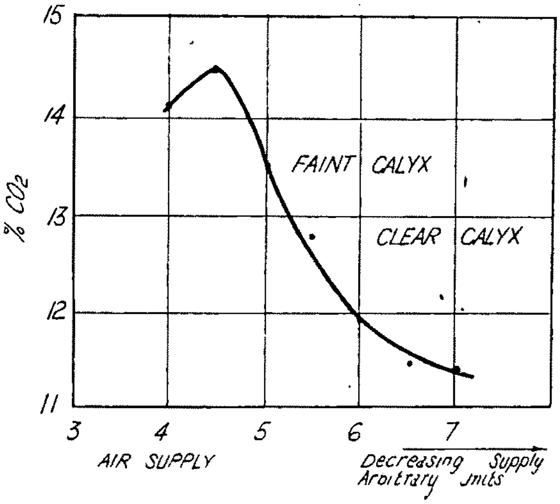
Use of 'Calyx' Burner to Determine Combustion Conditions

Brinsley and Stephens[1] have described an apparatus in which air and gas are pre-mixed and burned in a vessel from which the only exit is a small hole. When the proportion of air in a mixture originally air-rich is gradually reduced, the flame alters, and at one stage a violet sheath appears, surrounding the lower part of the flame. This sheath Brinsley and Stephens call a 'calyx'; they claim that it appears when the gas–air is that theoretically required for complete combustion.

It was thought that sampling the products of combustion as the theoretical mixture was burning would enable the maximum possible concentration of carbon dioxide in these products to be determined by a single analysis. This would be of service in testing gas appliances.

A mixture of coal gas and air was used. It was found that the flame is stable over only a small range of needle-valve settings: both the rate of supply of the mixture and its constitution have to be approximately correct or the flame goes out. Adjustment is not difficult once the operator has become familiar with the appearance of the flame in various circumstances, and the flame changes described by Brinsley and Stephens can then be readily observed.



Tests were made keeping the gas supply constant and cutting down the air in a series of arbitrary steps; at each setting a sample of the combustion products was taken and analysed for carbon dioxide. The results are shown in the accompanying graph. It will be seen that the calyx did not appear until after the maximum carbon dioxide concentration had been passed, and even then was only faintly visible. This reveals the chief objection to the use of the phenomenon for determination of theoretical combustion conditions. The calyx does not appear sufficiently suddenly; it 'fades in' as the air supply decreases, and the threshold visibility depends on the eyesight of the observer and on his experience. If it were used for determination of the maximum concentration of carbon dioxide in the combustion products, low results would be very probable.

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A New Sulpha Compound ("6257") and its Use in Human Cholera Infection

It was observed by one of us (S. S. B.) in 1939 that hexa-methylene-tetra-amine, in a 10 per cent solution in normal saline, killed cholera vibrio in less than half an hour up to a concentration of 10^{12}. Although interrupted by conditions of field service, efforts resulted in the production of three crude compounds of hexamine linkage to *para*-aminobenzene sulphonamide, experiments with which, on animal and human cholera infection, gave hope of successful chemotherapy against Asiatic cholera. A chance discussion with the scientific department of C.I.B.A. (Basle) resulted in our obtaining a condensation product—"6257"—of two molecules of 2 *p*-amino-benzene sulphonamido-thiazole ('Cibazol') and three molecules of formaldehyde with the formula $C_{21}H_{22}O_6N_6S_4$ (the actual constitution not having yet been worked out) and molar weight much greater than that of any other sulpha compound so far employed in clinical therapy.

In vitro, the bactericidal action of this compound on cholera vibrio was found to be powerful. When one million organisms of either the strain Inaba or Ogawa were seeded into 10 ml. of peptone water (*p*H 8·0) and 50 mgm. of the drug added, suspended in gum arabic in 0·1 ml. volume, it was found that samples plated on alkaline agar, 6, 12 and 24 hours after incubation at 37° C., remained sterile. Further confirmation of this observation was obtained (*a*) by testing the total inoculum of 10 ml. by the pour-plate method, when there was complete absence of growth; and (*b*) by transferring the total inoculum, in portions of 0·1 ml. each, to a hundred tubes of glucose peptone water with Andrade indicator, the absence of visible growth and of acid fermentation being taken as indices of non-viability.

Where the concentration of the drug was less than 50 mgm. (40, 30, 20 and 10 mgm.) well-marked bacteriostatic action was evident on the initial inoculum of one million bacterial cells, as judged by colony counts and hæmocytometer readings in comparison to control tubes. With 5 mgm. of the drug there was no difference between the control and experimental tube readings.

In vivo experiments on mice further confirmed these results. Twenty mice were employed for each experiment. Separate sets of animals were given 50 mgm. and 40 mgm. of the drug by the intraperitoneal, the subcutaneous and the oral routes, in divided doses, for two days prior to the test dose. This was injected intraperitoneally and was kept in the region of 2 *M.L.D.* to exclude mortality by toxic action alone. The mice were thereafter given two doses of "6257", morning and evening, for four days only, and the mortality-rate was observed for fifteen days. 100 per cent protection was obtained by the intraperitoneal and the subcutaneous routes. By oral feeding, however, only 10 per cent of the animals were saved. Post-mortem examination of dead mice revealed that intraperitoneal cholera infection resulted in septicæmia, the vibrios being isolated from heart blood, liver and spleen. Poor absorption of the drug from the intestinal tract, as judged by low blood concentrations, was therefore responsible for the high mortality in this group.

Field trials were carried out in the Tanjore District of South India, where there were cases of Asiatic cholera in many villages. The patients were treated in their homes without any other medical aid, in co-operation with local health authorities. The great majority of cases were under-nourished women and children with purgation, vomiting, suppression of urine and concomitant symptomatology. A specimen of rice-water stool was obtained initially to establish the diagnosis bacteriologically. The drug was then administered in a dose of 6 gm. followed four hours later by another 4 gm., commonly by mouth; where it was not retained, it was given per rectum. Vomiting was invariably stopped and purgation much reduced within six hours; the flow of urine took place by the ninth hour. The alimentation was barley *kanji* with plenty of water, especially soda-water, wherever available, since it helped to re-establish the function of the kidneys. The total dosage was 28 gm., given as 10 gm. on the first day, two doses of 4 gm. on the second day, and two of 1 gm. each morning and evening every subsequent day for five days. Under this regime, cholera vibrios were absent from the stool on the fifth morning. Administration of the drug to other occupants of the hamlet protected them from becoming infected.

To date 85 cases of bacteriologically established Asiatic cholera in twenty-seven villages have been treated, with a case mortality of 4 per cent in contrast with an average mortality of more than 60 per cent during the past seven years. No toxic manifestations with a maximum dose of 50 gm. have been observed. Besides the curative effect of this simple form of therapy under conditions where the possibility of hospitalization and the availability of medical care is slender, its prophylactic and preventive aspects are emphasized.

Detailed investigations are being published elsewhere.

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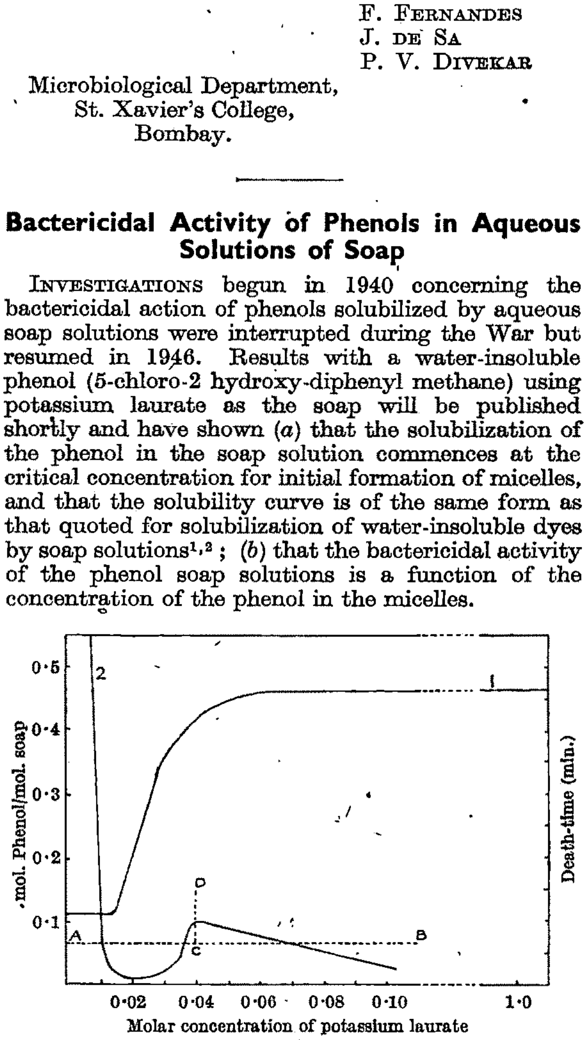
Bactericidal Activity of Phenols in Aqueous Solutions of Soap

INVESTIGATIONS begun in 1940 concerning the bactericidal action of phenols solubilized by aqueous soap solutions were interrupted during the War but resumed in 1946. Results with a water-insoluble phenol (5-chloro-2 hydroxy-diphenyl methane) using potassium laurate as the soap will be published shortly and have shown (*a*) that the solubilization of the phenol in the soap solution commences at the critical concentration for initial formation of micelles, and that the solubility curve is of the same form as that quoted for solubilization of water-insoluble dyes by soap solutions[1,2]; (*b*) that the bactericidal activity of the phenol soap solutions is a function of the concentration of the phenol in the micelles.



Curve 1 in the graph shows the solubility of the phenol in mol. phenol/mol. soap plotted against the molar soap concentration, and superimposed on it is Curve 2 representing the activity, in terms of the death-time of *B. coli*, at points along the line *AB* throughout which the ratio phenol/soap remains constant.

Below 0·01 *M* potassium laurate, the death-time decreases rapidly as the line is traversed in the direction of *B*, the concentration exponent over this range being of the order expected for an aqueous solution of a phenol. At 0·01 *M* potassium laurate the slope of the death-time curve alters sharply, first flattening, then rising to a maximum at about 0·04 *M* potassium laurate and finally decreasing again with concentration. In the range 0·01–0·04 *M* potassium laurate, the amount of the phenol which the soap will solubilize increases rapidly; but as the phenol/soap ratio remains constant in the solutions used; the degree of saturation of the micellar material actually decreases from about 0·015 *M* to 0·04 *M*, and it is this fact that is responsible for the rise of death-time in this range. That activity is greatest at approximately 0·01 *M* soap is due to the concentration of phenol in the micelles being greater at this point than elsewhere along the line *AB*. Death-times along line *CD* decrease rapidly as the amount of phenol per molecule of soap increases, indicating that maximum bactericidal activity is attained where the micelles are fully saturated with the phenol.

Experiments using sparingly soluble phenols like 2-chloro-5 hydroxy-1 : 3-dimethylbenzene and water-soluble phenols such as the cresols are in progress, and results will be published in due course.

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Calcium-Deficient Media: Their Effect on Phage Action

While typing staphylococci by the bacteriophage method of Wilson and Atkinson[1], I encountered three batches of nutrient agar that were strongly inhibitory to phage action; several of the phage filtrates had to be used in a concentration one hundred times greater than normal.

Stassano and de Beaufort[2], Asheshov[3], Bordet[4], Burnet[5], and others have reported on the inhibitory effect of sodium citrate when added to media used for the demonstration of phage action. This suggested that a deficiency of calcium in the medium might be responsible for the inhibition of phage action referred to above. On the suggestion of Dr. G. P. Gladstone of the Lister Institute, calcium chloride in concentrations of *M*/100 were added to two of the batches of inhibitory media; the third was unfortunately discarded. The effect was striking. The media were now found to be completely satisfactory for the demonstration of bacteriophage activity.

As a result of this experience, it is considered advisable to add calcium chloride to solid culture media that are to be used for the typing of staphylococci by the bacteriophage method.

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Production of Itaconic Acid and Kojic Acid by a Species of *Aspergillus*

The observation reported in the present note relates to an *Aspergillus* with yellow- to ochraceous-coloured conidia. The mould does not appear to correspond entirely with any published description.

Grown upon the surface of a 20–25 per cent sucrose solution containing the nutrient salts of Kardo-Ssyssojewa's medium[1] at 28° C. in the presence of calcium carbonate, this mould produces both itaconic acid and kojic acid. The relative proportions in which the two compounds appear may be varied by varying the conditions of the fermentation. At higher temperatures itaconic acid preponderates and may amount to more than 20 per cent of the weight of the sugar provided.

The itaconic acid was prepared from the calcium salt which is present in solution and often also separates as nodules on the underside of the mould. Its crystals showed characteristic cleavage; m.p. 163–166° C., not altered by admixture with authentic itaconic acid; analysis: C, 46·41, 46·53; H, 4·92, 5·00 per cent (calc. for $C_5H_6O_4$: C, 46·15; H, 4·61 per cent); equivalent, 65; the calcium content of the calcium salt was 21·5 per cent.

The kojic acid was prepared *via* the insoluble copper salt. It melted at 152–153° C.; its solution gave an intense blood-red colour with ferric chloride.

Itaconic acid has hitherto been shown to be produced by *A. itaconicus*[2] and by *A. terreus*[3]. The itaconic acid fermentation by *A. terreus* has since been extensively investigated in the United States in the Fermentation Division of the Northern Regional Research Laboratory[4–7].

The work now reported is being continued, and it is hoped to publish it fully elsewhere in due course.

It is a pleasure to acknowledge the assistance of my colleague Mr. J. H. Morrison and of a former colleague, Mr. C. W. Hutchinson.

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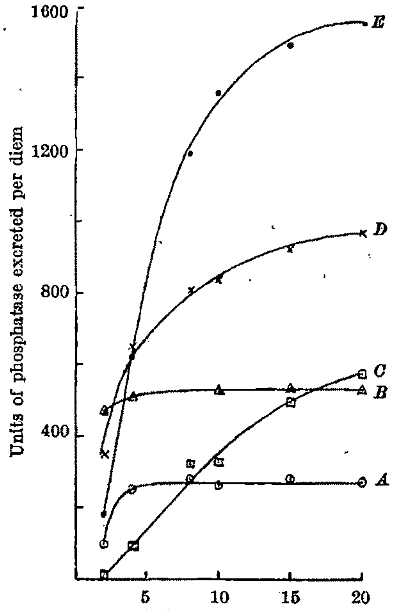
Presence of Substances Inhibitory to Acid Phosphatase in Normal Human Urine

In adult bilateral cryptorchid human subjects, a correlation has been found between androgen excretion in the urine and the amount of acid phosphatase in the semen[1]. The suggestion was made that if a similar correlation was found in normal subjects, measurement of acid phosphatase in semen might suffice for appraisal of urinary androgen content. Since specimens of urine are usually more easily obtained than those of semen, it seemed to be worth while to determine whether a correlation exists between urinary androgens and urinary acid phosphatase.

Recently Burgen[2] has described a method for the estimation of the urinary excretion of acid phosphatase, and his results on normal human subjects were a further indication that some correlation might exist between the daily excretion of this enzyme and that of 17-ketosteroids. It was found that the level of excretion of acid phosphatase is low in male children, but that from puberty onwards there is a sharp increase reaching a maximum in the fourth decade and then falling off in old age. Such a distribution resembles the known distribution of 17-ketosteroids with age in male subjects.

Experiments were therefore undertaken to compare the daily output of urinary acid phosphatase and urinary 17-ketosteroids by normal male subjects. The ketosteroid estimations were carried out by a standard colorimetric procedure and the acid phosphatase measurements were made, at least initially, by the method described by Burgen[2].

Difficulty in the estimation of the enzyme was encountered when some rather concentrated urines (daily volumes less than 700 ml.) were used. In Burgen's procedure the urine is prepared for assay by preliminary dilution with an equal volume of water. In order to reduce the blank values of these concentrated urines, higher dilutions were employed, and it was found that in some cases the amount of enzyme apparently increased with increasing dilution. In some urines the apparent amount of enzyme was still increasing at the limit of dilution in which it was practicable to estimate it. In other urines the amount of enzyme increased to a maximum after slight dilution of the urine, and then maintained a constant value to the limit of measurement. Urine from the same subject showed different behaviour with respect to this dilution effect on different occasions. Representative curves for five different urines are reproduced herewith. The daily output of acid phosphatase as computed from measurements of the enzyme on urine specimens initially diluted from two to twenty-fold is plotted against the dilution employed. It is clear that a reliable estimate of the urinary acid phosphatase can be obtained only on urines that show constant values on dilution (Curves *A* and *B*). In other cases no one value can be taken as a true measure of the enzyme content (Curves *C*, *D*, and *E*).



EFFECT OF DILUTION ON THE APPARENT ACID PHOSPHATASE CONTENT OF NORMAL MALE URINE

The most likely explanation of these results appears to be the presence in urine of one or more substances inhibitory to acid phosphatase. The variation in the dilution effect shown by different urines would then be due to the presence of different amounts of the inhibitory substance. Investigations on this point are now in progress. Until such inhibitors can be identified and eliminated from urine, it would appear that values for urinary acid phosphatase based on measurements at one dilution only must be regarded as provisional.

We should like to thank Dr. A. S. V. Burgen for helpful discussion and for showing us some of his unpublished results.

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Trace Elements and Nitrification

THE exact requirements of the nitrifying bacteria for inorganic nutrients are not yet known, though all workers on this group since Winogradsky[1] have assumed that they require iron, and many workers have added traces of other metals to their media[2], or used tap-water as a diluent, because of the possible trace elements it contains[3]. One of us has recently discovered[4], by the percolation method[5], that copper is apparently essential for nitrification in soil, so we decided to try the effect of iron and copper, alone and with other trace elements, on nitrite formation in cultures of nitrifying bacteria.

The cultures were grown at 25° C. in shallow layers of the following *liquid* medium : $M/200$ sodium chloride, $M/1,000$ magnesium sulphate, $M/1,000$ potassium dihydrogen phosphate, $M/200$ ammonium sulphate, dissolved in glass-distilled water, with 1 gm. calcium carbonate added to every 100 ml. They were not pure cultures, but must have contained a large population of nitrifying bacteria, as rapid and complete nitrification took place in them, the ammonia in the medium being converted first to nitrite and then to nitrate. The *inoculum* in the first experiment was taken from an active culture, the fourth transfer of a series in liquid media. The parent culture was obtained by incubating a small quantity of Rothamsted soil in Winogradsky's medium[1]; two serial transfers were later made to Winogradsky's medium, and two to the more dilute liquid medium described above. The *volume* of inoculum in the first experiment was only 8 drops to 100 ml. of medium; as nitrite formation was delayed in this case, the volume of inoculum was increased to 1 ml. in the other experiments, which were inoculated in each case from one of the control flasks of the previous experiment.

Salts of iron, zinc and copper were added to the medium to give the following quantities: iron

600 µgm., zinc 13 µgm., copper 14 µgm. per 100 ml. In the first experiment only, copper was added to two flasks at the rate of 28 µgm. per 100 ml. Nitrite was estimated colorimetrically with the Griess–Ilosvay reagent[5]; each figure is the mean of determinations on duplicate cultures.

Treatment	Experiment 1 11 days incubation Nitrite		Experiment 2 5 days incubation Nitrite		7 days incubation Nitrite	
	mgm. N/l.	% of control	mgm. N/l.	% of control	mgm. N/l.	% of control
Control	18	100	18·5	100	99	100
Iron	28	156	31·5	170	114	115
Copper 14 µgm.	21	117	27·5	149	80	81
Copper 28 µgm.	21	117	—	—	—	—
Iron + copper	34·5	192	22·5	122	94	95
Iron, copper and zinc	36·5	203	33·5	181	110	111

In a second pair of experiments the same three metals were added, together with a trace-element solution[6], supplying lithium, boron, aluminium, tin, manganese, nickel, cobalt, titanium, iodine and bromine. Iron was included in the medium in one experiment, and omitted in the other.

Treatment	Experiment 3 11 days incubation Nitrite	
	mgm. N/l.	% of control
Control	41	100
Trace elements only	20	49
Trace elements + zinc	22	54
Trace elements + copper	39	95
Trace elements, copper, zinc	34	83

Treatment	Experiment 4 10 days incubation Nitrite	
	mgm. N/l.	% of control
Iron only	125	305
Iron + trace elements	44	108
Iron, trace elements, zinc	45	110
Iron, trace elements, copper	94	230
Iron, trace elements, copper, zinc	99	241

The requirements of the nitrifying bacteria for elements such as iron and copper must be extremely small, as nitrite was formed in the control cultures, which must have contained the merest accidental traces of any of them. Also, as the medium contained an excess of calcium carbonate, only a very small proportion of the heavy metals added can have been in solution, and it is impossible to tell how much of the added elements were actually available to the bacteria. The outstanding feature of these results is the stimulating effect of iron; while mixtures of iron and copper, or iron, copper and zinc, had no more effect than iron alone. The unbalanced mixture of trace elements had an inhibiting effect on nitrite formation, which was not removed by zinc, but was removed by iron or copper. But the trace-element mixture with iron and copper, or iron, copper and zinc, had a stimulating effect. It appears probable that a proper balance of inorganic nutrients is more important for nitrification than the quantity of any one nutrient available.

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Vascular Patterns in the Testis, with Particular Reference to *Macropus*

IN the course of a comparative study of the vascular supply of the testis in mammals, a remarkable variety of patterns of the testicular artery in the spermatic cord and on the free surface of the organ has been revealed by radiography after the injection of colloidal bismuth and 'Wettal'[1]. Some of these findings are in agreement with those of earlier workers[2–6].

In all animals so far examined, except man and the wallaby, the testicular artery before reaching the testis undergoes a tortuous convolution. On reaching the testis, it does not pass into it at the mediastinum (as commonly stated in text-books), but ramifies over the free surface of the gland on the deep aspect of the tunica albuginea in a variable pattern. Thus, in the rabbit, the white-spotted squirrel and Bosman's potto (*Perodicticus potto*), the artery may encircle the gland two or three times before giving off any branches to the testis parenchyma, while in the rat, porcupine, ram, bull and rhesus monkey it describes a series of zig-zagging convolutions on the surface of the testis before supplying the gland.

The most interesting pattern in the spermatic cord and on the testis is, however, seen in the wallaby, *Macropus rufogrisea fruticus*. The single artery, near the testis, divides into no less than ninety-six separate branches which pass down to the organ without anastomosing (Fig. 1), to reach the mediastinum and then join again to form three to four vessels which ramify over the posterior surface of the testis in arborizing fashion. The veins are collected in a similar pattern from the anterior surface of the testis and pass over the superior pole to collect at the mediastinum. From here a pampiniform plexus of about a hundred veins passes up the spermatic cord. In the transverse section of the cord shown in Fig. 2 (× 9) the numerous branches of the testicular artery, containing colloidal bismuth injection, are seen intermingled with the veins of the pampiniform plexus. This remarkable branching of the testicular artery to form a sort of 'rete mirabile' may possibly be a marsupial characteristic; but further material will need to be examined before this can be determined.

Despite the diversity of pattern of the testicular artery in the spermatic cord and on the testis in

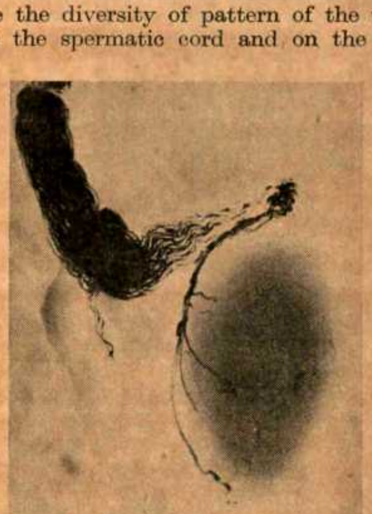

Fig. 1. A RADIOGRAPH OF THE TESTIS AND SPERMATIC CORD INJECTED WITH COLLOIDAL BISMUTH AND 'WETTAL' THROUGH THE TESTICULAR ARTERY BEFORE DIVISION. NATURAL SIZE

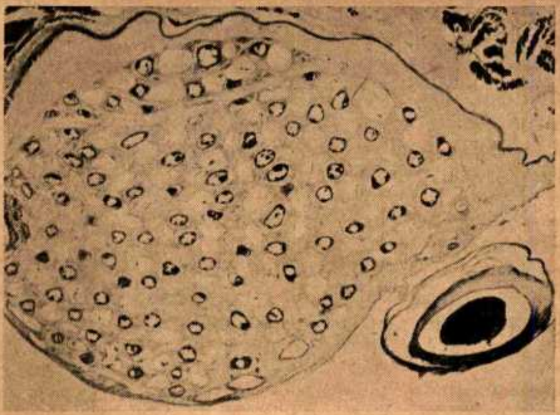

Fig. 2. TRANSVERSE SECTION OF THE SPERMATIC CORD. × 9

different mammals, it seems that the different arrangements possibly have a common functional significance, namely, to provide a mechanism for the exchange of heat in the temperature control of the testis. Experiments to test this inference are now being undertaken.

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Relationships in the Plumbaginaceæ

POLLEN- and associated stigma-dimorphism within the family Plumbaginaceæ were discovered in 1883 by McCleod[1], who observed them in *Limonium*. Since then, the range of genera showing pollen-dimorphism has been extended by various authors[2–5] to include *Armeria*, *Acantholimon* and *Limoniastrum*, while stigma-dimorphism has also been demonstrated in *Armeria*[3,4].

I have made a survey of all genera within the family and have established that the clear pollen-dimorphism is found only within the tribe Staticeæ, where there is no reason for believing that it has arisen more than once. The tribe Plumbagineæ contains only pollen-monomorphic genera, and there is evidence that this monomorphism is primitive. Extreme modification in embryo-sac structure is typical of the Plumbagineæ[6] but not of the Staticeæ, so that the direct derivation of the latter from the former is not possible. It is probable that the two tribes represent diverging lines from a common (but very ancient) ancestral stock. Within the Staticeæ, *Ægialitis* is unique in showing pollen-monomorphism with grains which are probably of the same type as in the Plumbagineæ. This genus is likely to be more ancient than any others within its tribe and therefore to have diverged least from the Plumbagineæ.

In the remaining genera of the Staticeæ, pollen-dimorphism appears to be intimately connected with a genetically determined incompatibility mechanism. Derived monomorphism, however, occurs in *Limonium* and *Armeria* at least and appears to be connected, here, with self-compatibility, which may be of use in regions where pollinating insects are sparsely represented and also in facilitating establishment after long-distance dispersal.

Heterostyly occurs in *Limonium*[7], and in the Plumbagineæ[7,8], but there is some slight evidence that the development of the incompatibility mechanism made visible by pollen- and stigma-dimorphism has preceded heterostyly in the Staticeæ. If this be true, heterostyly in the two tribes would have resulted from parallel evolution.

The detailed results of these and other studies within the family will be published elsewhere in a series of papers, but this further extension of the use of pollen-morphology to indicate relationships is possibly of general interest.

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Pharmacology of Ch'ang Shan *(Dichroa febrifuga)*, a Chinese Antimalarial Herb

FOR centuries in China the roots (Ch'ang Shan) and the leaves (Shuu Chi) of *Dichroa febrifuga*, Lour. have been used against malarial fevers. In our first report[1] in 1943, it was recorded that a crude extract of this root had been effectively used on clinical cases of tertian malaria. Then in 1945, when *Plasmodium gallinaceum* became available to us, we found that the crude extracts of both the root and the leaves of the herb were also effective for chicks infected with *P. gallinaceum*, the leaves being about five times as active as the roots. An alkaloidal fraction of the root exhibited a marked antimalarial activity, but of the three alkaloids, F (later called dichroine A), G and I, and two neutral principles, E (later dichrin A) and H (later dichrin B), none was found active[2]. In the following year we announced the isolation of an active alkaloid, dichroine B, melting at 237–238° C. with decomposition (considered as hydrochloride at first, later identified as dihydrochloride). It was effective against chicken malaria in intramuscular doses of 2–4 mgm./kgm. twice or thrice a day[3]. The empirical formula of dichroine B was first reported as $C_{16}H_{19}O_3N_3$ [4], and later as $C_{16}H_{21}O_3N_3$ when purer batches were examined[5]. As reported to the general conference of the Chinese Physiological Society on May 14, 1947, we had thus far isolated from Ch'ang Shan altogether five alkaloids and two neutral principles. Among the five alkaloids, dichroine A, dichroine B, dichroine C, dichroidine and quinazolone (4-keto-dihydroquinazoline), the first three members were soon found to be isomers mutually convertible under certain conditions. In conformity with the conventional nomenclature of isomers, they have been, thenceforth, called dichroine-α, dichroine-β, and dichroine-γ respectively[5]. With the probable exception of dichroine-α, all these alkaloids are more or less effective against *P. gallinaceum* infection in chicks, their antimalarial activity being in the descending order as follows: dichroine-γ, dichroine-β, dichroidine and quinazolone. From analytical studies of the oxidation products of dichroine-α, it is apparent that the dichroine isomers are quinazoline derivatives. Of the two neutral principles, dichrin *A* and dichrin *B*, the first has been identified as umbelliferone. In the accompanying table, the chemical and pharmacological properties of these seven substances from *Dichroa febrifuga* are summarized.

Principle	Formula	M.p.	*L.D.*50, mice. I.V. (mgm./kgm.)	Antimalarial activity, *P. gallinaceum*, (mgm./kgm.)
Dichroine-α	$C_{16}H_{21}O_3N_3$	136	18·5	Ineffective up to 8 mgm.
Sulphate		230*†		
Hydrochloride		210†		
Dichroine-β	,,	146	4·6	4
Hydrochloride		219†		
Dihydrochloride		238†		
Sulphate		224†		
Dichroine-γ	,,	161	5·0	1
Hydrochloride		219†		
Dihydrochloride		238†		
Sulphate		224†		
Dichroidine	$C_{16}H_{25}O_3N_3$	213		Effective 40
Quinazolone	$C_8H_6ON_2$	212		
Hydrochloride		250		
Dichrin *A* (Umbelliferone)		228–230		Ineffective up to 4 mgm.
Dichrin *B*		179–181		Ineffective up to 4 mgm.

* Crystallizing from water. † Melting with decomposition.

We also wish to state that another Chinese herb, Tou Ch'ang Shan, exhibits potent antimalarial action on chicken malaria. This herb has been tentatively identified as *Hydrangea umbellata*, Rheder., belonging to the same family (Saxifragacea) as *Dichroa febrifuga*. Its active fraction has been found to be also alkaloidal in nature, and several crystalline alkaloids have been isolated.

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Annealing of Glass

It is well known that the relaxation of stress in glass during annealing does not follow the Maxwellian relaxation formula. Indeed, annealing schedules for glass are always based on Adams and Williamson's[1] empirical law that the reciprocal of the stress is proportional to the time. Littleton[2] and Lillie[3] have attempted to account for the discrepancy on the basis of the viscosity being a function of the time, and many workers have attributed it to the dependence of the stress relaxation on some 'molecular viscosity' or upon changes in the equilibrium state of the glass.

If the change in the state of glass associated with temperatures about and above the annealing range is pictured as the development of 'holes' (or the equivalent concept, the development of two-positioned sites for some of the ions[4]) with increasing temperature, one can express the number of such holes as a function of temperature and pressure for equilibrium, and, by a treatment similar to that used in calculating the rates of crystal growth[5], one can find the rate of approach to equilibrium. Thus an equation for the stress relaxation may be derived:

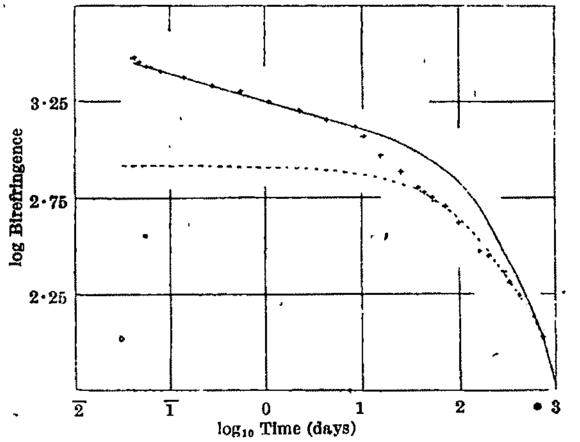
$$\log S_0/S = at + b \log \{1 + D(1 - \text{expt.-wt.})\}.$$

At low temperature (430° C.) 'W' is very small, so that provided the time is not too long:

$$\log S_0/S = at + b \log (1 + ct),$$

where S_0 and S are the initial and subsequent stresses and t is the time.

In this expression the constant a is inversely proportional to the viscosity, and no allowance is made



for variation of viscosity with time, although such is to be expected because of the changing state of the glass. While the first term on the right-hand side has a form similar to Maxwell's relaxation, the constant a differs from his expression rigidity/viscosity by virtue of the 'hunting' action of the pressure-sensitive equilibrium upon the stress.

Morey's[6] experimental results for 'Pyrex' chemical resistance glass at 430° C., which extended over two years, are shown in the graph, where both stress (birefringence) and time are plotted as logarithms. The full curve is calculated from the expression above, while the stress calculated from the empirical law according to Adams and Williamson is dotted.

Inspection will show that the departure of the continuous line from the observed values is such as would be expected from neglect of viscosity variation.

Adams and Williamson's law holds only over a small part of the total time range, and is therefore of little theoretical significance. Its value lies in that it holds over just that range of time which is of practical importance.

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Determination of Silicate Inclusions in Steel

THE appearance of non-metallic inclusions and their influence on the mechanical and corrosion properties of steel have been the subject of many investigations[1,2]. For the determination of silicate inclusions, many methods (chlorine, bromine, iodine and electrolytic) have been used successfully. But they are all rather difficult; other simpler methods, such as the dissolution of the steel sample in nitric, hydrochloric or sulphuric acids, give uncertain results. In the search for a simple method, we used the dissolution of steel in acetic acid.

The treatment worked out by us is in outline as follows: 20 gm. very fine drillings of unhardened steel (hardened steel gives results which are too high on account of the adsorption of silicic acid on carbon) are put into 500 c.c. of 2 N acetic acid in an Erlenmayer flask. The flask has a stopper with two tubes, through one of which nitrogen is introduced (or other indifferent gas) free of oxygen; the nitrogen passes through the acid and escapes by the second outlet. The flask is put on a boiling water bath and, when the drillings are dissolved (for very fine drillings it takes three to four hours), the solution is decanted through a fine filter (Schleicher and Schüll, Blau Band) in a Buchner funnel, washed with distilled water, then with 3 per cent solution of sodium carbonate and finally with hot distilled water. The filter with the residue is ignited in a platinum crucible. Then we determine silicon dioxide in the ash in one of the usual ways; or (1) after melting it with sodium carbonate, or (2) by expelling the SiO_2 by heating the residue with a mixture of hydrofluoric and sulphuric acids after previous treatment of the residue with a mixture of hydrochloric and nitric acids (in order to remove the greater part of iron oxides). In the remaining oxides we can determine the Al_2O_3 content of the steel.

To test the method we determined the SiO_2 content of seven steels, the compositions of which are shown in Table 1.

TABLE 1. COMPOSITION OF STEELS (PER CENT)

Number of steel	C	Si	Mn	P	S
1	0·14	0·14	0·46	0·014	0·028
2	0·40	0·35	0·60	0·021	0·010
3	0·46	0·30	0·62	0·021	0·026
4	0·57	0·24	0·57	0·033	0·042
5	0·65	0·30	0·70	0·037	0·026
6	0·98	0·16	0·32	0·024	0·010
7	1·09	0·29	0·19	—	0·008

In Table 2 are summarized the results of determinations of SiO_2 by the chlorine, bromine, electrolytic (Benedicks – Skapski) and the method described above. The results of the chlorine, bromine and electrolytic methods are average results.

TABLE 2. PERCENTAGE OF SiO_2 IN STEELS

Number of steel	Chlorine method	Bromine method	Electrolytic method	Acetic method	
					Mean
1	0·021	0·019	0·0185	0·020 0·018 0·020	0·0193
2	0·0115	0·015	0·0097	0·012 0·010 0·009	0·0103
3	0·0055	0·0055	0·005	0·005 0·006 0·004	0·0050
4	—	0·007	0·006	0·008 0·006 0·006	0·0067
5	—	0·0105	0·014	0·013 0·012 0·013	0·0127
6	0·005	0·008	0·0085	0·008 0·008 0·007 0·007	0·0075
7	0·0023	0·0032	0·00325	0·0030 0·0029 0·0032	0·00303

The agreement of the results obtained by the new method with those by generally accepted methods is quite satisfactory. The determination of the Al_2O_3 content in steel gives good results, too, in comparison with the results obtained by the dissolution in nitric acid or electrolytic dissolution.

A detailed description of the method will be published in the near future.

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Extinction of Petrol Fires by Methyl Iodide

THE distressing and increasingly frequent incidence of fatal fires in tankers, aeroplanes and other petrol-using machines, and in factories and laboratories employing fuels and inflammable solvents, has repeatedly directed attention to the need for a quick quenching agent. In such straits, so long as they contain carbon tetrachloride, the brass squirts so universally carried are of less use than mascots. This substance will not extinguish petrol fires. At best, it may localize the combustion. It yields stifling clouds of black soot and twice its own vapour-volume of chlorine. It is itself toxic.

As a young man, I worked as an assistant both to R. V. Wheeler and to H. B. Dixon, and it has occurred to me to follow up the latter's investigation of the former's discovery of the combustion-inhibiting influence of the iodides. One of many reasons for the choice of methyl iodide for the initial experiments was its physical resemblance to carbon tetrachloride. Chemically and physiologically it is very different. It is safer and pleasanter in use; and it does not yield noxious or corrosive end-products.

It was found that in all cases where carbon tetrachloride was effective, methyl iodide was equally effective with one fifth of the quantity. Both were better sprayed than squirted, and the pumps and syringes needed non-greasy lubrication. The crucial experiment was then tried of spraying it on to a water-borne layer of petrol on fire. Up to forty square feet, garden syringes were used. Over greater areas a pump was desirable. This test gave a complete failure to carbon tetrachloride, a saturated water solution of ammonium iodide and to methylene di-iodide. These substances burnt in the flames. Under a spray of methyl iodide, however, the petrol flames broke, wilted and withered. There was no smothering or swamping; the effect resembled that of a policeman's hand on traffic. Moreover, the petrol can at will be repeatedly rekindled and requenched until it is made safe or exhausted.

Tray-fires of ether, methylated spirits, and white spirit, which could not be extinguished by carbon tetrachloride, were swiftly quelled by methyl iodide.

Some hundreds of comparisons made, less picturesquely, with a flash-point apparatus contain no single exception to this overwhelming superiority of methyl iodide.

This fact has immense possibilities in social consequences—the price, of course, must fall just as the price of *D.D.T.* fell. What it amounts to in physical chemistry seems to be a fascinating example of how combustion-chains may be affected by iodine atoms freshly liberated from a single valency. The iodine, liberated in the burning of methylene di-iodide would clearly seem to have a different mode of existence.

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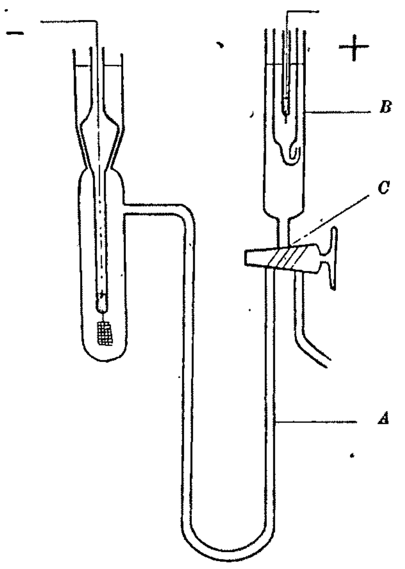
A Simple Moving-Boundary Apparatus

IN the conventional types of apparatus for the measurement of transference numbers in electrolyte solutions by the moving-boundary method, elaborate devices are used to achieve the initial formation of a reasonably sharp boundary[1,2]. It seems surprisingly to have escaped notice so far that a sharp 'sheared' boundary can be formed satisfactorily and with less trouble by the use of a single three-way tap of good quality.

The apparatus used by us, illustrated in the accompanying figure, has been designed for the measurement of the transference number of hydrogen ion in hydrochloric acid solutions by a descending boundary in the tube *A*, using lithium chloride as the 'indicator' electrolyte. The adaptation of the principle to other measurements is obvious.



The whole apparatus is first filled with the hydrochloric acid solution with the tap in the position connecting *A* and *B*, after which the anode vessel is emptied (by turning the tap through 180°). *B* can then be rinsed through with the indicator solution at leisure. After turning the tap through 90°, *B* is filled with the indicator solution and, on connecting *A* and *B* again by turning the tap to the initial position, a sharp boundary is formed at *C* the velocity of which may be measured after it has passed through the tap.

We wish to thank Messrs. E. C. A. Horner and A. D. Jenkins for experimental assistance.

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Elminius modestus in the Netherlands

RECENTLY, Jones[1] remarked that the barnacle *Elminius modestus* Darwin, if introduced into France and Holland, is likely to become particularly troublesome for the oyster culture industry. It may be worth while to state that the species seems to be already fairly common in the southern part of the North Sea coast of the Netherlands.

As Bishop[2] stated that the barnacle was taken from the hull of the M.V. *Empire Wansbeck*, which had been plying between Harwich and the Hook of Holland, the species might be expected here. To direct attention to its probable occurrence, a note giving particulars of the barnacle was inserted in a stencilled periodical devoted to the study of the seashore, and the Leyden Museum soon received material of *Elminius* from Scheveningen and its surroundings and from Serooskerke in Zeeland. The first specimens on flotsam were collected on September 19, 1946; the first specimens on piles were obtained on October

18, 1947. The latter, therefore, undoubtedly have developed from larvæ occurring in Dutch waters.

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What is a Dialysate ?

IN *Nature* of November 22, 1947, p. 720, H. G. Derx has commented upon the confusion caused by the lack of a suitable name for the material retained by a dialysing membrane. He has proposed the use of the term 'residue'. We have found the term 'impermeate', coined by Dr. Howard Eder in our laboratories some years ago, a very descriptive and helpful one to apply to such material

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Operational Research

IN spite of the frequency with which operational research has been referred to recently, there are extremely few published discussions from which the layman can obtain an idea of what it is[1]. Its nature is actually extremely straightforward; the very simplicity of the basic idea is probably one of the reasons why many people seem to find it so difficult to grasp. In the first place, operational research is research in the true sense. I would refer to Blackett's obituary notice of E. J. Williams[2], in which he tells how Williams found the phenomena of U-boat warfare as intellectually enthralling as those of atomic physics; and Williams could scarcely have been accused of not knowing what scientific research really means. The adjective 'operational' does not mean that the activity is not true research, any more than do the adjectives in such expressions as 'chemical research', 'genetical research', etc. It characterizes, not the quality of the research, but its subject-matter, which was originally the operations of armed forces. In a wider definition, operational research can be described as the application of the methods of scientific research to the study of the problems which face an executive authority.

The special characteristic which differentiates operational research from other branches of applied science is that it takes as the phenomenon to be studied the whole executive problem and not the individual technical parts; its interest may be focused, for example, on 'how to find U-boats from aircraft', while specialist applied sciences would be studying component parts of the situation, such as the physics of radar, the psycho-physiology of fatigue, etc. It is, perhaps, because operational research scientific workers had to depend so largely for detailed information on the generous collaboration of their specialist colleagues that some people appear to think that they invented new techniques of teamwork. How badly the world needs such techniques ! But it is for the sociologists, not the operational research workers, to discover them.

In point of fact, operational research possesses no new or special technique of its own. It uses the normal methods of scientific research to discover the facts about the phenomena which it is studying. Naturally, some of science's armoury of methods are more appropriate to its subject-matter than are others, just as genetical research often calls for statistical methods, while experimental embryology finds more use for manipulative skill. But it has no secret weapon.

Why, then, it may be asked, is it important to consider whether sufficient use is being made of operational research during peace ? The answer, I think, is that although the methods of operational research are not new, the direct application of those methods to executive problems had only been made very spasmodically before the War, and, when undertaken on a reasonably large scale, proved itself to be extremely fruitful. The Services, which, on the fighting side, have an organisation designed for the specific purpose of deciding what to do and then doing it, soon recognized the difference between analysing the situation (operational research), drawing up a scheme to cope with it (planning) and putting the scheme into effect (operations), and possessed a framework into which the first of these could easily be fitted. The civil branches of government, which have only recently been called upon to initiate and carry out major enterprises, seem to find these distinctions more difficult to grasp ; and we find *Nature* implying that operational research is a method of planning[3]. Research by itself can never produce a plan ; its function is to prepare the basis on which a rational plan can be founded, by identifying qualitatively the factors in the situation, and, as far as possible, by evaluating them quantitatively. It seems to me astonishing that any scientific worker should doubt that the scientific method is by far the most powerful instrument we have for performing the analysis and fact-finding on which executive decisions should be based. Surely no one could be satisfied to try to "re-deploy the scientific effort of Great Britain" without trying first to find what the probable demands are in the various fields ; what the available resources are, and would become ; how many men of science could function equally well if re-directed into other fields ; for what reasons scientific workers have taken up the work they are now doing ; what the demands on teaching establishments would be to achieve different rates of redeployment ; and so on. Investigations of this nature, which would take into account all the factors which could be shown, or surmised, to influence the situation, would be equally necessary whether the planners eventually decided to put their schemes into effect by a totalitarian *fiat*, or by any of the gamut of subtler systems of payments and incentives. A beginning should be made with them, even though one believes that the brute facts, like Archimedes' tortoise, can never be completely overtaken by scientific analysis. But it only obscures the issue if consideration of the importance of research on behalf of the executive planners is prejudiced by opinions as to the method by which the plan should be put into operation.

C. H. WADDINGTON

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University of Edinburgh. Jan. 15.

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[3] *Nature*, **161**, 1 (1948).

[As Prof. Waddington remarks, there have been few widely available accounts of operational research. The article by Sir Charles Goodeve on p. 377 will help to clarify the situation. EDITORS.]

A FACTOR IN HEART MUSCLE REQUIRED FOR THE REDUCTION OF CYTOCHROME *c* BY CYTOCHROME *b*

By E. C. SLATER

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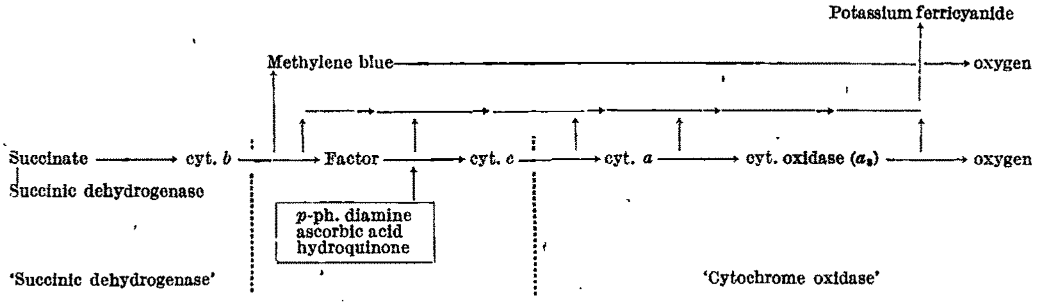
IT is well established[1] that the intracellular respiratory complex catalysing the aerobic oxidation of succinate (the succinic oxidase system) includes the cytochrome system in addition to the specific enzyme responsible for the activation of succinate (that is, succinic dehydrogenase). Thus the transport of electrons from succinate to molecular oxygen proceeds through a chain of electron carriers of successively higher oxidation-reduction potential[2]. Four such carriers have been identified spectroscopically, namely, cytochromes *b*, *c*, *a* and a_3. Cytochrome a_3 is probably identical with cytochrome oxidase[3]. The purpose of the present communication is to present evidence for the existence of an additional carrier. This evidence was obtained by studying the mechanism of the action of certain reducing agents (particularly the dithiol 2,3 dimercaptopropanol (*B.A.L.*)) on the succinic oxidase system of heart muscle.

It was found that the oxidation of this dithiol by air at *p*H 7·1 was catalysed by the heart-muscle preparation of Keilin and Hartree[1]. Treatment of the heart-muscle preparation with *B.A.L.*, in the presence of air, had two quite distinct effects on the enzymes responsible for the oxidation of succinate: (*a*) Complete inactivation of the succinic oxidase system (measured by the rate of oxidation of succinate in the presence of excess cytochrome *c*), without any effect on the succinic dehydrogenase (measured by the rate of oxidation of succinate in the presence of methylene blue and potassium cyanide); this inactivation is complete soon after the addition of the *B.A.L.* (*b*) A partial inhibition of succinic dehydrogenase, which does not occur until more than half the *B.A.L.* is oxidized; this inhibition is probably largely due to the action of oxidized *B.A.L.* on the sulphydryl groups of succinic dehydrogenase (cf. Hopkins and Morgan[4]). Incidentally, these observations reconcile the apparently divergent findings of Barron *et al.*[5] and of Webb and van Heyningen[6] on the action of *B.A.L.* on the succinic oxidase system, since the former workers measured the effect on the complete succinic oxidase system, whereas the latter studied the effect on the succinic dehydrogenase alone.

The inactivation of the complete system without concomitant inhibition of succinic dehydrogenase was produced only if *B.A.L.* was oxidized in air in the presence of the enzyme. No inhibition resulted from contact with the dithiol under anaerobic conditions, while oxidized *B.A.L.* only slightly inhibited the succinic oxidase system and at the same time inhibited succinic dehydrogenase. Although it was found that hydrogen peroxide was produced during the oxidation of the *B.A.L.*, the effect on the enzyme was not due non-specifically to this hydrogen peroxide, since hydrogen peroxide produced by other systems (notatin-glucose; *d*-amino-acid oxidase and its substrates) inactivated the enzyme only partially, and this inactivation, but not the *B.A.L.*-induced inactivation, could be partly protected by alcohol and by pyruvate and was increased by catalase. Moreover, the addition of copper, which increased the rate of oxidation of *B.A.L.* and, therefore, the rate of production of hydrogen peroxide, decreased the degree of inactivation.

Treatment of the heart-muscle preparation with *B.A.L.* under conditions which led to complete inactivation of the succinic oxidase system had very little effect (about 10 per cent inhibition) on the cytochrome oxidase activity (measured by the rate of oxidation of ascorbic acid, hydroquinone or *p*-phenylene diamine in the presence of excess cytochrome *c*). The ability of the heart-muscle preparation to catalyse the oxidation of *p*-phenylene diamine in the absence of added cytochrome *c*[7] was inhibited by about 35 per cent by the same treatment.

This treatment with *B.A.L.* did not affect the intensities of the cytochrome $a + a_3$, *b* and *c* bands, after reduction with sodium hydrosulphite, showing that the amounts of these cytochromes were not altered. When, however, succinate was added instead of sodium hydrosulphite, an impairment of the rate of oxidation of cytochrome *b* by cytochrome *c* was observed: thus on adding succinate to heart-muscle preparation treated with *B.A.L.* and shaking with air, the *b*-band alone was visible, that is, in the reduced state (cf. the action of narcotics[1]). The cytochrome *b* could, however, be oxidized by the addition of methylene blue or dichlorphenol indophenol. Although cytochromes $a + a_3$, *b*, *c*, were not destroyed by *B.A.L.*, the total hæmatin content (measured by the intensity of the pyridine-hæmochromogen band at 548–560 mμ after the addition of sodium hydrosulphite and pyridine) was reduced by about 20 per cent when the succinic oxidase system was completely inactivated. Thus treatment with *B.A.L.* destroyed some hæmatin compound the spectrum of which is not visible in the heart muscle preparation, either before or after treatment with hydrosulphite. There was a close correlation between the amount of hæmatin compound destroyed and the



THE COMPONENTS OF THE SUCCINIC OXIDASE SYSTEM degree of inactivation of the succinic oxidase system when different concentrations of *B.A.L.* were allowed to act on the enzyme for various times.

The enzyme preparation after treatment with *B.A.L.* could not be reactivated by catalase, cytochrome *c*, serum proteins, denatured globin, calcium phosphate gel, Straub's '*SC* factor'[8], copper, aqueous extract of fresh heart-muscle mince (rich in myoglobin) or various fractions of the heart muscle preparation. The enzyme could, however, be protected from the action of *B.A.L.* by the presence, during treatment, of cytochrome *c*, which caused rapid oxidation (through the cytochrome oxidase system) of the dithiol.

Treatment with *B.A.L.* under conditions which caused complete inactivation of the succinic oxidase system, with about 10 per cent inhibition of succinic dehydrogenase, inhibited the activity of the system, measured anaerobically by the rate of reduction of ferricyanide, by 35 per cent.

These observations suggest the existence of a *B.A.L.*-labile factor, probably a hæmatin compound, which transfers electrons from cytochrome *b* to cytochrome *c* and is destroyed by coupled oxidation with reducing agents (cf. the action of ascorbic acid on hæmoglobin, Lemberg *et al.*[9]) when the heart-muscle preparation is treated with reducing agents in the presence of air.

The relationships between this factor and the cytochromes are shown in the accompanying scheme, the arrows showing direction of electron transfer. Thus destruction of the factor would not affect the oxidation of succinate through methylene blue as carrier, nor the oxidation of various reducing agents through cytochromes *c* and *a* and cytochrome oxidase; but would prevent completely the transfer of electrons from cytochrome *b* to cytochrome *c* and thence to molecular oxygen. It is postulated that potassium ferricyanide, with an oxidation-reduction potential (E'_0 at pH 7·3 $= + 0{\cdot}41$ V.) much higher than that of succinate $\rightleftharpoons$ fumarate (E'_0 at pH 7·3 $= -0{\cdot}01$ V.) or of cytochrome *b* (E'_0 at pH 7·3 $= - 0{\cdot}04$ V.) operates partly directly with cytochrome *b* and partly through the *B.A.L.*-labile factor or the cytochromes of higher oxidation-reduction potential (E'_0 of cytochrome $c = + 0{\cdot}26$ V., cytochrome $a = + 0{\cdot}29$ V.). Thus the destruction of the factor causes a partial, but not complete, inhibition of the rate of oxidation by ferricyanide.

It is possible that the factor is the same as, or closely related to, the component *X* suggested by Bach *et* al.[10] to be necessary for the reduction of cytochrome *c* by cytochrome b_2 in yeast.

The complete experimental data and a discussion of these findings in relation to previous work on the succinic oxidase system will appear elsewhere.

I would like to express my sincere thanks to Prof. D. Keilin for his most valuable advice throughout this investigation. I also wish to thank the British Council for a scholarship.

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PLANT ANALYSIS AND FERTILIZER REQUIREMENTS

A QUICK and reliable method of determining the fertilizer requirements of crops and of discovering what nutrient deficiency is responsible for the unsatisfactory growth of some particular crop would be of immense value in advisory work. The problem can be approached from several different points of view, such as soil analysis, field trials, pot cultures, leaf injection, plant analysis and the use of visual symptoms. The relative advantages and disadvantages of these various methods of diagnosing fertilizer requirements are briefly but clearly summarized in the paper under notice*, and an extensive list of references facilitates fuller study of the individual methods.

A short historical account of the early work on diagnostic plant analysis reminds the reader that there is much to be learnt from these early papers. Developments during the past twenty-five years are discussed in more detail, and a great deal of information on the content of nutrients in plant material in relation to the incidence of deficiency or toxicity symptoms is summarized in tabular form.

Reference is also made to the use of plant analysis in the determination of current nutrient requirements by so-called 'tissue tests'. Carried out on sap or extracts of fresh material, it is suggested that the fractions estimated by these tissue tests are mainly unassimilated material which has recently entered the plant and that their concentration thus represents the *current* rate of nutrient intake. The rapidity with which 'tissue tests' can be performed and the fact that their results can be translated into immediate fertilizer treatment quickly enough to be effective even on annual crops, provided the problem is recognized early in the life of the crop, makes them specially attractive in advisory work. If they can be shown to be reasonably reliable and their interpretation does not require the establishment of a very elaborate series of standards, they seem likely to displace some of the older methods used in advisory work.

As the authors of this paper point out, when defining the aim of a method of deficiency diagnosis, there is an important distinction between methods to be used to improve the nutrition, during the course of its growth, of the crop analysed, and those where the plants analysed serve only as an index of the state of the soil and as a guide to the best fertilizer treatment for subsequent crops.

In a discussion of the relation of internal nutrient concentration to nutrient supply, evidence from barley grown in sand cultures, to which nutrients were added before germination, is used to show that: (1) the concentration in the tissues will depend upon the time during development at which determinations are made; and (2) the results will depend upon the part of the plant chosen for analysis. Analysis of the plant soon after germination (when the seed reserves are exhausted) will give some measure of the concentration of the nutrients in the rooting medium, especially in plants like cereals that branch very rapidly in the early stages.

The bearing of these facts on the relations to be expected with plants growing in the field are complicated by the difference in the mode of supply of the nutrient; for not only are the differences in the concentration of the nutrient in the field of a different order from those in the sand cultures described, but also rates at which nutrients in the soil become available are likely to be more important than actual concentrations in the soil solution, and the supply may continue at a relatively high level throughout the growing period. This is specially important in those types of plant, such as barley, in which nutrients taken up after the stage when further elaboration of meristems ceases lead to no further increase in yield but merely raise the concentration within the plant, thereby checking the normal tendency to decline to a minimum at harvest. Hence plant analyses from field crops can show considerable variations in concentration at harvest. High concentration of nutrient in the mature cereal plant may be due either to limitation of growth by some other nutrient factor leading to 'luxury consumption' or to a high supplying power of the soil maintained throughout the growing period. In the former case, the authors point out that yield will tend to be low and could be improved by the addition of the nutrient in minimum; but in the latter case yield will be high. Hence the use of analyses of mature cereal plants as indicators of the nutritional status of soils depends on the fact that differences in the nutrient-supplying power of the soil persist throughout the growing season, leading to accumulation at harvest, and not upon any causal relationship between final internal nutrient concentration and yield.

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* Chemical Composition of Plants as an Index of their Nutritional Status. (Tech. Comm. No. 17, Imperial Bureau of Horticulture and Plantation Crops.) By Dr. D. W. Goodall and Dr. F. G. Gregory. Pp. 167. (Aberystwyth: Imp. Bur., 1947.) 9*s*.

A good deal of consideration is given to the best method of selecting plants for analysis, to the influence of time of day and time of year or stage of development of the plant when samples are taken, and to the advantages of analysing the whole plant as compared with a single organ of the plant. On the subject of which organ is likely to prove the most suitable for analysis, the authors have collected all the available evidence and present it in tabular form under the various crops. In the majority of cases the leaves seem to show the greatest proportional increase in internal concentration of a nutrient with increase in its supply. Necessary precautions in the preparation of material for analysis are discussed, followed by consideration of the analysis itself, including the need to determine particular chemical fractions and the choice of extraction methods.

The interpretation of the results of diagnostic analysis is perhaps the most difficult part of the whole problem of the use of plant analysis to determine fertilizer needs. Standards of reference are essential, together with data on the performance of the plants from which they are derived. To establish standard values for internal nutrient content requires data on the yield responses of plants at varying levels of nutrition and on their composition. Emphasis is placed on the dangers of basing conclusions on data for a single element without allowing for variations in the content of other nutrients. Nevertheless, it is pointed out that many investigators have specified optimal levels or limiting values above which the supply of a particular nutrient may be regarded as adequate, presumably where the content of other nutrients is not limiting. A comprehensive table of these suggested standard values for nutrient content of a wide variety of crops is included in the paper.

Suggestions by numerous workers for standard ratios of various plant nutrients are also given in tabular form; but the authors state that in their opinion there is no reason for supposing that ratios of nutrients in general are likely to be of greater use in diagnostic work than the content of the elements individually. They consider that ratios of nutrients within the plant should generally be used in conjunction with data for individual concentrations. The authors express the view that 'foliar diagnosis' work must be subject to much the same criticisms as other work involving the use of ratios.

In their final consideration of the place of plant analysis among other methods of nutritional diagnosis, the authors suggest that a combination of soil and plant analyses may give the most satisfactory results: soil analysis to determine pre-planting fertilizer treatment, and plant analysis for perennial crops and to indicate the need of annual crops for side or top dressings of fertilizer. Diagnosis by visual symptoms is an easy and rapid method where symptoms can be readily and definitely recognized, but has the disadvantage that waiting for deficiency symptoms to appear before treatment can be given may reduce the final yield.

SOCIOLOGY OF MENTAL DISEASE

THE physical and biological sciences have at last been accepted as indispensable adjuncts to the art of government, but the psychological and sociological lag behind. No clearer evidence of this is needed than the assumption that the men of science whose help should be asked to solve the problem of controlling atomic bombs are those who are specialists in making the machine rather than those who are specialists in the study of the minds likely to set the machine in motion.

It is encouraging, therefore, that the National Association for Mental Health should have had full and practical governmental support for its conference in the Seymour Hall during January 15–16. By sanctioning the payment of expenses, the various Ministries secured a very large attendance of delegates from local authorities. Moreover, the Parliamentary Secretary to the Minister of Health contributed that rarest of things—an opening address which must have usefully coloured the minds of everybody throughout the ensuing meetings.

Mr. Edwards emphasized that mental illness is a social disease with sequelæ deleterious to national and international life, that its consequences affect production drives, foreign policies, the family institution, and the efficacy of education. Moreover, it is a matter which cannot be left simply to technicians, since it affects every individual, however, sane potentially, since complete sanity is impossible for anyone who has to live in a community riddled with mental and nervous troubles.

Dr. G. R. Hargreaves, principal medical officer of Lever Bros. and Unilever, Ltd., and Dr. Donald Stewart, medical adviser to the Austin Motor Co., provided the text for the conference by epitomizing the Russell Fraser Report on the incidence of neurosis among factory workers*. In a sample of more than three thousand male and female workers in light and medium engineering factories, 10 per cent suffered from definite and disabling neurotic illness and a further 20 per cent from minor forms of neurosis during the course of six months. Neurotic illness accounted for a loss of three working days by every man studied and six days by every woman. It is at least as important a source of industrial loss as colds and influenza, or accidents and industrial disease.

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* No. 90. Industrial Health Research Board, 1947. (H.M. Stationery Office.) 1s. 3d.

Moreover, since neurosis is a disease of human relationships, in which the sick man's associates and family suffer, there must be added an incalculable loss caused by interference with the smooth working of those who do not themselves report sick.

Dr. Hargreaves suggested that hitherto social effort has been concentrated on psychotics and serious certifiable disease too exclusively, and that so long as the whole problem outruns the supply of trained personnel it is wiser to concentrate on the lighter neurotic diseases which interfere far more with the social machine than the psychotic do.

Dr. Kenneth Soddy, medical director of the National Association for Mental Health, and Dr. Doris M. Odlum, vice-president, discussed the obligations and opportunities given to local authorities by the National Health Service Act, 1946, in dealing with this problem.

Dr. Soddy gave a series of case-histories which showed that the problem of the neurotic cannot be treated as a purely medical one, and that the psychiatric social worker has a specific task, involving the mastering of a difficult technique, to co-ordinate the various administrative organs which might be needed to cope with a socially and personally 'unstuck' individual.

It is clear that the provision of sufficient trained psychiatric social workers—one in 2,500 of the population—is virtually impossible for many years. Not only is it impossible to train this number; but also there are probably not sufficient people of the right character and temperament fit for training. It is on this problem that it was possible to sense a difference of opinion within the conference.

On one hand, Dr. Greenwood Wilson, medical officer of health at Cardiff, speaking as a delegate, said that Cardiff proposes to use health visitors to help supplement the trained psychiatric workers, and pointed out that health visitors are not only experienced in human nature, but also masters of the special technique of breaking into the family circle in quest of private and intimate information. On the other hand, Brigadier A. Torrie, director of army psychiatry, gave his opinion that only a person with psychiatric training could be entrusted with any part of the work. It is to be hoped that Brigadier Torrie is wrong, since we shall not have a hundredth part of the required army of psychiatric workers trained for years to come. Fortunately, the National Association for Mental Health is aware of the danger of establishing a vested interest point of view on this matter.

The real difficulty is that applied psychiatry involves two requisites: a technique to be acquired by a specific training, and a personal character which cannot as yet be acquired. An industrial physicist or chemist may be a drunkard, a wife-beater or a child murderer without it necessarily interfering with his scientific work; but an industrial psychiatrist can ill afford these idiosyncrasies.

Whatever it means to-day, psychology used to mean the study of the human 'soul', and there used to be a profession or a vocation called a 'cure of souls'. Why the cure of souls has been taken over from the clergyman by the psychiatrist is a question which cannot be gone into here. Possibly there are too many clergy who have character without technique, but it is certain that technique by itself will be no adequate substitute for character. The admirable speech of the Earl of Feversham, chairman of the National Association, left the conference in no doubt that the Association is fully alive to this necessity for wedding technique and character in all cure of souls, and along with Mr. Edwards' opening address must have sent the delegates away realizing that they must act not only as administrators but also as human beings if the rising tide of mental sickness is to be held back. Both Dr. Odlum and Miss Clare Britton repeatedly emphasized that good results depended on personnel who know how to be humane. Miss Britton made a good point when she suggested that personnel for boarding schools for difficult children should never be expected to spend more than seven years of their lives at this exacting task. All psychiatry involves such inroads on emotional resources, apart altogether from its demands on those parts of the human intellect usually called upon for scientific work, that it should only be practised for limited periods.

It is to be hoped that all local authorities represented at the conference will have been impressed with the opportunities afforded them under the new Act for dealing with the chronic minor diseases of human relationships which cause so much more trouble than the far rarer and more spectacular mental disorders to which their attention was once confined.

ASSOCIATION OF BRITISH ZOOLOGISTS

DESPITE the predominantly urban nature of the population of Great Britain, one of its characteristics at the present time is a reawakened interest in, and a feeling of responsibility for, the countryside. This is made more acute by the realization of the part which agricultural workers can play in supplying food, and by the fear that, in a small island like Great Britain, indiscriminate exploitation by industry or the Services might destroy what could never be replaced. That this spirit is beginning to permeate the teaching of biological subjects in both schools and universities was indicated at the meeting of the Association of British Zoologists held on January 8, in the rooms of the Zoological Society of London. Prof. H. Graham Cannon was in the chair and the general topic of discussion was "The Field Study and Conservation of the British Fauna".

The universities of Britain are, for the most part, situated in its big towns, and at present the combined difficulties of congested time-tables, large classes and inadequate staff often mean that little or no field-work can be introduced into their zoological courses. Such work of this type as has been done in the past has almost invariably been marine, and the field courses of longest standing are those held at the various marine laboratories. These, as was stressed by Prof. F. W. Rogers Brambell, must remain the most important in the training of the general zoologist; but they should be supplemented by others which would introduce the student to freshwater or entomological ecological problems, and which would provide special training in these where that is necessary. Prof. J. W. Munro described in this connexion the way in which the Silwood Park Field Station of the Imperial College of Science and Technology could be used for both undergraduate teaching and for introducing post-graduate workers to field research in entomology—a very important development if many of the schemes for the Colonies, such as that for growing groundnuts in Africa, are to be supplied with properly trained biologists. Without the help of such men, all these projects were liable to failure, with very grave consequences for both the Colonies and for Britain.

Mr. F. H. C. Butler, director of the Council for the Promotion of Field Studies, explained how this five-year-old body functions, and described how the centres which the Council operates at Flatford Mill, Juniper Hall, Malham Tarn, and Dale Fort might be used to increase the variety of types of field work now possible. These offered to school-children, university students and private individuals alike the opportunity of doing supervised work in the field on biological and related subjects, of observing the interaction of these studies and so counteracting the tendency towards over-specialization. Dr. E. A. Ennion, warden of the Council's centre at Flatford Mill, gave an account of the way in which work there is carried out, stressing in particular the precautions which are taken to ensure that the natural life of the environment is conserved and that rare species are not rendered extinct by over-zealous collecting.

This particular example of a more general danger led the Association to consider the topic of the conservation of the wild life of England and Wales, Capt. C. Diver describing the proposals of the Wild Life Conservation Special Committee. These include the setting aside of certain parts of Britain as Nature reserves and the starting of a State biological advisory service. A specific instance of the way in which properly trained biologists could act to ensure efficient public services and economy of public money was given by Prof. E. A. Spaul, of the University of Leeds, who described some of the work done by zoologists there on the biology of sewage and sewage disposal, much of which has been shown to depend upon the animal population of the filters. Mr. R. S. R. Fitter gave some examples of the type of problem—bird migrations, liberation of populations of known genetic constitution—to which answers might be found by the use of the special category of experimental Nature reserves which are also proposed.

NATURAL SELECTION OF *DROSOPHILA*

RECENT studies on wild populations of *Drosophila* are shedding considerable light on the effects of natural selection. By means of the cytological examination of salivary gland chromosomes, it is possible to analyse the nuclear constitution more precisely than in other living forms. For example, an inversion of part of a chromosome *abcde* to form a different chromosome *adcbe* is not infrequent, and may be quickly detected in the hybrid between two *Drosophila* containing these respective chromosomes. Generally there is no apparent difference in the characters of the individuals carrying normal or inverted chromosome arrangements. Occasionally, however, a large position effect is noted such as in 'roughoid' (Gruneberg, 1939).

Dobzhansky[1] and Dubinin and Tiniakov[2] have shown that the proportion of individuals carrying an inversion alters with time and place in wild populations of *D. funebris* and in *D. pseudoobscura*. For example, Dubinin and Tiniakov show that the proportions of individuals of *D. funebris* with inversions is lower in urban than in rural districts, and that under the intense natural selection of winter conditions the inversions II1, II2 and II4 were greatly reduced in proportion, whereas the inversion IV1 increased slightly. On the other hand, these inversions increased rapidly in proportion during the summer up to a maximum when the population was at its prime.

Similarly, Dobzhansky has shown that cyclic changes with the seasons took place in a wild population of *D. pseudoobscura* at Pinon Flats, California. These changes were on the whole constant during the years 1939–46. There was no trend towards one particular chromosome arrangement, although the proportions in the population were significantly different at different times of each year. This evidence becomes more significant when it is found that the same chromosome arrangements do show a definite trend at Keens Colony, which is 15 miles from Pinon Flats. During the years 1939–46 the standard arrangement increased in the population from 30 to 50 per cent, whereas the 'Arrowhead' arrangement decreased from 30 to 15 per cent. In all these cases no detectable difference in the morphology or physiology of the animals with different chromosomes has been observed.

In *D. pseudoobscura* the inversion heterozygotes are adaptively favoured in comparison with both the homozygotes; but in *D. funebris* there appears to be no difference between the inversion homozygote and the inversion heterozygote in respect of survival value. In each of the above cases either one simple or one compound rearrangement is present on one chromosome; it is expected and found that there is a consequent instability and increased plasticity of the population.

Recently a constant breeding population of *D. funebris* consisting entirely of individuals heterozygous for three inversions on chromosome 5 has been found near Manchester by Berrie and Sansome[3]. The three inversions are evenly placed on the chromosome, and no homozygotes have as yet been obtained among the forty individuals caught, or in their progeny. A multiple, probably successive, series of chromosome arrangements had occurred and a highly stable heterozygous system was the result. Obviously, the creation of such a system must be fortuitous, at least in respect of the occurrence of the inversions; but natural selection could control the trend of the subsequent evolution. F. W. SANSOME

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ORIBATID MITES AND THEIR ECONOMIC IMPORTANCE

By M. ANANTARAMAN
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REVIEWING some of the literature on Tyroglyphid mites, Lapage[1] directed attention to their role in pulmonary acariasis of man, in addition to destruction of stored food-products. The Oribatids are allied to these cheese- and flour-mites and to the well-known harvest- and chigger-mites, and have been, until a few years ago, of comparatively little economic significance. Otherwise known as moss-mites and beetle-mites, they have been studied for many years and from all over the world. They are mostly microscopic in size, free-living and terrestrial, although a few are aquatic and crawl on weeds. Their activity is greater in darkness, when they swarm out in search of food, and progression is normally slow. They have a shiny chitinous body-wall, a wing-like extension (the pteromorpha) at the antero-lateral corner of the abdomen on each side, a pair of peculiarly shaped sense-organs (the pseudo-stigmatic organs), and no eyes.

By and large denizens of the soil, the oribatid mites occur in decaying vegetation, among fungal mycelia, moss or algæ, and form a conspicuous group amid the soil biota. Some are confined to the soil and migrate on blades of grass during the night; others conceal themselves in the bark of trees or crawl on twigs and leaves. Depending upon their habitat, they are classified as terricolous, dendricolous, bryobious and humicolous.

In the group Acarina, which comprises parasites (Ixodoidea and Sarcoptidæ), predators (Trombidiidæ), and suckers of plant sap (Tetranychidæ), the Oribatoidea are outstanding in being herbivorous or saprophagous. They feed on moulds (fungivorous), algæ, decaying leaves or animal matter, and are distinctly inoffensive. Consequently, although systematists like Banks, Berlese, Nicolet, Michael, Oudemans, Jacot, Grandjean and Ewing have revealed the abundant and ubiquitous occurrence of these organisms, very few investigators attributed any importance to them. Michael[2], in his monograph, has remarked that none of the species is "injurious to man or his works". Jacot[3] regarded them, as "negative, humble and devoid of weapons of offense"; afterwards[4], he commented on the occurrence of *Damæosoma alces*, *Protoschelobates pembertoni* and *Xylobates pembertoni* in holes in cane roots, of *Lohmannia insignis* on bean seedlings and of *L. insignis dissimilis* on tulip bulbs as having no significance, because no evidence could be adduced that the holes were caused by the mites. He concluded that "the case against oribatides as non-injurious is becoming weightier".

Stunkard's[5] experiments on the development of *Moniezia expansa* disclosed the identity of the intermediate host of this tapeworm. He announced that *Zetes* (*Galumna*) *emarginatus* harboured the cysticercoids of the worm to the infective stage, and this discovery heralded a series of publications on the life-cycles of other Anoplocephalid cestodes. The work of Krull[6] (U.S.A.) on *Cittotænia* and *Moniezia*, of Stunkard[7] (U.S.A.) on *Bertiella studeri*, of Pullar[8] (Australia) on *Moniezia*, of Bashkirova[9] (U.S.S.R.) on *Anoplocephala* spp., and *Paranoplocephala mamillana*, of Potemkina[10] (U.S.S.R.) on *Thysaniezia ovilla*, and of the present writer[11] (India) on *Moniezia expansa* and *M. benedeni*, has involved oribatid mites of various genera and species as the undoubted vectors of these worms. Moreover, the same species of mite is observed to be capable of conveying more than one species of the cestode in a locality.

The Anoplocephalid tapeworms, characteristically devoid of rostellar hooks, are among the worst enemies of livestock, and to the veterinary parasitologist the oribatid mite has therefore suddenly become of major importance.

[1] *Nature*, **156**, 427 (1945).

[2] "British Oribatoidea", 1 (1884).

[3] *Amer. Nat.*, **59**, 272 (1925).

[4] Bern. P. Bishop Mus. Bull., **121**, 93 (1934).

[5] *Parasit.*, **30**, 491 (1938).

[6] *Proc. Helm. Soc. Wash.*, **6**, (1), 10 (1939).

[7] *Amer. J. Trop. Med.*, **20** (2), 305 (1940).

[8] *Austral. Vet. J.*, **15**, (2), 71 (1939).

[9] *C.R. Acad. Sci. URSS.*, (N.S.) **30**, (6), 576 (1941) (in English). *Vestn. Sel.-khoz. Nauk.*, *Veterinariya*, No. 2, 57 (1941, in Russian, with French summary).

[10] *C.R. Acad. Sci. URSS.*, (N.S.), **30**, (5), 474 (1941); **43**, (1), 43 (1944).

[11] Unpublished work.

THE MESON FIELD AND THE EQUATION OF MOTION OF A SPINNING PARTICLE

By R. C. MAJUMDAR and DR. S. GUPTA
Tata Institute of Fundamental Research, Bombay

THE outstanding difficulty in obtaining the equation of motion of a spinning particle in a meson field which will take account of the reaction of the emitted meson field and is free from singularities is well known. The equation of motion was first obtained by Heisenberg[1] for a dipole of finite extension and is therefore not relativistically invariant. The relativistically invariant equations of motion for a point dipole which have been developed by Bhabha and Corben[2] and by Bhabha[3] are extremely complicated and involve a number of arbitrary constants which are not determined uniquely. These equations in their final form are free from singularities, and have been proved to involve only the contribution of the so-called radiation field, defined as half the retarded minus the advanced field, which is finite on the world line. However, the equations are established by proving that the singular terms are perfect differentials and can therefore be subtracted away.

In 1939, Riesz[4] developed an elegant method for solving the differential equations of hyperbolic type in which the divergent difficulties are avoided by a process of analytical continuation. The method has been recently applied by Fremberg[5] to obtain the classical equation of motion of a charged particle in an electromagnetic as well as in a meson field. Following Riesz, we shall define the potential and the field of a dipole for a parameter $\alpha > 2$ and show that the analytical continuation to $\alpha = 2$ gives the classical values corresponding to those of Lienard–Wiechert outside the world line, and a finite value on the world line itself giving the reaction of the field. The equations of motion of a point dipole can then be obtained in a straightforward way from the usual equation of a dipole as given by Frenkel[6]. The equations are free from singularities and do not contain any arbitrary constant except the spin angular momentum of the dipole.

We define the Riesz potential for the dipole at a point $P(\mathbf{x})$ outside the world line in the form,

$$\varphi_\nu^\alpha(P) =$$

$$\frac{g_2\chi^{4-\alpha}}{2^{\frac{1}{2}(\alpha-2)}\,\Gamma(\alpha/2)}\,\frac{\partial}{\partial x_\mu}\int_{-\infty}^{\tau_0} S_{\mu\nu}(\tau)\,(\chi s)^{\frac{1}{2}(\alpha-4)}\,J_{\frac{1}{2}(\alpha-4)}(\chi s)\,d\tau, \tag{1}$$

where τ is the proper time of the particle, τ_0 the retarded point of P, $J_n(x)$ is the Bessel function of order n and $g_2S_{\mu\nu}$ is the antisymmetrical tensor describing the dipole moment. The four-dimensional distance s is given by

$$s^2 = s_\mu s^\mu,\quad s_\mu = x_\mu - z_\mu. \tag{2}$$

The integral converges for $2 < \alpha < 5$. The potential (1) satisfies the wave equation of a dipole in a meson field given by

$$\frac{\partial}{\partial x_\rho}\frac{\partial}{\partial x^\rho}\varphi_\mu + \chi^2\varphi_\mu = 4\pi\frac{\partial}{\partial x_\nu}S_{\nu\mu}, \tag{3}$$

when we continue analytically to $\alpha = 2$.

Now it can be shown after some calculations that the analytical continuation to $\alpha = 2$ of the Riesz potential (1) and the corresponding field-strength for the dipole lead to the well-known Lienard - Wiechert results, as already obtained by Bhabha and Corben :

$$\varphi_\nu{}^2(P) = \varphi_\nu{}^{\text{ret}} = g_2 \left[\frac{1}{\varkappa}\frac{d}{d\tau}\left(\frac{s^\mu S_{\mu\nu}}{\varkappa}\right)\right]_0 - \frac{g_2\chi^2}{2}\left[\frac{s^\mu S_{\mu\nu}}{\varkappa}\right]_0 + g_2\chi^2 \int_{-\infty}^{\tau_0} \frac{s^\mu S_{\mu\nu}}{s^2} J_2(\chi s)d\tau, \quad (4)$$

$$F_{\mu\nu}{}^2(P) = F_{\mu\nu}{}^{\text{ret}} = g_2\left[\frac{1}{\varkappa}\frac{d}{d\tau}\left(\frac{S_{\mu\nu}}{\varkappa}\right)\right]_0 + g_2\left[\frac{1}{\varkappa}\frac{d}{d\tau}\left(\frac{1}{\varkappa}\frac{d}{d\tau}\left(\frac{T_{\mu\nu}}{\varkappa}\right)\right)\right]_0 - \frac{g_2\chi^2}{2}\left[\frac{S_{\mu\nu}}{\varkappa}\right]_0 - \frac{g_2\chi^2}{2}\left[\frac{1}{\varkappa}\frac{dT_{\mu\nu}}{d\tau}\right]_0 + \frac{g_2\chi^4}{8}\left[\frac{T_{\mu\nu}}{\varkappa}\right]_0 + g_2\chi^2\int_{-\infty}^{\tau_0}\frac{S_{\mu\nu}J_2(\chi s)}{s^2}d\tau - g_2\chi^3\int_{-\infty}^{\tau_0}\frac{T_{\mu\nu}J_3(\chi s)}{s^3}d\tau - \text{the same}$$

terms with μ and ν interchanged, ... (5)

where $\varkappa = s_\mu v^\mu$, $T_{\mu\nu} = s_\mu s^\sigma S_{\sigma\nu}$. The suffix 0 implies that the value of the function is to be taken at the retarded point of P.

In order to calculate the potentials and the fields at a point P on the world line, we divide the integrals into two parts, one in the interval $-\infty$ to $\tau_0 - \varepsilon$, and the other from $\tau_0 - \varepsilon$ to τ_0. It is easily seen that the first integral vanishes for $\alpha = 2$. We then expand the quantities in the second integral in power series of τ, measured from τ_0 taken as zero, and obtain by analytical continuation to $\alpha = 2$ the following expressions :

$\varphi_\nu{}^{\alpha=2}$ (on the world line) =

$$- g_2\left[\frac{1}{3}\ddot{v}^\mu S_{\mu\nu} - \frac{1}{3}v^\mu S_{\mu\nu}(v\ddot{v}) + \dot{v}^\mu \dot{S}_{\mu\nu} + v^\mu \ddot{S}_{\mu\nu}\right] - \frac{1}{2}g_2\chi^2 v^\mu S_{\mu\nu} + g_2\chi^2\int_{-\infty}^{\tau_0} s^\mu S_{\mu\nu}\frac{J_2(\chi s)}{s^2}d\tau, \quad (6)$$

$F_{\mu\nu}{}^{\alpha=2}$ (on the world line) =

$$g_2\Bigg[\frac{2}{3}S_{\mu\nu}(\dot{v}\ddot{v}) + \frac{2}{3}\dot{S}_{\mu\nu}\dot{v}^2 + \frac{2}{3}\dddot{S}_{\mu\nu} - \Big\{\frac{4}{3}v_\mu S_\nu{}''' + 2v_\mu S_\nu{}'\dot{v}^2 + \frac{1}{3}\dddot{v}_\mu \$_\nu + \frac{2}{3}\ddot{v}_\mu\dot{v}^\sigma S_{\sigma\nu} + \frac{4}{3}\ddot{v}_\mu S_\nu{}' + \frac{4}{3}v_\mu\ddot{v}^\sigma\dot{S}_{\sigma\nu} + \frac{2}{3}\dot{v}_\mu\ddot{v}^\sigma S_{\sigma\nu} + \frac{1}{3}v_\mu\dddot{v}^\sigma S_{\sigma\nu} + 2v_\mu\dot{v}^\sigma\ddot{S}_{\sigma\nu} + 2\dot{v}_\mu S_\nu{}'' + 2\dot{v}_\mu\dot{v}^\sigma\dot{S}_{\sigma\nu} + 2v_\mu\$_\nu(\dot{v}\ddot{v}) + v_\mu\dot{v}^\sigma S_{\sigma\nu}\dot{v}^2 + \dot{v}_\mu\$_\nu\dot{v}^2\Big\}_- + \chi^2\Big\{\dot{S}_{\mu\nu} - [v_\mu S_\nu{}']_- - \frac{1}{2}[v_\mu\dot{v}^\sigma S_{\sigma\nu}]_- - \frac{1}{2}[\dot{v}_\mu\$_\nu]_-\Big\}\Bigg] + 2g_2\chi^2\int_{-\infty}^{\tau_0} S_{\mu\nu}\frac{J_2(\chi s)}{s^2}d\tau - g_2\chi^3\int_{-\infty}^{\tau_0}[s_\mu s^\sigma S_{\sigma\nu}]_-\frac{J_3(\chi s)}{s^3}d\tau, \quad \ldots \quad (7)$$

where

$$\$_\nu = v^\sigma S_{\sigma\nu},\ S_\nu{}' = v^\sigma\dot{S}_{\sigma\nu},\ S_\nu{}'' = v^\sigma\ddot{S}_{\sigma\nu},\ S_\nu{}''' = v^\sigma\dddot{S}_{\sigma\nu}, \quad (8)$$

and the minus sign as subscript denotes that the terms inside the brackets are to be subtracted with interchange of μ and ν.

It is to be noticed that the field given by (7) is, in fact, the retarded field, and agrees with the so-called radiation field of Dirac as obtained by Bhabha and Corben, provided we put $k_1 = -1/3$, $k_2 = -7/15$, $k_3 = 1/3$, $k_4 = 4/3$, $k_6 = 0$ in (140) (Bhabha and Corben) and $k = 2$ in (110) (Bhabha). There is, however, disagreement in terms with constant k_5, which has also been noticed by Harish-Chandra[7], whose calculations of the radiation field on the world line by retaining the finite and the unambiguous terms of the fields agrees with our result (7).

The equation of motion is now obtained from Frenkel's equation

$$I\,\dot{S}_{\mu\nu} = g_2[S.F^{\text{ext}}]_{\mu\nu} + g_2[S.F^{\text{react}}]_{\mu\nu}, \quad (9)$$

where I is the spin angular momentum. The field $F_{\mu\nu}$ in the second term of the right-hand side is given by (7) above. The equation of motion of a point dipole in a scalar meson field is also similarly obtained.

The detailed paper will be published in due course in the *Physical Review*.

[1] Heisenberg, W., *Z. Phys.*, **113**, 61 (1939).

[2] Bhabha, H. J., and Corben, H. C., *Proc. Roy. Soc.*, A, **178**, 273 (1941).

[3] Bhabha, H. J., *Proc. Roy. Soc.*, A, **178**, 314 (1941).

[4] Riesz, M., Conférence de la Réunion internat. des math. tenue à Paris en Juillet 1937 (Paris, 1939). Prof. Riesz's papers are unfortunately not available in India.

[5] Fremberg, N. E., *Medd. Lunds Univ. Mat. Sem.*, **7** (1946) *Proc. Roy. Soc.*, A, **188**, 18 (1946).

[6] Frenkel, J., *Z. Phys.*, **37**, 243 (1926).

[7] Harish-Chandra, *Proc. Roy. Soc.*, A. **185**. 269 (1946).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, March 15

Royal Physical Society of Edinburgh (at the Royal Scottish Geographical Society, Synod Hall, Castle Terrace, Edinburgh), at 5.15 p.m.—Prof. T. N. George : "Fossils and Evolutionary Theory".

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Sir Charles Goodeve, F.R.S. : "Operational Research".*

University College (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. George Sarton : "Science and Tradition". (Further Lectures on March 16 and 19.)*

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the Dartford Branch of the Pharmaceutical Society, at the County Technical College, Essex Road, Dartford), at 7.15 p.m.—Dr. A. Albert : "Physico-Chemical Concepts in Interpreting Drug Action".

Tuesday, March 16

British Psychological Society, Industrial Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Annual General Meeting ; Mr. Dermot Straker : "The Importance of Information in Vocational Selection".

Chadwick Public Lecture (in the Sir Edward Meyerstein Lecture Theatre, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1), at 2.30 p.m.—Dr. J. R. Nicholls : "Adulteration of Food and its Detection".*

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. E. Marsden, F.R.S. : "Co-ordination of Research in the Pacific".

Linnean Society of London (joint meeting with the Systematics Association, at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Organization of Taxonomic Research".

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Miss Laura E. Start : "Indian Textiles from Guatemala and Southern Mexico".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. F. J. Anscombe : "The Validity of Comparative Experiments".

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. W. Mayer Gross : "Mental Health Survey in a Rural Population".*

Conway Discussion Circle (at Conway Hall, Red Lion Square, London, W.C.1), at 7 p.m.—Dr. W. E. Swinton : "The Rise and Fall of the Dinosaurs".*

Institution of the Rubber Industry (at Caxton Hall, Caxton Street, London, S.W.1).—Dr. D. A. Harper : "The Technology of some New Condensation Rubbers".

Tuesday, March 16—Thursday, March 18

Institute of Metals (at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Annual General Meeting.

Wednesday, March 17

Society of Chemical Industry, Food Group (joint meeting with the Midland Section of the Society of Dairy Technology, at the Technical College, Wolverhampton), at 2.15 p.m.—Discussion on "The Chemical Sterilization of Food Plant" (to be opened by Dr. E. B. Hughes and Mr. J. C. L. Resuggan).

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the London Branch of the Institute of Physics, at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Dr. A. E. Alexander: "Emulsions and Emulsification".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. H. G. Champion: "Re-afforestation as a World Problem".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting; Prof. H. H. Read, F.R.S.: "Place in Plutonism" (Presidential Address).

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion on "Atmospheric Turbulence".

Royal Microscopical Society (at B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. R. J. Ludford: "Application of the Barnard Ultra-Violet Light Technique for the Study of Living Cells"; Mr. J. Smiles: "New Development in Visual Light Microscopy".

British Institution of Radio Engineers, Scottish Section (at the Heriot Watt College, Edinburgh), at 6.30 p.m.—Dr. Angus Campbell: "The Development of Radiology".

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Annual General Meeting; Mr. R. S. Brown: "Modern Heat Treatment Furnaces".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Growing Points in Science", 3. (To be opened by Prof. O.R. Frisch and Dr. K. Weissenberg.)

Institution of Naval Architects (at 10 Upper Belgrave Street, London, S.W.1).—Annual General Meeting.

Wednesday, March 17—Friday, March 19

Institution of Naval Architects (at the Royal United Services Institution, Whitehall, London, S.W.1).—Eighty-ninth Annual Meetings.

Thursday, March 18

Chemical Society (in the Lecture Theatre, Physical Chemistry Laboratory, South Parks Road, Oxford), at 12 noon.—107th Annual General Meeting; at 3 p.m.—Prof. C. N. Hinshelwood, F.R.S.: "Some Aspects of the Chemistry of Hydrocarbons" (Presidential Address).

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. J. D. Griffith Davies: "John Wilkins and the Royal Society" (The Wilkins Lecture).

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. H. R. Potts: "Further Notes on Converter Practice at Rio Tinto".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. G. Birkhoff: "Lattice Theory and its Applications".

British Glaciological Society (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.15 p.m.—Dr. A. Farrington: "The Glacial Drifts of the Leinster Chain".

Illuminating Engineering Society, Manchester Centre (in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. T. S. Jones: "School Lighting".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. H. Davies: "Flight Testing at High Subsonic Speeds".

Oil and Colour Chemists' Association, London Section (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Dr. L. Ivanovsky and Dr. A. C. Healey: "The Uses of Greases and Waxes in Printing Ink and Related Materials".*

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Symposium on "Photography in Nuclear Research".

Friday, March 19

Physical Society, Colour Group (in the Small Physics Lecture Theatre, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 3.45 p.m.—Eighth Annual General Meeting; Mr. J. G. Holmes: "The Aims and Activities of the Colour Group"; at 5 p.m.—Mr. J. G. Holmes: "The Physical Structure of Coloured Glass".

Institution of Electrical Engineers (joint meeting of the Measurements and Transmission Sections, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. W. Connon and Mr. E. Smith: "The Influence of Inverse Time-Relay Characteristics on Discriminative Time".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Annual General Meeting.

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. Arnold Emerson and Mr. N. A. Witney: "Experiment Work on Merchant Ship Models during the War".

British Institution of Radio Engineers, Midland Section (at the Technical College, The Butts, Coventry), at 6.30 p.m.—Mr. N. E. Head: "Methods of Measuring Insertion Loss, Phase Shift and Time Delay of Transmission Networks".

*Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Lawrence Bragg, F.R.S.: "Metal Physics".

Friday, March 19—Saturday, March 20

British Rheologists' Club (joint meeting with the Textile Institute, the Society of Dyers and Colourists, the Leeds Area Local Sections of the Chemical Society and the Royal Institute of Chemistry, the Yorkshire Section of the Society of Chemical Industry, and the Manchester and District Branch of the Institute of Physics, in the Department of Textile Industries, The University, Leeds).—Conference on "Rheology in the Textile Industries".

Saturday, March 20

Amateur Entomologists' Society (at Buckingham Gate Central School, Wilfred Street, London, S.W.1), at 2 p.m.—Entomological Exhibition.*

Institution of Chemical Engineers, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. N. T. Gridgeman: "Value of Statistics to the Chemical Engineer".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Scientist, Grade I (with good honours degree in science or an equivalent qualification)—The Administrative Officer, National Coal Board, Northern Division, Scientific Department, The Grange, Longbenton, Newcastle-upon-Tyne (March 20).

Laboratory Steward for the Department of Zoology—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (March 22).

Research Assistant in the Professorial Unit—The Secretary, Royal Eye Hospital, St. George's Circus, London, S.E.1 (March 22).

Assistant Lecturer in Horticulture, an Assistant Lecturer in Poultry Husbandry, and an Assistant Lecturer in Rural Domestic Economy, including Dairy Husbandry, at the Essex Institute of Agriculture, Writtle—The Chief Education Officer, County Offices, Chelmsford (March 23).

Assistant (male) in the Technical and Advisory Section to assist in putting over the work in progress to scientists, fruit-growers, and the general public—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (March 27).

Lecturer (Grade II or Grade III) in Electrical Engineering—The Secretary and Registrar, The University, Bristol (March 27).

Lecturer in Theoretical Chemistry, a Lecturer in Pure Mathematics, and a Lecturer in Zoology—The Secretary, The University, 38 North Bailey, Durham (March 27).

Senior Stressmen (2), a Radio and Electrical Engineer, and Senior Draughtsmen (2), for work in Australia on the design of small high-speed, jet-propelled aircraft—The Deputy High Commissioner, Australia House, Strand, London, W.C.2 (March 31).

I.C.I. Research Fellowships in biochemistry, chemistry, engineering, pharmacology or physics—The Secretary of University Court, The University, Glasgow (March 31).

Lecturer and Assistant Lecturer in Statistics with experience in the application of statistical methods in the social sciences—The Secretary, London School of Economics, Houghton Street, Aldwych, London, W.C.2 (March 31).

Demonstrator in each of the Departments of Physics, Chemistry, Botany and Zoology, at the University College of the West Indies, Jamaica—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (April 1).

Lecturer (Grade III) in the Department of Geography—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (April 3).

Senior Assistants (one in Bacteriology and one in Pathology), and a Senior Lecturer in Physiology, in the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (April 5).

Second Assistant at the Bolus Herbarium, University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (April 5).

Chair of Psychiatry—The Registrar, The University, Manchester 13 (April 9).

Research Fellowship in Science—The Secretary, The University, 38 North Bailey, Durham (April 10).

Assistant Director, Engineering Class, in the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2132 (April 12).

Professor of Chemistry—The Registrar, University College, Singleton Park, Swansea (April 17).

Lecturer or Assistant Lecturer in the Department of Physics, and a Lecturer or Assistant Lecturer in Psychology to work under the Professor of Philosophy—The Registrar, The University, Sheffield (April 24).

Lecturer (Grade II or Grade III) in Statistics, and an Assistant Lecturer (Grade III) in Applied Mathematics—The Registrar, The University, Liverpool (May 15).

Chair of Electrical Engineering—The Secretary, Royal Technical College, Glasgow.

Assistant Serologist—The Secretary, Wright-Fleming Institute of Microbiology, St. Mary's Hospital, Paddington, London, W.2.

Physicist to the Radiotherapy Centre—The House Governor, Hull Royal Infirmary, Hull.

Physicist to investigate, in collaboration with senior rheologist, physical properties of bovine secretion—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

Lecture Assistant in the Department of Chemistry—The Registrar, University College, Singleton Park, Swansea.

Assistant Editor of "Science Abstracts" to select and edit abstracts for "Physics Abstracts"—The Secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2.

Junior Chemists (2, in Derby and London respectively)—The Scientific Research Manager, Railway Executive (London Midland Region), Euston Station, London, N.W.1.

NATURE

No. 4090 SATURDAY, MARCH 20, 1948 Vol. 161

CONTENTS

Page
- The European Tradition of Freedom 413
- Documentation of Organic Chemistry. By Prof. J. W. Cook, F.R.S. . 415
- Probits. By Prof. J. H. Gaddum, F.R.S. 417
- Data for Nuclear Physics. By Dr. J. D. Cockcroft, F.R.S. . . . 418
- Biology of the Louse. By Dr. A. D. Imms, F.R.S. 418
- The Draining of Binley Lake and its Ecological Consequences. By Wing-Commander T. R. Cave-Browne-Cave, C.B.E.; V. S. Summerhayes and Dr. W. B. Turrill 420
- Physiology of Disease Resistance in Plants 422
- Chemistry of Visual Processes. By S. Ball, F. D. Collins, Prof. R. A. Morton and Dr. A. L. Stubbs 424
- Obituary:
  - Dr. A. L. Du Toit, F.R.S. By Sir Edward Bailey, F.R.S. 426
- News and Views 427
- Letters to the Editors:
  - A Revised Sargent Diagram.—Prof. N. Feather, F.R.S. . . . 431
  - Electron Tracks in Photographic Emulsions.—R. W. Berriman . 432
  - Resolution Testing in Autoradiography.—G. W. W. Stevens . 432
  - Relation of Vomicine to Strychnine and Brucine.—Dr. A. S. Bailey and Sir Robert Robinson, F.R.S. 433
  - The *C/D* Ring Union in Œstrone and Equilenin.—Dr. W. Klyne. 434
  - *p*-Aminosalicylic Acid in the Treatment of Tuberculosis.—D. D. Martin, Prof. F. S. Spring, Dr. T. G. Dempsey, C. L. Goodacre and D. E. Seymour 435
  - A Modified Technique in Filter-Paper Chromatography.——L. Rutter 435
  - Inner-Complex Salts of Trivalent Thallium.—Prof. Fr. Feigl . 436
  - Order of Stability of Metal Complexes.—Dr. D. P. Mellor and L. Maley 436
  - Polarographic Determination of the Gamma-Isomer of Benzene Hexachloride.—G. B. Ingram and H. K. Southern . . . 437
  - Size of the Brain in the Ape-Man, *Plesianthropus*.—Dr. R. Broom, F.R.S., and J. T. Robinson 438
  - Nicotinic Acid in Human Blood Cells at Birth.—R. F. A. Dean and W. I. M. Holman 439
  - Effect of Removal of Neurosecretory Cells in the Brain of Adult *Calliphora erythrocephala* Meig.—Dr. Ellen Thomsen . . 439
  - Ribose Nucleic Acid in the *Drosophila* Egg.—H. G. Callan . . 440
  - *Trypanosoma heptatretae* sp. n., a Blood Parasite of the Hagfish.—Marshall Laird 440
  - Relationship of Glioma to Encephalitis in the Domestic Fowl, and an Associated Parasitic Agent.—Prof. Cecil Jackson . . 441
  - Shrivelled Wheat Grain from Rust-Affected Crop as Seed.—R. B. Ekbote and K. R. Sahasrabuddhe 442
  - Recent Climatic Fluctuations.—L. Lysgaard 442
  - Daily Variation of the Horizontal Magnetic Force at the Magnetic Equator.—J. Egedal 443
  - Citizenship and Current Affairs in Army Education.—Lieut.-Colonel Eric Lowe 444
- Alkaline Phosphatase in Taste Buds and Nasal Mucosa. By Dr. Geoffrey H. Bourne 445
- Dietetic Hepatic Lesions and Protein Deficiency. By Dr. M. V. Radhakrishna Rao 446
- Measurement of 'Environmental Resistance' in the Australian Plague Grasshopper. By Dr. H. G. Andrewartha and L. C. Birch . . 447
- Research in Industry: Working Party Reports 448
- Fifth British Empire Forestry Conference 449
- Magnetic Field of Massive Rotating Bodies. By Prof. H. T. H. Piaggio . 450
- Recent Sociological Periodicals. By Prof. P. Sargant Florence . . 450
- Northern Ireland Fishing Industry Developments during the War Years 451

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THE EUROPEAN TRADITION OF FREEDOM

As the Marshall Plan for Europe takes shape, the question of the future design of Western Europe grows more acute and urgent. No longer is it possible to avoid the challenge which this Plan, and also the course of events in Eastern Europe, are throwing down to those nations of Western Europe which recognize the value of the European tradition of freedom. We have indeed to consider as a matter of urgency whether the United Nations is not already an inadequate instrument in view of the breach between east and west in Europe, and whether it can yet be modified or strengthened to serve the purposes for which it was designed; or whether on the other hand we must seek other means of securing peace and upholding the freedom and great cultural and spiritual values which we have inherited in the civilization of Western Europe.

It is to this problem that Sir Harold Butler addressed himself in his book "Peace or Power" before the Marshall Plan was announced, and it is also the theme of publications issued by the Design for Freedom Committee[*], which appeared later. One of them, "Design for Europe", urges that the ideal of world unification which has steadily developed through the past century should be given effect so far as possible by the free nations of the world, and that new machinery should be developed for this purpose by all those nations which are willing to co-operate in giving effect to the ideals of world government.

There can be no accommodation between the ideas of the liberty of man and the slave State, and accordingly the Design for Freedom Committee concludes that the ideal of a single world organisation is at present impossible. Proceeding to analyse the alternatives, it is urged that the only real obstacles to world unity which exist to-day lie in the realm of thought; within the ranks of those who demand human liberty there is no justification for the erection of artificial distinctions and divisions, in the economic, cultural or political spheres. It is suggested that the free world includes all those countries in which Roosevelt's Four Freedoms are regarded as good and desirable; the British Empire, the United States, France, part of Latin America, the Scandinavian countries, Holland, Belgium and Luxembourg, resurgent Italy and Switzerland. Greece is a battlefield where the issue is still at stake. But as a first step, it is urged that a Monnet Plan is required for Europe as a whole, and this as a first condition of giving effect to the Marshall proposals by freeing European trade.

It is suggested that those countries which wish to benefit from American financial help should without delay accept the general principles of the "Proposals for an International Trade Organisation", although the European Plan itself may constitute the special circumstances which provide justification for new preferential arrangements requiring an exception to the provisions of the agreement. Next, those countries must undertake that, as a condition of participation, they will not raise their tariffs or impose quotas on some particular range of goods. The Plan should also provide for some form of free trade over European waterways and railways, at least for the right of passage of goods in bond across one country to their destination. Some super-national administration will be necessary for the funds made available by the United States, involving limitation of sovereignty to the extent of seeing that the conditions are enforced. Although this is economic in intent, its consequences are bound to be political, and something beyond the administration contemplated in the European Recovery Programme proposed to Congress by President Truman on December 19 may therefore well be required.

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[*] "Design for Europe." Pp. 24. "The New Courageous." By John Maude. Pp. 16. (Design for Freedom Committee, 22 Chester Square, London.) 1s. each.

These conditions fall short of the United States of Europe urged by Mr. Churchill at Zurich in September 1946, though they are broadly in line with the actions which President Truman suggested in the recovery programme each country should pledge itself to take. That programme indeed goes further, suggesting pledges to increase industrial and agricultural production, to take the necessary measures to stabilize currency, establish or maintain a proper rate of exchange, make efficient use of the country's own resources, as well as of the goods and services made available through the United States aid, and stimulate the production of specified raw materials ; these undertakings are so plainly questions of self-interest to the country concerned that failure to give and to honour them is tantamount to a confession of bad faith. "Design for Europe" does not hesitate to touch bluntly on issues that have been kept rather in the background, and is a stimulus to the thinking that should be proceeding throughout Europe.

It is well that it should be remembered that domestic policy cannot be pursued without regard to its international implications ; policies which hinder the immediate creation of an international organisation in which the genuine confidence of all the nations of the free world can straightway be placed are dangerous and reactionary. No satisfactory economic plan for Europe can be devised without some sacrifice of sovereignty on the part of the nations concerned, nor can we expect others to make this sacrifice if we are not equally prepared to do so. The same condition applies to that close association of the British Commonwealth and the United States of America for which the Design for Freedom Committee believes the condition of the world calls. Recognition of this need is at least as important as the attempt now being made to obtain a degree of unity in Europe, for any scheme of European unification will eventually break down if it is not underwritten by joint Anglo-American action.

Here then we find the value of a further Design for Freedom publication, "The New Courageous", by John Maude. In it the emphasis is laid on the things that government cannot provide, and the challenge to the moral qualities of the ordinary citizen that the situation offers. Not merely harder work and lower standards of living are demanded of us, but also higher standards of co-operation and friendship between all men. The wisest and most courageous leadership cannot supply the things of the spirit upon which, above all, the happiness of a people depends ; it can only help to provide the conditions in which the individual citizen has the best chance to achieve the health, security and leisure out of which his own exertions can build a full and satisfying life.

Mr. Maude rightly stresses the need for leadership, local as well as national ; but his pamphlet is above all a call to face the fact that recovery will be arduous in the extreme and will require personal sustained exertion and the moral qualities which can make a people great. It is these same moral qualities which provide the firm basis of Anglo-American unity as much as of European unity, whether in the form immediately presented to us, or ultimately in the United Nations Organisation, or the Federal World suggested by Clarence Streit. These ideals may be remote, but they are not impossible if we match them with the courage and vision which illuminate the Marshall Plan, and refuse to allow narrow interests to stand in the way of a new approach to Europe's needs.

Although it is different in scale and scarcely reaches the nobler plane of his earlier work "The Lost Peace", Sir Harold Butler's recent "Peace or Power"* reflects much the same spirit. The larger part of the book reviews briefly but incisively the course of events from the armistice of 1918 to the outbreak of war in 1939, and then the trend of events in Europe since the German surrender. Sir Harold is at pains to discern the real causes of the conflict between east and west ; and, like the Design for Freedom Committee, he finds it has deeper historical roots than just a clash between communism and democracy. It is a clash between the free ideals of Western civilization and the authoritarian ideals of the East.

Sir Harold argues that the way to perfection cannot be through hatred, intolerance, injustice, tyranny and misery, by whatever names they may be disguised, or by whatever sophistry they may be excused. But the suggestion that the conflict between democracy and communism is not so much an affair of ends as of means is open to question. All the evidence at present goes to show that the police State is poles apart from the Four Freedoms and the whole tradition of Western civilization of which Sir Harold himself is no mean exponent. His discussion of recent changes in Central European and Slav countries scarcely maintains the level of his chapters on "The German Reckoning", "The British Price for Victory" or "The American Impact". Although he rightly stresses the dominant importance of the agrarian problem, his treatment of Russia in Europe is sometimes superficial and tends to overlook the earlier contacts of Russia with Byzantium and with Europe through the Hanseatic league. None the less, on the vital issue he is unequivocal ; and although he recognizes that parliamentary democracy is fatally compromised in the greater part of Eastern Europe, he believes that Western democracy —the willing submission of the minority to the majority in the confidence that its submission will not be abused—provides the only approach to peace. In that, moreover, is involved a more positive and constructive conception of democracy such as is implicit in the Marshall offer and the European Recovery Programme put forward in the United States.

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* Peace or Power. By Sir Harold Butler. Pp. 260. (London: Faber and Faber, Ltd., 1948.) 15s. net.

In the national democracies, survival depends upon the response of their citizens to the new conception of positive duties and to the ability to train men and women to accept and discharge those responsibilities of citizenship. So too, as Mr. Middleton Murry has pointed out, the survival of world-society depends upon an equally new conception of the positive duties of one nation to another in the economic sphere and in the maintenance of the world's peace. We may fairly claim that Britain has been a pioneer of positive domestic democracy; but we should also be prompt to recognize in the American offer to Europe that the United States is the pioneer of positive international democracy, and to match her vision and generosity with vigorous, prompt and radical action. The challenge is, indeed, to wring from destiny a peace which only men of good will can achieve; and the success of that plan—the issue of peace or power—depends supremely on whether Britain and Europe can find the men of good will.

One need look no further than to the study by Mass-Observation entitled "Peace and the Public"* to realize how immense is the task of creating an informed and intelligent public opinion on international affairs, or the dangers inherent when a general intangible desire for peace is accompanied by ignorance of what is involved, and a disposition to lay the responsibility for action on others.

The question of peace or power is fundamentally one of men, of values and of positive measures, and as such it touches the man of science closely. Leaving on one side the implications and the urgency which the advent of nuclear energy and atomic warfare has brought to the situation, in the conception of positive democracy he has already played a large part, as Dr. Julian Huxley has shown in his little book "Democracy Marches" and later in "T.V.A.—Adventure in Planning". Moreover, if, as Dr. Huxley emphasizes, freedom of speech, of opinion, of discussion, of belief, and of research are vital to a democratic society, the man of science must accept some responsibility for safeguarding them. In General Smuts' words, "Europe has been the spiritual home of the west, the source of our concepts of progress, liberty and all the other basic ideas of our higher life . . . Europe is the heart of the cause of man, and her decadence would mean an immeasurable loss to all that is most precious in the human heritage". None the less, the challenge of Soviet Russia to the civic and personal liberties at stake all over Europe must be met by positive achievement, by the proof that the great traditions of the past—the heritage of freedom—can supply the mainspring for fresh advances, creative thought and the effective service of the changing needs of man. That, too, depends on the co-operation of the man of science. Whatever he can do to spread more widely the scientific outlook and an appreciation of what is implied in the scientific method will fortify his fellow citizens against the dangers of propaganda.

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* "Peace and the Public." A Study by Mass-Observation. Pp. vii + 58. (London: Longmans, Green and Co., Ltd., 1947.) 2*s*. 6*d*. net.

DOCUMENTATION OF ORGANIC CHEMISTRY

Elsevier's Encyclopædia of Organic Chemistry
Edited by E. Josephy and F. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 13: Tricyclic Compounds. Pp. xx + 1265. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1946.) £25 17*s*.; to Subscribers to Series 3, £22 2*s*.; to Subscribers to Whole Work, £19 7*s*.

LIKE most other sections of the community, organic chemists have their peculiar worries. One perpetual cause for concern is the increasing difficulty of finding, in easily accessible form, complete and up-to-date information about results of research on individual compounds or in particular fields. The older original literature is well indexed and fully summarized, but the task of compiling the standard indexes and reference works has not kept pace with the accumulation of new knowledge. Publication of the fourth edition of Beilstein's "Handbuch der organischen Chemie" began at about the same time as the reviewer's chemical career—that is, more than a quarter of a century ago. With its first supplement, this fourth edition completes the survey of the organic chemical literature only up to the end of 1919. Several volumes of the second supplement have been published, and if all goes well with plans now being made this supplement will be complete in 1952. By then, therefore, the literature up to the end of 1929 will have been covered; but the advances of the intervening twenty-three years will have no adequate and comprehensive summary.

It is against this background that Elsevier's "Encyclopædia of Organic Chemistry" must be regarded, for there is no doubt that it is intended as a serious competitor to "Beilstein", and that it claims superiority to "Beilstein" in certain important respects. The "Elsevier" scheme provides for the issue of twenty volumes of the main work, which is arranged as four series. Vol. 14, the first to be issued, has already been noticed in these columns (*Nature*, 160, 626; 1947); it deals with tetra- and higher-cyclic compounds. The volume now under review is concerned with tricyclic compounds; it is to be followed shortly by vol. 12 (bicyclic compounds), subdivided into 12*A* (excluding naphthalene) and 12*B* (naphthalene compounds). Vols. 12, 13 and 14 together comprise Series 3 of the whole work (Carboisocyclic Condensed Compounds). Other volumes besides 12 are apparently to be subdivided, as it is stated that the entire work will consist of approximately thirty-eight parts. The price of the complete work will place it beyond the reach of individuals, and it is clearly intended for libraries and research institutes. But the arrangement of material is such that each volume is largely self-contained, and many organic chemists (and even physical chemists) will wish to obtain for their own bookshelves selected volumes or perhaps a series. The present volume, dealing *inter alia* with fluorene, acenaphthene, anthracene, phenanthrene and their derivatives, will be invaluable to those with a special interest in compounds of these classes. The largest section, dealing with anthracene and its derivatives, comprises 590 pages, excluding indexes, and is a treatise in itself. It contains an excellent modern survey of the bibliography of anthracene and anthraquinone, and their derivatives.

Future parts of the "Encyclopædia" are scheduled to appear at six-monthly intervals, and the plan provides for the completion of the whole work by 1963. Each volume is to include all the original literature of the compounds within its purview, up to four years prior to its date of appearance. Supplements are also to be issued, each ten years after the respective part of the main edition.

This is an ambitious scheme and a formidable undertaking, about which many searching questions will be asked. Will it be possible to adhere to the proposed time-schedule ? Does the system of classification facilitate rapid reference ? Is there justification for the publisher's claim that the "Encyclopædia" gives "complete information on all chemical and physical properties and on the most important physiological properties of organic compounds" ? Is the information absolutely reliable, and are the data accurately transcribed from the original memoirs ? How does the work compare with "Beilstein", and is there a need for both these works of reference ?

"Beilstein" is an established institution in organic chemistry, and has acquired great prestige and a tradition for comprehensiveness and reliability. It will not be lightly discarded in favour of some new and untried publication. "Beilstein" is not completely infallible ; but it is a rare and outstanding achievement to find an error. The chief defects are (*a*) the time-lag which causes much of the material to be nearly thirty years out of date, and (*b*) the cumbersome system of classification, which results in data on closely related compounds being scattered over the entire range of volumes, and makes it sometimes difficult to find the desired information.

It is pertinent to ask what are the prospects of the quality of "Beilstein" being maintained in the future and of reducing the period of induction before new knowledge is available in the "Handbuch". Prior to the War the indexing and preparation of material was carried on in Berlin in direct association with the German Chemical Society, which no longer exists. There was ample accommodation for the work and excellent facilities, especially in regard to the availability of periodicals. A few months ago the reviewer had the opportunity to see the present editorial office at Frankfurt-Hoechst, in the American Zone, and to renew acquaintance with Dr. Richter, the editor. Working conditions fall far short of those formerly enjoyed in Berlin, and if the project to complete the second supplement by 1952 is to succeed there will need to be great improvement in office accommodation, supply of periodicals, etc. Moreover, under present conditions in Germany supplies of paper and publishing facilities are by no means assured for a venture of this magnitude. The outlook is probably not so gloomy as these comments might suggest, as there are powerful and sympathetic interests at work in support of the "Beilstein" organisation, and there is reason for hoping that many current difficulties will be surmounted.

As regards the Elsevier "Encyclopædia", it would be premature to attempt now any final assessment of its completeness and its accuracy. This will be made by the many chemists who will use it during the coming years. At this stage one can give only first impressions from what has necessarily been a somewhat superficial survey. These impressions, as regards the volume under review as also in regard to vol. 14, have been wholly favourable. The reviewer had already had the opportunity of seeing, in 1939, the organisation set up in Amsterdam for the production of this "Encyclopædia", and of meeting the editors, Dr. Josephy and Dr. Radt, both of whom were formerly members of the "Beilstein" staff. Dr. Josephy was 'liquidated' by the Nazis during the occupation of Holland. Dr. Radt, who happily survived the War, had a considerable share in the composition of the first supplement of "Beilstein", and had been entrusted with the direction of the preparatory work for the second supplement. It was clear, therefore, that the preparation of the Elsevier "Encyclopædia" was in very experienced hands, and the extensive array of card indexes in the editorial office bore witness to the immense amount of work already put into the project by 1939.

Vol. 13 is an excellent production. It is admirably printed in clear type, and the text is liberally illustrated with structural formulæ. Throughout the main sections the left-hand page bears at the top the structural formula of the parent compound, with its numbering. Chronological lists of references are given at the end of each sub-section, and at the foot of each page is given, where necessary, the numbers of the pages on which the appropriate references are listed. Many users will find it inconvenient not to have the full reference on the same page as the description of the compound, but the system used probably saves space. Publication was delayed by the War, and the present volume, dated 1946, states that the literature up to and including 1936 has been consulted, and the literature concerning the structure of compounds up to 1947. Certainly the newer work seems to have been noted in cases where important revisions of structure have been made, and there are numerous references to publications of the period 1937–45.

In the preface to vol. 14 it is claimed that all the data from the 231 journals listed have been taken directly from the original journals. Presumably this claim applies also to the list of nearly 270 periodicals given in the present volume. Where abstracts only have been consulted the abstract references are given. The most important omission concerns patent specifications, to which reference is not made. This limits considerably the usefulness of the present volume to chemists who are interested in anthraquinone dyestuffs. Apart from this, the reviewer has looked in vain for errors or omissions. It is claimed that the "Encyclopædia" will list and describe all organic compounds reported in the scientific literature throughout the world. It is not claimed that all references to a particular compound will be mentioned in the entry relating to that compound, and, in fact, this has not been done. In some cases this may lead to confusion. For example, p. 712 gives a structure (in an obsolete form which appears to have been copied from "Beilstein") of 5-diazoanthraquinone-2-sulphonic acid. In the only paper cited in this entry the compound is described as the 1-diazo-2-sulphonic acid, an error which was corrected in a paper published five years later. The reference to the later paper, although it is given in a neighbouring entry in the "Encyclopædia", does not appear under that relating to the diazo compound, and without this reference there is nothing to show why the structure has been modified.

The presentation of the data has been done with great skill, and gives evidence of expert chemical knowledge and sure instinct. Thus, there are apt editorial comments concerning the possible origin of certain bands in the infra-red absorption spectrum recorded for phenanthrene (p. 789); on the structures of an ether of xanthopurpurin (p. 527), of the nitration product of 2-ethoxyanthracene (p. 279), and of an alleged hexahydroanthracene (p. 518). An attractive feature is the introduction of schemes of formulæ illustrating reactions of certain rather complex natural products such as abietic acid and some related compounds, cedrene, tricyclene and its derivatives, colchicine, thebaine and carminic acid (given as carmic acid); similar schemes show the reactions of the dicyclopentadienes. Extensive quotation of physical constants and references to papers dealing with biological effects of many of the substances will appeal to many users. Space is saved and reference facilitated by describing in tabular form the characteristics of numbers of closely related compounds; for example, the colours of the azo derivatives of anthraquinone-sulphonic acids, and the physical constants of the alkylphenanthraquinones and of the pharmacologically interesting phenanthrylaminoalkyl carbinols.

The arrangement adopted in the "Encyclopædia" aids rapid reference, and groups together hydrocarbons and their various functional derivatives. It has, nevertheless, certain disadvantages. Thus, there are references to tricyclic sesquiterpenes in two widely separated sections of the present volume, and other classes of sesquiterpenes will presumably be included in other volumes. Again, although the tetracyclic sterols and bile acids are properly dealt with in vol. 14, some of their tricyclic degradation products (for example, ætiobilianic acid) appear in the present volume. In other cases the names only are given, with cross-references to volume 14, and this method of treatment, although not strictly logical, is to be preferred. The present volume also includes a number of phenanthrene derivatives obtained by degradation of alkaloids such as morphine and thebaine, corytuberine, glaucine, boldine, laurepukine and artabotrine. The English style of the work is satisfactory, and only very rare lapses betray the Continental origin of the publication. The British reader, for example, will probably be mystified by expressions such as "fat coals" (p. 28) and "brutto formula" (p. 207). There are an excellent subject index and a comprehensive formula index.

In the opinion of the reviewer it is deplorable, in the present state of organic chemical documentation, that the duplication of effort involved in the production of both Beilstein's "Handbuch" and Elsevier's "Encyclopædia" should continue. It would be equally deplorable if the tremendous amount of labour already put into either project should be wasted. What is needed is an amalgamation of the two organisations, with the view of concentrating all the available resources on the rapid completion of an up-to-date comprehensive survey of the organic chemical literature. It is clearly desirable that use should be made of modern methods of punched cards and mechanical sorting systems, in conjunction with a cyphering system such as the elegant and ingenious system of Dyson. Only by the use of every possible device can the herculean task be accomplished. The provision of a complete survey of the literature of all organic compounds is an international service, and the project should be conducted under international sponsorship, provided always that this can be made fully effective, with adequate resources. Organic chemists throughout the world should speak with united voice on the urgent and imperative need for resolute action on these lines. J. W. COOK

PROBITS

Probit Analysis

A Statistical Treatment of the Sigmoid Response Curve. By D. J. Finney. Pp. xiii+256. (Cambridge: At the University Press, 1947.) 18*s*. net.

BOOKS on statistics are apt to be either shallow or obscure. A book which avoided both these dangers and yet covered the whole field would have to be a very long book; but it is possible to achieve both profundity and perspicuity by restricting the scope of the book to the discussion of one technique, and this device has been adopted in a new book by D. J. Finney.

Whatever we may think of its etymology, the word 'probit' (probability-unit) has become firmly embedded. It was introduced by C. I. Bliss to denote a function into which percentages are converted in order to facilitate computation. When the dose of a poison is plotted against the percentage mortality, an S-shaped curve is obtained; but when the logarithm of the dose is plotted against the probit of the mortality, the results can usually be fitted with a linear regression line. A report dealing with this technique was published by the Medical Research Council in 1933, but this report has long been unobtainable. In the meantime, the subject has become more complicated, and many biologists and others will welcome the appearance of a complete text-book dealing with the whole subject. The book contains a history of the method, a discussion of its mathematical basis, full details about the use of a calculating machine for working out an example, a large number of other examples with less detail, and all the necessary special tables.

There is also much discussion of the more complex applications of probits, and it is really surprising to see what an elaborate subject this has become. Allowance can be made, by Abbott's formula, for the mortality in control groups of animals receiving no poison, and methods are given for calculating the maximum likelihood solution in this case. When the mortality depends on two factors, such as dose and time of exposure, the results can be interpreted by calculating the probit plane. When two poisons act together, or when one poison acts in two ways, the results will not, in general, be fitted by a straight line, and the shapes of the curves to be expected in this case are discussed. Methods are given for analysing the variance of the sensitivity of the animals when tests are carried out on different days. The case when each animal receives a different dose is discussed. A section is devoted to the general formula proposed by Parker-Rhodes which includes, as special cases, both the normal distribution of individual lethal doses and the normal distribution of the logarithm of this quantity. The last chapter refers briefly to the treatment of the results of tests in which the response of each animal is measured quantitatively, as, for example, when a vitamin is estimated by its effect on the weight of rats.

The book will serve as a valuable guide to this branch of statistics. Everyone who is interested will be able to learn something from it. The novice will find full instructions for making complicated calculations, and even the experts will find things that they did not know before. There is, however, one criticism to be made. In previous writings on this subject the symbol λ has been used to denote the standard deviation of the logarithm of the independent variate, such as the dose. This notation was proposed because σ commonly denotes the standard deviation calculated directly, and it is convenient to use a different symbol when logarithms are used. This convention is not necessarily good, but has been widely adopted; it is therefore unfortunate that in this new book the same rather exotic symbol is used to denote the dose. Surely some other symbol might have been found for this purpose.

J. H. GADDUM

DATA FOR NUCLEAR PHYSICS

Nuclear Physics Tables

By J. Mattauch; and An Introduction to Nuclear Physics, by S. Fluegge. Translated from the German by Eugene P. Gross and S. Bargmann. (Published and distributed in the Public Interest with the consent of the Alien Property Custodian.) Pp. viii + 173 + 8 plates. (New York and London: Interscience Publishers, Inc., 1946.) 72*s*.

THIS work combines a comprehensive set of tables of nuclear physics data compiled by J. Mattauch with an introduction to nuclear physics by S. Fluegge. It was first published in Germany in 1941 and has now been republished in the United States by Interscience Publishers.

The first table gives a list of all the measured constants of stable nuclei. This includes relative abundance, spin, magnetic moment, quadrupole moment, and mass defect. The third table gives mass differences for all the important doublets used in the mass-spectrograph determinations of isotopic weights. The fourth table gives a list of all isotopes, stable and unstable, and their isotopic weights with probable errors of the determination. It gives the details of half-life, radiations emitted and method of formation for all radioactive isotopes. This table is specially valuable since it provides in separate columns for the thirteen common methods of formation of radioactive isotopes, (α, p), (α, n), (p, γ), (p, n), etc. It is possible, therefore, to see very quickly all the known reactions, say, of the (n, γ) type or, for example, to look up a specific positron emitter having a positron energy above a desired value. The sixth table gives a list of energy yields (Q values) of a large number of nuclear reactions of atomic number less than 33.

There is finally a chart of the well-known 'wall type' in which all known nuclei are represented by black, red or green squares depending on whether they are stable, unstable or isomeric, while arrows show all possible transitions.

The tables are complete with references, and contain all information available in 1941. Their principal deficiency to-day is in the list of fission products and their properties, most of this information having been released within the last year by the various atomic energy projects.

Information on nuclear absorption and scattering cross-sections is conspicuously lacking, and is a second deficiency. A good deal of this information was available in 1941, and much better and more complete information is now available.

The "Introduction to Nuclear Physics" comprises 109 pages. It includes subjects such as K-capture, isomerism and the meson theory of nuclear forces which have not been available in earlier text-books. Mass spectrographs and methods of calculation of mass defects are treated fully, as are experimental methods of determination of nuclear spin and nuclear moments. The chapter describing methods of observation in nuclear physics, such as ionization chambers, counters and amplifiers, is now out of date owing to the important developments in technique during the war years.

The book, therefore, fills a gap in existing literature in nuclear physics; but it is rather far from satisfying the need for a really comprehensive text-book embodying all the published knowledge now available.

J. D. COCKCROFT

BIOLOGY OF THE LOUSE

The Louse

An Account of the Lice which Infest Man, their Medical Importance and Control. By Prof. Patrick A. Buxton. Second edition. Pp. viii+164. (London: Edward Arnold and Co., 1947.) 10*s*. 6*d*. net.

THE louse (*Pediculus humanus*) is a highly specific parasite of man. Prof. Buxton's book deals with this creature more especially from the biological and medical points of view. It is an insect of great importance in human economy since it is well known to be concerned in the transmission of epidemic, or exanthematous, typhus from one person to another. The epidemic type of relapsing fever is also transmitted by it, as is the disease known as trench fever. The latter malady was a major factor in the health of the opposing armies in the First World War; but its actual or apparent disappearance since its close has yet to be explained.

The new edition of Prof. Buxton's book bears testimony to the great increase in knowledge of the louse since the appearance of the first edition in 1939. Ideas and knowledge of louse control have been well-nigh revolutionized in that interval, particularly owing to the fortunate discovery of the remarkable effects on the insect of the compound known as *D.D.T.* The wide use made of this substance in the great typhus outbreak in Naples in 1944 led to the epidemic being arrested in the course of about half a year. Tens of thousands of persons at one time were treated daily simply by blowing *D.D.T.* as a dust under the garments, without any undressing being involved. Even more effective is the impregnation of clothes with *D.D.T.*, since this compound retains its lice-killing properties after they have been worn for several weeks and repeatedly washed with hot soap and water. It appears that an impregnation of 1 per cent by weight of garments in store with *D.D.T.* enables them to retain their insecticidal properties to a large extent even after a year. As Prof. Buxton remarks, the efficiency of *D.D.T.* in louse control is so great that perhaps we have now seen the last great typhus epidemic.

The study of the collective biology of louse populations has virtually come into existence in the short interval since 1939, mostly through Prof. Buxton's own researches. Also, Wigglesworth's work on the sensory physiology of the insect is a further noteworthy advance in our understanding of its behaviour. These, and many other aspects of the louse in relation to man, are fully dealt with in this authoritative and indispensable little book. Being written with a breadth of viewpoint only to be acquired by a truly scientific outlook, we commend it not only to medical officers but also to entomologists the world over. Another feature is the very complete bibliography of louse lore that accompanies the text of this manual.

A. D. IMMS

The Detection and Control of Garden Pests

By G. Fox Wilson. (Agricultural and Horticultural Series.) Pp. 194+54 plates. (London: Crosby Lockwood and Son, Ltd., 1947.) 12*s.* 6*d.* net.

A GOOD sound book on pests of the garden has long been overdue, and Mr. Fox Wilson's effort certainly fills the gap admirably. Very often insect damage to cultivated plants is uncommonly difficult to identify. Unless it can be recognized in its early stages and measures of repression put into force, it is usually "too late to mend". The book is an expanded and revised version of the author's serial articles entitled "Symptoms of Pest Attack on Plants" published in the *Gardener's Chronicle* during 1932–36. The basis of the book is, therefore, laid on diagnosing pest injuries, and each chapter deals with the insects or other pests of a separate part of plants. Thus Chapter 3 deals with roots, and here the reader will find an account of the injuries inflicted by all the root-enemies that are likely to be encountered. Other chapters deal with stems and shoots, flowers, seeds, and so on. There is no doubt that this method of treating the subject facilitates quick identification better than any method of grouping the different pests under their natural orders or their specific plants.

The measures advocated for the control of the various pests are the best that present-day knowledge can offer—some are completely effective, others partially so. The photographic illustrations of damaged plants are a useful aid together with those of individual pests. While the nomenclature used for different pests is not always very modern, little confusion will result. In fact, it will prove an advantage to the general reader for the reason that it will facilitate reference to works of earlier date, since in these works the older names are current.

The author has done a real service in writing this book at a time when we need to produce and conserve so much in the vegetable kingdom. A. D. I.

The Adjustment and Testing of Telescope Objectives

By H. Dennis Taylor. Fourth edition. Pp. viii+95. (Newcastle-upon-Tyne: Sir Howard Grubb, Parsons and Co., 1946.) 17*s.* 6*d.*

THOUGH the first edition of this work was published more than fifty years ago, in 1891, it still has value as a standard work on the adjustment and testing of telescope objectives. The firm of Sir Howard Grubb, Parsons and Co., which has taken over the astronomical interests of Messrs. Cooke, Troughton and Simms, has performed a useful service in publishing a new edition. This edition follows the text of the third edition, published in 1921. The new edition would have had a greatly increased value, however, if the opportunity had been taken to revise the material thoroughly and to make additions to bring it up to date. New methods of testing objectives are available and might well have been included. The introduction to the volume refers to the refracting telescope as "the most convenient and generally reliable form of telescope"; but since this was written the reflecting telescope has become much more favoured. All large modern telescopes are necessarily reflectors, and reflectors are much used by amateurs because, for a given aperture, a reflector is less costly than a refractor and also because mirror making is within the ability of many amateurs. It would have been valuable to have included an account of methods of testing mirrors—spherical, paraboloidal and hyperboloidal. Other material could with advantage now be omitted as not strictly pertinent to the subject of the book. At some future date, a new edition is likely to be required, and it is suggested that the opportunity might then be taken to make a complete revision.

I fondamenti scientifici della astronomia

Per Prof. G. Armellini. Pp. xv+320. (Milano: Ulrico Hoepli, 1947.) 650 lire.

THE aim of the author in writing this book was to fill a gap in Italian scientific literature by presenting a logical mathematical account of the foundations of that part of astronomy which is concerned with the study of the movements of the celestial bodies, and with the calculation of their distances and of their dimensions. The book is intended primarily for the students attending courses in astronomy at Italian universities, and the knowledge of mathematics required does not go beyond simple applications of the differential calculus. In addition to the ground usually covered in elementary text-books on spherical astronomy, the author deals with the calculation of an orbit from three observations, with the determination of the solar motion, with the rotation of the galaxy and the determination of its dimensions and mass, with elementary stellar statistics and dynamics, with the distribution of the external galaxies and with the curvature of space. Most of the subjects dealt with are necessarily discussed only in an introductory manner. The student who masters this book will, however, have a sufficient grounding to enable him to proceed to the study of more advanced text-books. The author plans to follow this work with a further volume on the scientific foundations of astrophysics, which will be concerned with stellar photometry, astronomical spectroscopy, and the physics of the sun, planets, stars and nebulæ. H. S. J.

Native Peoples of the Pacific World

By Prof. Felix M. Keesing. (Pacific World Series.) Pp. xv+144+32 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1946.) 15*s.* net.

FOR most people there is a strange glamour about the South Sea Islands and their inhabitants, due in part, no doubt, to the works of such visitors as R. L. Stevenson and Gauguin. But few people know anything accurately either about the islands themselves or about the various peoples who live there, their material culture, customs, etc.

This book, written mainly for American soldiers during the War, sets out to supply this need, and it has the great advantage of being written by a specialist; Prof. F. M. Keesing was born in Malaya, brought up in New Zealand, and has been professor of anthropology in the University of Hawaii. He is at present professor of anthropology in Stanford University, California. After a general chapter on the geography of the South Sea Islands, the Polynesians, Micronesians and Melanesians are in turn briefly described, such matters as languages, types of government, methods of livelihood, home conditions and social customs being mentioned. Finally, there is a chapter on religion. The whole is profusely illustrated and the work is very readable. Unfortunately, there is no bibliography; but a beginner interested in these far-away peoples will here find an excellent introduction to the subject. M. C. B.

THE DRAINING OF BINLEY LAKE AND ITS ECOLOGICAL CONSEQUENCES

By WING-COMMANDER T. R. CAVE-BROWNE-CAVE, C.B.E.*

A DESCRIPTION of the formation of drainage channels in the mud exposed by draining a large lake and the exceptionally rapid growth of vegetation on the lake bed may be of some general interest. The work was done for camouflage during the War.

A large expanse of water is the most outstanding landmark seen from the air at night. To an airman who knows how to approach it from the correct quarter in suitable conditions of light, it will shine out in sharp contrast with the general darkness of the landscape. A few miles to the east of Coventry is Binley Lake, some 90 acres in extent, and of a most distinctive horse-shoe shape. It would be an invaluable landmark to an enemy approaching a target so far from the coastline. It was therefore decided, after consultation with the Air Staff, to drain the Lake in order to suppress its outstanding appearance.

The Lake contained a great quantity of coarse fish, and the owners derived very considerable revenue from fishing. But their co-operation was prompt and most helpful. A stream flowed into one end of the Lake. Water passed out through sluices so placed that the Lake would drain without difficulty when they were fully opened. Arrangements were made with the Fishery Board of the area to net the fish and transfer them to streams and reservoirs in the neighbourhood. The experts who did the work estimated that they successfully decanted nearly a million fish, ranging from pike of more than 20 lb. to bream of about 20 gm. The netting process necessitated lowering the water-level very slowly. When most of the important fish were out, the last of the water was released. That left ninety acres of flat wet mud which would shine and reveal the distinctive shape just as well as the water would have done. Even if the bed did dry out during the summer, it would return to its wet brilliance after every heavy rain storm. It was considered that not until the mud was well drained and aerated after several seasons would there be any strong growth of vegetation. The mud was very soft and 4–6 ft. deep. Any work of artificial drainage would have been almost impossible. There was, however, such a complete absence of those drainage channels which appear in mud flats left by the tide in an estuary that it seemed worth while to arrange for another 'tide', which ebbed more rapidly.

The Lake was allowed to refill to a depth of some 12 inches. The sluices were then opened wide, so as to get the maximum possible rate of outflow. In less than two hours, a perfect system of drainage channels started to develop and gradually spread over the whole area in perfect pattern. It was therefore probable that the mud would gradually dry out and would not re-flood, because rain storms would tend to cut the channels deeper. Fig. 1 is from a photograph taken on November 13, 1942, from the outlet sluices, a few hours after drainage was complete.

The site was examined occasionally from the air until it was obvious that the mud had dried so well that there was no risk of shine. It was not until some eight months later—November to July—that a further survey was made. The report was rather surprising, so an examination on the ground was made. The lake bed was completely covered by dense vegetation. Fig. 2 is from a photograph taken on September 22, 1943, from the same point as Fig. 1, but ten months later and in a slightly different direction. The expanse of supposedly waterlogged and sterile mud was covered with a dense growth, including some willows more than 8 ft. high. Presumably the drainage and aeration had been rather better than expected. The crust had hardened sufficiently to allow men to walk across the Lake with circumspection; but there was a pronounced jelly-like movement which suggested the mud underneath.

There can be no doubt of the excellence of the camouflage. The cost of making the change was small. It may be significant that, although Coventry had been heavily raided on two occasions previous to the draining, two raiders which came to that area not long after the Lake was drained dropped their bombs in open country within ten or fifteen miles of the vitally important area.

After the need for camouflage had ceased, the problem of returning the Lake to its owners and determining the extent of compensation arose. Expert advice was taken upon the action which would most promptly enable the lake bed to return to a condition in which the Lake could satisfactorily be

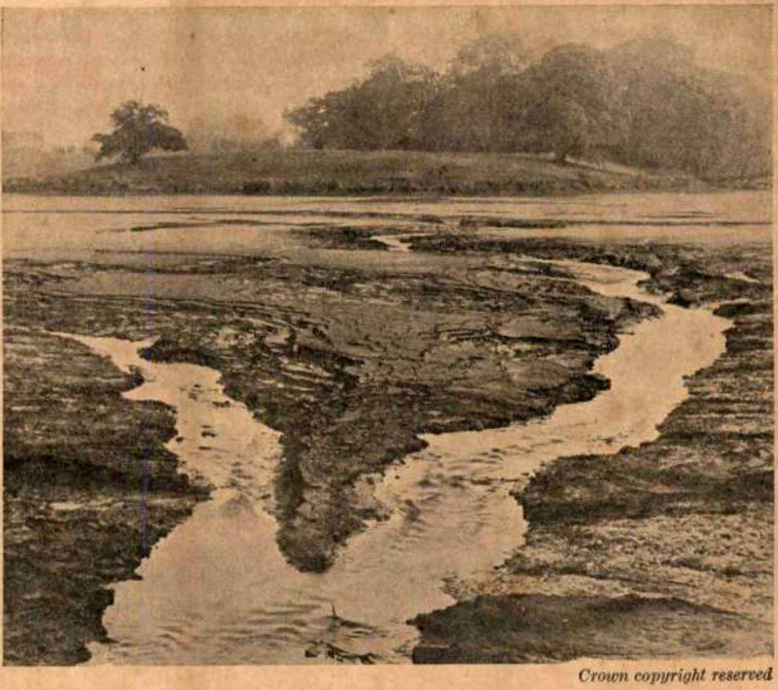

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Fig. 1. DRAINAGE CHANNELS PRODUCED IN THE BED OF BINLEY LAKE

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* Of University College, Southampton, late Director of Camouflage.

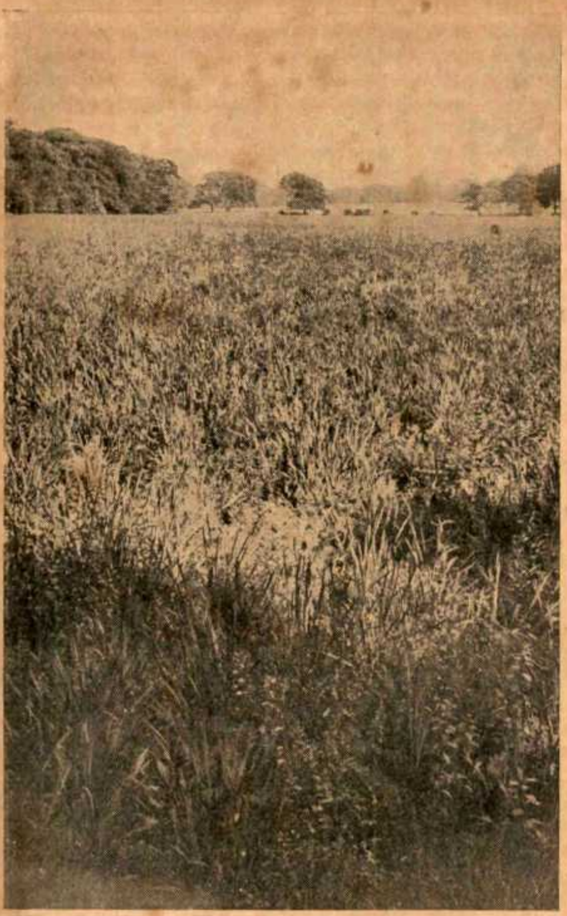

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FIG. 2. VEGETATION COVERING THE BED OF BINLEY LAKE TEN MONTHS AFTER DRAINING

re-stocked. It was considered that until the Lake was reasonably clear of rotting vegetation, the oxygen content of the water would be too low to justify re-stocking with fish. It was also doubtful whether 6–8 ft. of water would be sufficient to kill the vigorous growth which had arisen during the two years the Lake had been empty.

The owners were therefore advised that the vegetation should be cut close down in the spring, the autumn and the following spring before the Lake was re-flooded. Compensation was based upon this suggestion, and allowance was made for a reasonable period before the Lake and its fish could be expected to have recovered full fishing value. The owners decided, however, not to incur the expense of cutting, and they re-flooded the Lake in October 1944, almost exactly two years after it had been drained.

A visit to the Lake in August 1947 showed that during two seasons a few men had been employed in pulling out the bullrushes and similar growth which showed above the surface. In March 1946 there were large areas of open water with belts of reedmace at the shores. Some eight thousand roach, bream, pike, rudd and tench were then put in; a further seven thousand, with some golden carp, were added in September 1946. All seemed well until in July 1947 a strong growth of hornwort (*Ceratophyllum demersum*) developed in almost every part of the Lake. The growth extended to the surface in many places, where it entrained a quantity of ordinary pond weed and made fishing almost impossible. The fish, however, appeared to thrive. No dead fish have been seen, and those caught show good growth and are in good condition.

The problem now is to find what action can be taken without injury to the fish to avoid the growth of weed in subsequent years.

Dr. W. B. Turrill and Mr. V. S. Summerhayes, of Kew, visited the Lake in December 1943, and a brief summary of their findings is appended.

VEGETATION AFTER DRAINING

By V. S. SUMMERHAYES and DR. W. B. TURRILL

A visit to Binley Lake was made on December 2, 1943, under the guidance of Mr. F. P. Knight, of the Directorate of Camouflage. The Lake had been drained and its bed was occupied by a dense growth of vegetation fairly uniformly spread over the whole area. The dominant plant was the reedmace (*Typha latifolia*), except in a few small patches where other species (mainly *Phragmites communis* and *Carex* sp.) had obviously established themselves, previous to the draining, in shallow water against the shore. The reedmace plants were up to 6–8 ft. in height, and a very large number of them were in full fruit. Though they were distributed over the whole lake bed, the mature plants of reedmace were somewhat denser in some parts than in others. In places willows (*Salix capræa* and *S. viminalis*) had become established and were 8 ft. tall. Locally these willows were abundant. The reed grasses *Phragmites communis* and *Glyceria maxima* occurred in a few places, and many marsh and some dry-land species were listed as present in one to several individuals. It was fully established, from the morphology of the *Typha* and other plants, that this remarkable growth of vegetation had occurred within one year. The botanical evidence was in complete agreement with the dated records that the fruiting *Typha* plants had developed from seedlings in less than twelve months, a surprising rapidity of growth from establishment on bare mud.

The vegetation was only partially closed. In many places, leaves of separate plants touched or overlapped, but there was mostly bare mud between individual plants. On this mud were innumerable seedlings of *Typha*, low-growing marsh plants, some in flower or fruit, and mosses. The presence of mosses was not unexpected; but the species represented were mostly well-known dry land ones. Far and away the most abundant was a form of *Funaria hygrometrica*, which sometimes appeared in continuous patches a foot or more square, but more often in smaller clumps. Other species present in fair quantity, but scattered throughout much of the area of the lake bed, were: *Barbula unguiculata*, *B. tophacea*, *Bryum argenteum*, and *Bryum* sp. (barren). Small quantities of *Webera carnea* and *Dicranella heteromalla* were also noticed, and one patch of the liverwort *Marchantia polymorpha* was found near the inlet end of the Lake.

The reedmace which, at the time of the visit, had so largely occupied the mud, must have spread as seeds from near the top (inflow) end of the Lake, where there was an old-established community of this species forming what had evidently been a *Typha* swamp. No other *Typha* was found growing in or near the Lake, except the young plants and seedlings all less than a year old.

PHYSIOLOGY OF DISEASE RESISTANCE IN PLANTS

AT the Royal Society symposium held on December 11 on the "Physiology of Resistance to Disease in Plants", three papers, by Prof. W. Brown of the Imperial College of Science and Technology, Prof. F. T. Brooks of the University of Cambridge and Dr. F. C. Bawden of the Rothamsted Experimental Station, respectively, were read. Unfortunately, there was no time for a general discussion at the end of the papers.

Prof. W. Brown claimed that physiological analysis of the host-parasite relationship is most readily attempted in the case of the facultative parasite. The latter can be cultivated *in vitro* and its metabolism, therefore, studied up to the limits set by available experimental techniques. One can thus obtain some idea of the means by which fungi and bacteria attack plants—the so-called 'offensive mechanism' of the parasite—and conversely of the resistance which plants are able to oppose to such attack. The establishment of parasitism involves the carrying out of a series of operations which will be discussed in the following sequence: (1) pre-penetration phase, (2) the act of penetration, and (3) post-penetration phase.

In the pre-penetration phase the first requisite is that spore germination should take place. The more vigorous the germination the more likely is penetration to occur. Moist conditions, that is, presence of free water or of a sufficiently high relative humidity, are essential, and these must persist for a time sufficient to allow of germination and entrance into the host, otherwise death of the germ-tubes by desiccation would result. Meteorological conditions largely determine whether a particular plant disease can establish itself or whether alternatively it reaches epidemic proportions. Even under wet-weather conditions, some plants are protected from invasion by possessing an unwettable type of surface, so that one of the preliminary conditions for infection is not satisfied. This is an example of 'disease escape', the plant not being attacked even though it may be inherently susceptible.

Granted suitable environmental conditions, the germinative capacity of the spores of any fungus varies with their age and with the conditions of culture under which they were grown. A factor of importance at this stage is the passive exosmosis of solutes from the underlying host cells, and these affect the amount and vigour of spore germination according to their quantity and quality. The presence of other fungi or of bacteria in the inoculum has in general a depressing effect on germination and therefore on the establishment of parasitism. This is an example of microbiological antagonism which is more prominently shown with certain root-invading fungi.

The stimulus to penetration was at one time considered to be of chemotropic nature, but that view has been largely discarded. With fungi which penetrate directly through the cuticle, the stimulus is one of mechanical contact, the germ tubes becoming fixed to the surface of the host by formation of an appressorium (attachment organ), at which point they attempt to penetrate. The mechanism of penetration is also physical, the fungus putting an extremely fine outgrowth through the cuticle. The evidence on this point is partly cytological and partly that no cuticle-dissolving substance is known to be produced by fungi. The mechanical properties of cuticularized epidermis and the intrinsic penetrative capacities of fungi are the determining factors at this stage. A part of cuticular resistance depends upon the hydrostatic backing of the underlying epidermal cells. By these means one can explain the penetration of young or old leaves when the leaf is not penetrable in its mature, fully active condition.

Cuticular resistance is the only means of defence of some plants against specific parasites (wound parasites). Frequently the cuticular barrier is circumvented by invasion through stomata or other natural opening, or by way of parts (for example, the stigmas of flowers) where the cuticle is poorly developed. Once inside the plant, parasites of the facultative type disorganise the host tissue and live on the dead remains. The chief substance concerned in this process is pectinase enzyme. Resistance may take the form of retardation or inhibition of growth of the invader or interference with its offensive mechanism. Thus acidity of cell-sap, or presence of tannins, oils, glucosides, etc., may prevent growth of a potential parasite. A similar effect is obtained when the metabolism of the latter leads to the formation of substances ('staling substances') which by and by inhibit growth; hence the formation of lesions of limited size.

The reaction of the host to the presence of the parasite may be to lay down mechanical barriers (gum, cork) which seal off the lesion. Chemical responses, for example, the localized formation of phenolic compounds, may occur; but it is not clear how far these are effective. It is very doubtful if there is in plant pathology (apart from some viruses) an antigen-antibody type of reaction comparable to what is known in animal diseases.

A more general type of resistance is seen where, in the absence of any obvious anti-fungal property of the plant sap, the plant in its normal condition shows resistance to a fungus which appears to have the necessary offensive mechanism. Slight modifications of the host, as produced by raising its water-content or by previous incubation at a warm temperature, may swing resistance over to susceptibility. Other components of this problem are the differential effects of nutrient upon the capacity of fungi to produce pectinase, and differences in detailed properties of pectinase as derived from various fungi. The continuance or otherwise of attack appears to rest upon the functioning of an intricate enzymic process, the details of which have not been worked out as yet.

Finally, there is a kind of resistance which depends upon insensitiveness of the plant tissue to the enzymic secretion of the fungus. As the primary enzymic effect is hydrolysis of the cell walls, the factor which confers immunity in this case is the chemical composition of the cell wall.

Prof. F. T. Brooks pointed out that the fundamental difficulty met with in studying the physiology of obligate parasites is that the fungus cannot be grown on culture media and thus has to be studied in relation to the host itself. The relationship of host and parasite is bound up with subtle protoplasmic properties of the two organisms, though even here there is some evidence that structural properties of the host confer a measure of resistance; for example, the presence of a greater amount of sclerenchyma in certain wheats, the thickness of the mature cuticle in the barberry leaf which resists penetration by the germinating sporidia, etc. Resistance of cereals to rust attack has long been known to rest upon the 'hypersensitive' effect, invasion by the fungus leading to localized necrosis of the host cells, so that further advance of the parasite is stopped. With the fully susceptible host the rust establishes a kind of common life with the invaded tissue and there is no evidence of mutual antagonism. Intergrades between the two types of reaction occur.

One can do little more than speculate as to the physiological nature of these reactions. It has been suggested that hypersensitiveness arises by the excretion from the fungus of a toxin and that the fungus eventually dies from starvation or more probably through the agency of lethal substances excreted by the host. No satisfactory explanation in biochemical terms is as yet available of the difference between susceptible and resistant host varieties.

The hypersensitive reaction is affected by changes in the environment; for example, by nutritional alterations of the host as brought about by varied illumination or by differential manuring, and even by the presence of another parasite in the tissue. Thus under certain conditions a susceptible host becomes resistant and *vice versa*. Frequently susceptibility in seedling cereal plants gives way to resistance as the plants grow older ('mature plant resistance'). This effect is of great practical importance, but its physiological meaning is unknown.

Resistance to attack by mildews first becomes evident at the stage where a sub-cuticular papilla is formed. Whereas in a susceptible host a haustorium emerges from the papilla to invade the underlying epidermal cell, such emergence does not occur where there is resistance. The host cell is undamaged, though a hypersensitive effect has also been described. A similar range of behaviours is seen in connexion with the invasion of potato varieties by the wart disease fungus, though here the striking response is the large development of gall tissue when the variety is susceptible.

With certain facultative parasites there are defensive mechanisms in resistant hosts which, while not preventing initial invasion, preclude the fungus from spreading extensively in the tissues. Such is the gum barrier produced from wood carbohydrates when a resistant variety of plum is invaded by the silver-leaf fungus. A susceptible variety produces no such protective barrier, though under conditions of enhanced metabolism it may do so to some extent. Resistance to the root-invading fungus, *Armillaria mellea*, also appears to be due in part to the gumming reaction, though here cork barriers are developed in addition. The functioning of cork barriers is well seen in varieties of apple trees resistant to canker; in this case the effectiveness of the barrier is largely dependent upon the state of metabolism of the host, so that under some conditions a normally resistant variety becomes susceptible. The well-known 'shot-hole' appearance in the leaves of many plants is often due to the limitation of the lesion by a cork barrier.

Resistance to wilt-producing fungi appears to arise in a number of ways. With flax-wilt, resistance is seated in the cortex of the roots, so that the fungus is shut off from reaching the vascular bundles. In hop varieties resistant to wilt, the fungus enters the vessels, where it grows much as in a susceptible variety, but no harm ensues. It has always been considered that the wilting effect is due to the formation by the fungus of a toxin, and recently the toxin of tomato wilt has been identified as a polypeptide of known composition. Presumably the resistance of certain hop varieties to wilt is due to the non-elaboration of a toxin, or to insensitiveness of these varieties to the toxin produced. In some cases resistance of plants to wilt appears to be a property of the root only, in others of the whole plant.

Among the few examples in which resistance to fungal invasion is associated with particular substances of known composition, the best known is that of coloured types of onion against certain parasites. In contrast to white varieties of onion, which are susceptible, coloured ones owe their resistance to the presence in their outer scales of catechol and protocatechuic acid.

Resistance is rarely absolute under all conditions. The precise result obtained depends to some extent on the amount of inoculum applied and on environmental factors as affecting both host and parasite. The latter has already been referred to in connexion with resistance of cereals to rusts. A notable example of the effect of temperature on disease response is seen with the scab disease (*Fusarium*) of wheat and maize. Wheat seedlings are susceptible at the higher, maize seedlings at the lower temperature ranges, and in both cases it has been shown that susceptibility is correlated with a pectic type of cell-wall structure, the temperature under which the plants were grown being the determining factor for this.

Dr. F. C. Bawden dealt mainly with viruses. These are unique pathogens, for they are both wound parasites and obligate parasites. All uninjured plants are immune from all viruses, and most viruses have a narrow host range. Thus immunity is the common state, susceptibility is exceptional. Nothing is known of the conditions conferring natural immunity. The growth requirements of viruses are unknown, and though plant extracts often contain virus inhibitors it is uncertain whether these substances function as such *in vivo*. One is, therefore, limited to considering variations in degree and type of resistance shown by susceptible plants.

Viruses rely for transmission on vectors, chiefly leaf-sucking insects, and usually produce systemic infections. Possibly because of their systemic nature, virus diseases provide the only authentic examples of acquired resistance in plant pathology. There are two types, both simulating conditions well known with animal diseases. In the first type, infection leads to severe initial symptoms, from which the plants recover, and then resist effects of further inoculation. The recovery is not because of antibody formation, and the virus is present all the time in the resistant tissues. The second type of acquired resistance simulates the process of vaccination in animals: protection against a severe strain of a virus is given by previous infection with a mild strain. Again there is no antibody formed. Protection is based on mutual antagonism between the two viruses. It is suggested that there are only a limited number of sites of virus multiplication in a cell, and if these are occupied by one strain another cannot become established. The resistance is acquired only against related strains, and unrelated viruses may act synergistically, giving together severe symptoms when each alone gives only mild.

Virulence is not an intrinsic property of a virus strain but a reflexion of a host-parasite interaction, and is not correlated with the concentration of virus reached within the plant. Strains of potato virus *X*, for example, may cause severe diseases in some potato varieties and not in others. Hypersensitiveness, similar to that of cereals to rust fungi, affords a common form of resistance. Sometimes, however, there is a systemic hypersensitiveness in which the whole plant is invaded and killed. This is the extreme of susceptibility, but confers resistance by eliminating the virus from the stock as a whole. Varieties of potato which react to virus X in this way are rarely found infected in the field, whereas other varieties are almost universally so.

Short of hypersensitiveness, intermediate degrees of tolerance occur, down to the condition of 'carrier' varieties which show no symptoms though they may contain a high concentration of virus. The degree of tolerance is somewhat modified by environmental conditions.

With equal chance of infection, a greater incidence of disease occurs in some varieties than in others. This has been demonstrated both in field and controlled experiments. The inference is that different amounts of virus are needed to cause infection in different hosts. Though the evidence from dilution curves is that infection is caused by single virus particles, it seems that different numbers must be introduced into different cells to ensure that one becomes established.

With some viruses infection occurs only when the particles are introduced directly into the phloem; more often introduction into ordinary parenchyma cells is sufficient. The method of inoculation can affect susceptibility, infection taking place more readily when the inoculum includes a suitable abrasive. The severity of the symptoms shown may also be increased by this means.

An effect comparable to the 'mature plant' resistance of cereals to rust fungi is often seen, ease of infection and the severity of symptoms diminishing as the plant grows older. The cultural conditions of the host also influence resistance; thus some viruses are more readily transmitted in winter than in summer. The controlling factor appears to be light, and susceptibility to some viruses is enhanced by keeping the plants in darkness for 24 hours before inoculation. It is suggested that the presence of photosynthetic products interferes with the establishment of virus particles at sites of multiplication. The conditions of mineral nutrition are also important, phosphorus being most effective in increasing susceptibility, though quantitative comparisons are rendered difficult by unequal growth of the plant under different systems of manuring. Increased size of the plant itself tends to favour infection, and conversely small size gives plants a disease-escape mechanism which may simulate resistance in the field. Susceptible plants may also escape infection because they are unattractive to vectors or grow in situations which reduce the chance of visits by the appropriate insects.

CHEMISTRY OF VISUAL PROCESSES

By S. BALL, F. D. COLLINS, PROF. R. A. MORTON
AND
DR. A. L. STUBBS
Biochemistry Department, University of Liverpool

SINCE rhodopsin (visual purple) was first described in 1876 by F. Boll[1], much evidence concerning its chemical nature and physiological properties has accumulated. Relatively few attempts have been made, however, to devise theories embracing all the facts; the contributions of G. Wald[2], R. J. Lythgoe and his colleagues[3] and R. Granit and his co-workers[4] being outstanding. The objects of the present article are to describe experiments which seem to reconcile divergent findings, as between Wald and Lythgoe, and to provide a basis for discussing in chemical terms Granit's discoveries, concerning the electrophysiology of retinal elements.

It is necessary first to elucidate the decomposition of rhodopsin extracts. Wald[2] stated that retinene$_1$, later shown by Morton and Goodwin[5] to be vitamin A aldehyde, was the final product of bleaching. He was able to extract retinene from retinas freshly bleached by light, or from bleached solutions of rhodopsin, by using as solvent a mixture of acetone, ethanol and light petroleum. The retinene was identified by its ultra-violet absorption maximum 380–385 mμ in chloroform and its colour test maximum (664 mμ) with the antimony trichloride reagent. When a solution of rhodopsin in the aqueous digitonin used to detach the pigment from the retina was acidified before bleaching, the irradiated solution exhibited an absorption maximum at 443 mμ which afterwards disappeared, the final solution having the same general absorption on the long-wave side of 400 mμ as neutral or alkaline solutions. At that time Wald was not able to follow the absorption curves on the short-wave side. It seems clear, however, that he regarded retinene$_1$ as the sole and final product of bleaching rhodopsin *in vitro.*

Lythgoe and his co-workers were also restricted to wave-lengths exceeding about 395 mμ in recording absorption spectra. They observed that in acidified aqueous digitonin rhodopsin gave on irradiation 'indicator yellow' with $\lambda_{\max.}$ 444 mμ. In neutral or alkaline solution no maxima (at wave-lengths greater than 395 mμ) were observed. Lythgoe concluded that indicator yellow was the final product of bleaching rhodopsin; he suggested that it was a conjugated protein with $\lambda_{\max.}$ 444 mμ shown only in acid.

A. C. Krause[6] obtained a fraction from bovine retinas which exhibited $\lambda_{\max.}$ 444 mμ in acidified ethanol and 360 mμ when the solution was made alkaline. Krause obtained his materials from freshly bleached retinas rather than from rhodopsin solutions, and his findings are not strictly comparable.

The work carried out in our laboratory confirms and extends the observations made by both Wald and Lythgoe. Thus in neutral solutions rhodopsin bleaches to a substance exhibiting $\lambda_{\max.}$ 380 mμ and on which extraction by means of an ethanol – light petroleum mixture yields retinene$_1$ ($\lambda_{\max.}$ 385 mμ in chloroform, 664 mμ with the Carr–Price reagent). In acid solution, bleached rhodopsin shows $\lambda_{\max.}$ 440 mμ, and in alkaline solution $\lambda_{\max.}$ *c.* 360 mμ. In neither case is any absorbing material extracted by means of ethanol – petroleum mixture provided the pH is sufficiently different from 7. The substance giving rise in acid to the 440 mμ maximum is unstable even in the dark, and the final product is devoid of selective absorption. No retinene$_1$ can be extracted at that stage even after neutralization.

Further experiments have been carried out using pure retinene$_1$ obtained[7] by the oxidation of vitamin A. When dissolved in 1 per cent aqueous digitonin, pure retinene shows $\lambda_{\max.}$ 380 mμ, and the spectrum is unaffected by changing the pH of the medium. If, however, retinene$_1$ dissolved in aqueous alcohol or 1 per cent digitonin is mixed with one of the following: (*a*) an aqueous extract of bleached retinas, (*b*) a dialysed aqueous extract of choroid, (*c*) a solution containing a suitable protein, or (*d*) a solution containing a suitable amino-acid, absorption maxima at 440–460 mμ appear on acidification, or at 360–380 mμ in alkaline solution. The following proteins gave a positive result: egg albumin, trypsin, edestin, peptone. Gelatin, casein, zein and pepsin gave negative results. Of all the amino-acids tried, only β-alanine gave $\lambda_{\text{max.}}$ 440 mμ in acid solution. Arginine, aniline, *o*-toluidine, *o*-phenetidine hydrochloride, *p*-toluidine, diphenylamine and *p*-aminobenzoic acid all gave maxima at 500–525 mμ in acid solution. The reaction with *p*-aminobenzoic acid is interesting because the product responsible for the 535 mμ maximum is decomposed by light, and the consequent decrease in absorption at 535 mμ is accompanied by a rise at 390 mμ. Some interaction occurred between retinene$_1$ and the following, but was not accompanied on acidification by such marked changes in absorption: *d-iso*leucine, glycine, tryptophane, tyrosine, glutamic acid. Little or no effect was obtained with α-alanine, benzoic acid, dimethylamine, benzylamine, serine, benzoxazolone, pyridoxine, riboflavin, leucoriboflavin, phenol.

The conclusion to be drawn concerning 'indicator yellow' is that free or loosely bound retinene$_1$ (the final product of bleaching rhodopsin) may combine with any suitable protein or amino-acid which may be available. In that case 'indicator yellow' would be a fortuitous artefact having no direct relevance to visual chemistry, and Wald's cycle[2] connecting vitamin A retinene and rhodopsin need not be complicated by trying to fit in 'indicator yellow'.

Granit and his colleagues have greatly advanced the study of visual processes by the use of the microelectrode for picking up electrical impulses from optic nerve fibres subserving illuminated rods and/or cones. By using monochromatic light and measuring threshold intensities needed to obtain responses from rods or cones, action spectra can be arrived at.

At this point it is necessary to emphasize the distinction between an action spectrum and an absorption spectrum (cf. Dartnell and Goodeve[8], Hecht[9], Wald[2]). Granit[4] makes clear the distinction between equal energy and equal quantum action spectra. If I_0 is the incident intensity and I the emergent intensity of light of wave-length λ passing through unit area of 'retina' containing n absorbing molecules, $\log_{10} I_0/I = kn$, k varying with λ. If I_a is the intensity of absorbed light $I_a/I_0 = 1 - 10^{-kn} = a$, that is, fraction of light absorbed, and

$$100\, a\, \lambda/a_{\text{max.}} = 100(1 - 10^{-kn})/(1 - 10^{-k'n}) = \alpha.$$

Putting D for $k'n$ ('optical density' at $\lambda_{\text{max.}}$) and E for $100\, kn/k'n$, $kn = ED/100$ and

$$\alpha = 100\ \frac{(1 - 10^{-ED/100})}{1 - 10^{-D}}, \text{ or}$$

$$E = \frac{100}{D} \log \left(\frac{1}{1 - \frac{\alpha}{100}(1 - 10^{-D})} \right).$$

Plotting α against λ gives the action spectrum, and E against λ the absorption spectrum, α being the light absorption of wave-length λ expressed as a percentage of the absorption at $\lambda_{\text{max.}}$ and E being the extinction expressed as a percentage of $E_{\text{max.}}$ (D). When D is small, $E \simeq \alpha$; but action spectra and absorption spectra are not identical at higher values of D, thus:

VALUES OF E FOR DIFFERENT VALUES OF α AND D

a	D					
	0·01	0·05	0·1	0·2	0·3	0·5
20	19·8	19·2	18·2	16·7	15·2	12·8
50	49·7	48·6	47·1	44·2	41·5	36·3
80	79·8	79·0	78·1	76·0	73·7	68·8

Although the differences between α and E are very unlikely to vitiate any of Granit's findings, they may well become significant when comparisons between absorption spectra *in vitro* and his action spectra are used to try to trace the origin of the latter.

Granit's data imply the existence of a scotopic dominator (substance), the action spectrum manifested agreeing closely with the absorption spectrum of rhodopsin. A photopic dominator (substance) and several modulators must also be postulated. The dominators function in the perception of brightness and the modulators in colour discrimination. Evidence suggesting a chemical relatedness of the substances responsible for both dominator and modulator spectra emerges from the comparison of the data on eyes in which vitamin A (rhodopsin, retinene$_1$) occurs, and eyes in which vitamin A$_2$ (porphyropsin, retinene$_2$) is present (ref. 4, p. 290). In the two systems, corresponding absorption spectra and action spectra show parallel displacements. Bliss[10] recently recorded the extraction of retinene$_1$ from a solution of the photopic pigment iodopsin. It thus seems probable that vitamin A and its aldehyde occupy a key position in photopic and scotopic vision alike.

The action spectra of Granit's dominators correspond closely with the absorption spectra of rhodopsin and 'iodopsin'[11,12], $\lambda_{\text{max.}}$ 500 mμ and 560 mμ respectively. His modulators would correspond with much narrower absorption bands which have not hitherto been accounted for chemically. It seems that at least three chemical species must be postulated with narrow absorption bands in the visible region; they must be derived from a precursor (or precursors) available in the retina and they must have very special properties. The readiness with which vitamin A and retinene give rise to deeply blue-coloured solutions with antimony trichloride in chloroform, and the sharpness of the bands shown, coupled with the transient nature of the blue materials, suggest that with suitable environmental conditions retinene might give rise to ionized or halochromic molecules[13] resembling Granit's modulators.

It has been found that when vitamin A or retinene$_1$ is dissolved in concentrated sulphuric acid or syrupy phosphoric acid at temperatures near 0° C., coloured solutions are produced which exhibit well-defined selective absorption with maxima corresponding rather closely with Granit's maxima.

The absorption bands of the solutions derived from vitamin A and retinene$_1$ are narrower than those implied by Granit's action spectra. The solutions are sensitive both to light and heat, and in the 'fading' processes the maxima fall at different rates, suggesting the presence, not of one product with several bands, but of several products with one maximum to each. Although light hastens the fading, the solutions are not nearly so sensitive to light as are rhodopsin solutions.

WAVE-LENGTHS OF MAXIMUM ABSORPTION $\lambda_{max.}$ IN mμ

Rhodopsin		500					
Iodopsin				560			
Dominators		500		560			
Modulators	450–465	500	520–530		580–610		
Vitamin A in conc. H_2SO_4	465		530		590		620*
Vitamin A in conc. H_3PO_4	440–480		520			600	
Retinene$_1$ in conc. H_2SO_4	440–460		520	560			664*
Retinene$_1$ in conc. H_3PO_4	470	500		550	590		

* Shown better with the antimony trichloride reagent.

The conditions under which modulator analogues have been produced are obviously unphysiological. In the complete absence, however, of evidence for modulator precursors other than vitamin A and retinene$_1$ in rhodopsin eyes, the potentialities of these substances need to be explored. If it be granted that a *prima facie* case has been made out, the next and more difficult task will be to establish the physiological methods for stabilizing the modulator analogues.

It may be suggested tentatively that the greater width of Granit's modulator curves compared with the absorption bands of the analogues is consistent with a greater optical density of the modulators in cones than of rhodopsin in dark-adapted rods. Since the optical density varies as the product of molecular extinction coefficient and concentration, either or both could be important. The large difference between the thresholds of scotopic and photopic vision is well established; the quantum efficiency of the photo-decomposition of rhodopsin is nearly unity, and the molecular extinction coefficients of the modulator analogues are very high, but the substances fade less quickly than rhodopsin. The quantum efficiency of photochemical decomposition of modulators should thus be very low.

The photopic receptor substances, presumably conjugated proteins, may then be present at cone surfaces at relatively high optical density; they must be relatively thermostable as otherwise there would be a spontaneous sensation of light[14]; and finally, once detached from the protein moiety, halochromic or ionized prosthetic grouping derived from vitamin A or retinene would yield materials known to be present in retinas.

The special difficulties which are met in the study of photopic receptors make it important to pursue the study of the porphyropsin–retinene$_2$–vitamin A_2 system, because comparison of the rhodopsin–porphyropsin systems at all stages may be fruitful. The visual systems of invertebrates having eyes lacking either vitamin A_1 or A_2 present a further problem.

[1] Boll, F., see ref. 4, p. 193.

[2] Wald, G., *J. Gen. Physiol.*, 21, 795 (1938).

[3] Lythgoe, R. J., *J. Physiol.*, 89, 331 (1937).

[4] Granit, R., "Sensory Mechanisms of the Retina" (London, 1947).

[5] Morton, R. A., and Goodwin, T. W., *Nature*, 153, 405 (1944).

[6] Krause, A. C., *Amer. J. Physiol.*, 140, 40 (1943).

[7] Ball, S., Morton, R. A., and Goodwin, T. W., *Biochem. J.*, 40, *Proc.* lix (1946).

[8] Dartnell, H. J., and Goodeve, C. F., *Nature*, 139, 409 (1937).

[9] Hecht, S., *Physiol. Rev.*, 17, 239 (1937).

[10] Bliss, A. F., *J. Gen. Physiol.*, 29, 299 (1946).

[11] Wald, G., *Nature*, 140, 545 (1937).

[12] Bliss, A. F., *J. Gen. Physiol.*, 29, 277 (1946).

[13] Meunier, P., and Vinet, A., "Chromatographie et Mesomerie" (Paris 1947).

[14] de Vries, Hl., *Nature*, 161, 63 (1948).

OBITUARY

Dr. A. L. Du Toit, F.R.S.

THE death of Alexander Logie Du Toit on February 25 has removed a particularly interesting figure from the stage of international geology. Born in South Africa on March 14, 1878, he received his early education at Bishop's College, Cape Town, whence he proceeded in turn to the Royal Technical College, Glasgow, and the Royal School of Mines, South Kensington. His connexion with Scotland is recalled by an important paper on Old Red Sandstone and Highland Border rocks, communicated to the Edinburgh Geological Society in 1902. Most of his researches, however, concern his home country, South Africa. At one time or another he held official positions on the Geological Survey and Irrigation Department of the Union; and later, in private practice, he acted for De Beers Consolidated Mines. In 1925 he led a government expedition to the Kalahari. His text-book, "The Geology of South Africa", published in Edinburgh in 1926, is indispensable to students of the subject, and includes welcome chapters on soil and economics.

In geology, as in astronomy, workers in the southern hemisphere have much that is special to tell their comrades of the north, because they look in a different direction. The southern continents, including India, are so closely comparable in their late Palæozoic and early Mesozoic histories that Suess long ago separated them from the rest of the world under the name Gondwanaland. In 1910, F. B. Taylor, and in 1912, A. Wegener, advocated continental drift on a scale that would account, without intervening subsidence, for the present apparently scattered distribution of the components of Gondwanaland. Du Toit had visited Australia by the time he learnt of the new hypothesis; and now, not content with further comparisons based on reading alone, he persuaded the Carnegie Institution of Washington to send him across to South America. Here, in Brazil, Uruguay and the Argentine, during the latter half of 1923, and with generous support from the local governments and geologists, he was able to accomplish a remarkable amount of field exploration, and to master the very difficult relevant literature. The results are set out in a Carnegie Institution publication entitled "A Geological Comparison of South America with South Africa" (1927). The treatment shows little mercy to readers, who have to stagger on under the impact of strange geographical and stratigraphical names; but the impression is conveyed that a path has been blazed through a hitherto impenetrable jungle. The author himself entertains no doubt as to the drift separation of South America and South Africa. He maintains the same outlook in "Our Wandering Continents" (1937), where a gallant attempt is made to rewrite the whole of world geology.

To turn to quite another aspect of the man, it is worth recording that among his friends Du Toit laid claim to the faculty of dowsing.

The Geological Society of London honoured Du Toit with the Wollaston Fund in 1919, and the Murchison Medal in 1933. These awards were fittingly bestowed during the presidencies of G. W. Lamplugh and Thomas Holland, who successively had learnt much of South African geology during visits of the British Association in 1905 and 1929. Du Toit was elected a fellow of the Royal Society in 1943.

E. B. BAILEY

NEWS and VIEWS

Czechoslovakia

WITHIN a few weeks of receiving the honorary doctorate of Brno University which bears his father's name, Dr. Jan Masaryk passed away at the age of sixty-one, on March 10, in tragic circumstances. Born and educated in Prague, he would not claim to have been a man of science, though he fully appreciated the importance of science in world affairs. He had occasionally taken part in scientific and cultural discussions and conferences while in Great Britain and elsewhere. Many philosophers and men prominent in various sciences were among his numerous friends, and he was always ready to help students and others whenever an opportunity occurred, whether it was in connexion with the exchange of scholarships or of scientific literature. Like his father, the former philosopher-president of Czechoslovakia, Jan Masaryk was a great European, and his death is a loss to the whole world as well as a very serious blow to Czechoslovakia at a critical time in her tragic history.

Prague is shortly to celebrate the sexcentenary of the founding of its famous university, and though Masaryk had no direct connexion with that institution his death cannot fail to cast a cloud over the ceremonies planned for this historic occasion. Unfortunately, too, recent events in Czechoslovakia have given rise to anxiety in Britain and elsewhere concerning the position and fate of several colleagues well known for their researches and other contributions to the advancement of knowledge. It is understood that some, including the rector of the Charles University, Dr. Karel Engliš, have been dismissed. Science and learning suffered heavily enough during the Nazi occupation through the closure of the universities and the execution of many members of their staffs, and to-day Czechoslovakia cannot afford to lose a single talented teacher or scientific worker. Masaryk certainly realized this. His attitude towards his fellows was one of encouragement and tolerance. It found expression, for example, when he was filling up an American immigration form and came to the question, "What Race?" His answer was, "I belong to the human race".

Prof. Bohumil Němec

PROF. BOHUMIL NĚMEC, the well-known botanist, celebrated his seventy-fifth anniversary in Prague on March 12, and we are glad to report that he was then in good health. He is at present engaged upon a comprehensive text-book of general botany in Slovak for use by students at Bratislava University and for upper forms in the Slovak high schools, and a history of botany which will have a wider appeal. Němec's first researches, on diplopods, appeared in the *Transactions of the Royal Bohemian Scientific Society* in 1895, and since then he has published many researches in plant physiology in Czech, English and other journals. Only recently he exhibited to scientific audiences in England and France specimens of gold that had been extracted from ashes of plants obtained from Slovakia. He has been interested in the occurrence in plants of unusual elements for many years. Němec is not only a great experimentalist and investigator but also an able lecturer, and many of his students have contributed to the advancement of pure and applied botany. Practically all Czechoslovakia's scientific forestry and agricultural experts studied under him at the Botanical Institute of the Charles University of Prague, which he directed for so many years. Since 1945 he has been occupied at the University of Bratislava in lecturing to Slovak students, and has advised on, and supervised, the establishment of botanical and physiological institutes in that University, which dates only from 1919.

Botany at Bedford College, London: Prof. L. J. Audus

DR. L. J. AUDUS, who has just been appointed to the Hildred Carlile chair of botany at Bedford College, London, is a distinguished member of the younger school of plant physiologists. He received his physiological training at Cambridge under the late Dr. F. F. Blackman, whose admirable tuition matured so many brilliant pupils. From Cambridge he went to University College, Cardiff, where he was lecturer in botany until he joined the Royal Air Force in 1941. He was stationed at Singapore, and when that city fell he escaped to Java, but was there captured by the Japanese. For three and a half years he was a prisoner in Java and Amboina, undergoing many hardships. During this period he collaborated with Dutch men of science who were fellow prisoners to organise an extremely resourceful manufacture of yeast-food, on a scale sufficient to keep vitamin starvation at bay and thus prevent what would otherwise have been a terrible mortality from beri-beri. Dr. Audus is no mean artist and the sketches he was able to bring home illustrate life in Japanese prison camps with dramatic clarity. On his return to Britain he was appointed to the Soil Metabolism Unit of the Agricultural Research Council, then situated at University College, Cardiff, under Dr. J. H. Quastel, and he was engaged in research on the action of growth-promoting substances in the soil. The Unit was closed at the end of 1947 with the departure of Dr. Quastel to Canada, and Dr. Audus had just been appointed as Monsanto lecturer in plant physiology at Cardiff when the opportunity of the appointment at Bedford College called him away. He goes accompanied by the regrets and best wishes of all his colleagues at Cardiff.

Max Planck Society for the Advancement of Scientific Research

THE Max Planck Society for the Advancement of Scientific Research was formed on February 26, with the approval of the Military Governments of the British and U.S. Zones of Germany. It will replace the Kaiser Wilhelm Society for the Advancement of Science which was dissolved in July 1946. The fact that the latter society had during the War come under the influences of the Nazi regime was one of the reasons for the order being given for its dissolution. The new Society, which will operate under the provisions of the Allied Control Council's law No. 25, relating to the control of scientific research, will have as its main object the encouragement of fundamental and independent research on peaceful lines. It will make it possible once more for the British and American Zones of Germany to be fully represented in the international field of scientific research. Otto Hahn, known for his fundamental research in nuclear fission, has been elected president, and Dr. Ernst Telschow, of Göttingen, who, since the end of the War, has played a leading part in maintaining scientific work in the U.S.–British

Zones, has been appointed general director. The following have been elected members of council: Prof. Edrich Retener, director of the Institute of Physics, Technical High School, Stuttgart; Prof. Adolf Windaus, formerly director of the Chemistry Institute, University of Göttingen; Dr. Wilhelm Boetzkef, Banking Boetzkef, banking director, of Düsseldorf; Prof. Georg Schrieber, professor of theology, University of Münster; Dr. Theo Goldschmidt, director of the chemical manufacturing firm in Essen bearing his name; Adolf Grimme, Minister for Education, Land Niedersachsen; Prof. Richard Kuhn, director of the Kaiser Wilhelm Institute for Medical Research, Heidelberg; Dr. Alfred Petersen, president of the Frankfurt Chamber of Commerce and Industry; Senator Landahl of Hamburg; and Prof. Heinrich Weiland, formerly director of the Institute of Chemistry, University of Munich. Prof. Hahn, Dr. Telschow and Prof. Max von Laue are *ex officio* members of council. In addition to the president and the general director, the following will constitute the administrative council: Prof. Retener (vice-president); Prof. von Laue (general secretary); Prof. Kuhn (deputy general secretary); Dr. Boetzkef (treasurer); and Dr. Petersen (deputy treasurer).

Serological Museum of Rutgers University

THERE has been established at Rutgers University, in New Jersey, a museum for the collection, preservation and study of the proteins of the blood and other tissues of the bodies of organisms, in the belief that such proteins are as characteristic as other constituents and are as worthy of preservation and comparison as skins and skeletons. The establishment of the Serological Museum is a logical consequence of the studies in systematic serology which have been conducted at Rutgers University since 1925, by Dr. Alan Boyden and his students and colleagues. Dr. Boyden has himself collected many representative samples of the blood sera of animals from laboratories in the United States and Great Britain, and others have been contributed by institutions and individuals; in recent years lyophilized (frozen and dried) samples of animal sera or of the purified fractions of such sera have been contributed by industrial laboratories. The principal objectives of the Serological Museum will be to preserve representative sera or other proteins of organisms and to study the means of improving methods of preservation; to build up a collection of sera and other proteins of as many kinds of organisms as possible; to share the samples collected with competent workers; and to study the methods used in systematic serology. Although the sera of hundreds of species of animals have already been collected, no group of animals is as yet adequately represented in the collection. The sera of many kinds of animals—vertebrate and invertebrate—are still needed. The growth of this Museum and its capacity for service will depend largely on co-operative efforts by many individuals and institutions. Those interested in the subject are invited to correspond with Dr. Alan Boyden, Rutgers University, New Brunswick, New Jersey, U.S.A.

Climatic and Ecological Changes in Northern Waters

AT the meeting of the North-Western Area Committee of the Conseil Permanent International pour l'Exploration de la Mer on October 22, 1947, the possible influence of the present climatic changes on the lives of marine animals (density, distribution, reproduction, migration, etc.) was discussed. Having regard to the probable importance of these changes in fisheries investigations, it was decided that every opportunity should be taken, by fishery research vessels and other suitable ships, to obtain without delay all possible data bearing upon this problem, especially in waters north of the Faroes, north and east of Iceland and in the Denmark and Davis Straits. It was also decided that relevant information from sources other than those of fisheries research would be of great value and should also be obtained. The information required comprises hydrographical, meteorological, glaciological and associated changes in northern regions, and the influence of those changes on the habits and distribution of animals and plants, both terrestrial and marine. Records should include locality (latitude and longitude), depth (if marine records), date, name and profession of observer, and references to relevant publications. Especially important are new records of animals and plants from localities recently included within their range of distribution, or the absence of species from previously populated areas. All data should be given exhaustively but concisely, and arranged so far as possible under the following headings: (1) meteorology; (2) hydrography; (3) glaciology; (4) animals: (*a*) Mammalia, (*b*) Aves, (*c*) Testudinata (especially observations on the west coasts of the British Isles), (*d*) Pisces, (*e*) Invertebrata; (5) plants; (6) other items. Contributions to this inquiry are earnestly requested from everyone in possession of useful information, and should be addressed to Dr. Å. Vedel Tåning, Charlottenlund Slot, Charlottenlund, Denmark, preferably during December of each year.

Science and Religion

FOR two hundred years, popular writers have attacked traditional religious beliefs in the name of science and pretty well undermined the faith of the plain man. Now, however, the sceptical attitude is turned against science itself, at a moment when, thanks to recent developments of physical theory, science appears vulnerable intellectually and, thanks to recent developments of military and political technique, still more vulnerable morally. Modern men, finding themselves with nothing to put their faith in, fill the spiritual vacuum with bogus religion based on bogus science, like Nazism and Communism. Even the more modest alternative, the assurance that all problems are technological and that the salvation of mankind depends on bigger and better gadgets, is not entirely satisfactory. The new quarterly magazine, *Science and Religion* (edited by Dr. Robert E. D. Clark, Paternoster Press, Ludgate House, Fleet Street, London, E.C.4. 1*s*. 6*d*. per copy), is intended, as the editor says, "to make science cultural; to show how science may strengthen religious belief instead of being allowed to develop independently and unconnected with our deepest needs". It is intended for the general public and particularly the young who learn something about science at school and are eager to know more. The articles in the first two numbers are excellently designed for their purpose. They are short, simply written and informative. Many of them are reviews of recent important books. The subjects include chemistry, biology, anthropology, psychology on the more purely scientific side, also historical and philosophical work. If the present standard can be maintained, the venture deserves to be a success.

Incentives in Industry

The perennial problem of incentives in industry has recently been considered by Prof. C. H. Mace (*Occupational Psych.*, 22, No. 1; January 1948). After agreeing with a recent statement of Nigel Balchin's that the main satisfaction in work will come from making it as enticing as possible, Mace then suggests that an alternative satisfaction will come from making work obligatory, although, as he repeatedly states, all work is complexly motivated. The appeal to obligation is based on the belief that there are, in human nature, forces that impel a man to perform tasks that he finds unpleasant and which he is under no compulsion to perform. In times of crisis the 'emergency response' of the emotions will produce effects but only by a draft on reserves, and Mace suggests that to maintain the will to work at an optimum level will depend upon long-term sources of human motivation. In the professions and the skilled crafts a dominating motive which compels people to stick to their jobs is because they must. They depend upon something being expected of them and upon the sustaining influence of someone's valuation. In jobs which contain little of inherent interest Mace indicates that there should be a more effective use of social pressures by placing responsibility not exclusively on the individual but on the working groups; that is, instead of controlling human energies from above or from within, control should be from around. Scientific study of these problems would afford a new approach to the problem of incentives.

Potato Blight and the Weather in Britain

It would be of considerable advantage if initial outbreaks of potato blight could be forecast with accuracy. This would allow timely application of protective sprays, the value of which is directly proportional to the earliness of effective application. Van Everdingen in Holland has suggested conditions which would herald the first attack by blight, and A. Beaumont has investigated their application to Devon and South Cornwall (*Trans. Brit. Mycol. Soc.*, **31**, Parts 1 and 2; July 1947). The Dutch rules indicated blight in south-west England rather earlier than it appeared, and it has been found that revised conditions gave more accurate forecasts. The conditions are: (1) minimum temperature not less than 50° F., and (2) relative humidity more than 75 per cent for two consecutive days. Mr. Beaumont's suggestions have been available in summary form for some time, and have been tried in other areas. They have given useful forecasts; but in some northern areas of Britain it seems necessary to neglect the earliest forecasts of the season, presumably because blight spores may not be present.

British Museum (Natural History)

A series of exhibits illustrating the "Succession of Life through Geological Time", from the origin of life perhaps a thousand million years ago to the emergence of man within the last million years, has just been opened to the public in one of the geological galleries of the British Museum (Natural History). Each geological period is represented by a small selection of the fossil remains of plants and animals which lived in those times, showing how fossils reflect past conditions, and how the various forms of life developed and reacted on one another in slowly changing environments. The great amount of war damage still to be repaired will make it impossible to open all the geological galleries to the public for some time to come; and in the meantime this new series of exhibits will serve as a general introduction to the study of fossils.

Photocopies of French Scientific Periodicals

It has already been announced that a small French scientific library had been opened at the Institut Français du Royaume-Uni, and arrangements made to obtain on loan microfilms of articles from periodicals not available in the library (see *Nature*, November 15, 1947, p. 669). Since many requests have been received for photocopies in preference to microfilms, the Cultural Counsellor to the French Embassy, with the help of the British Exchange Control, has now arranged a scheme for obtaining microfilm enlargements from France against payment in sterling. Charges will vary according to the size of the enlargement, but for the average periodical page-size (18 cm. × 24 cm.) will be about 1*s.* 4*d.* a page, plus a small charge for postage. All requests for photocopies should be addressed, not to the Institut Français, but to the General Secretary, French Scientific Office, 58 Knightsbridge, London, S.W.1, from whom further details can be obtained.

Frank B. Jewett Fellowships: Awards for 1948–49

The American Telephone and Telegraph Company has awarded Frank B. Jewett fellowships for 1948–49 for research in the physical sciences to the following: Dr. Warren J. Brehm, at present investigating the possible synthesis of lysergic acid at Harvard University; Dr. Ernest M. Grunwald, for the study of the activity of non-electrolytes in certain solvents; Dr. Leon A. Henkin, instructor in mathematics at Princeton University, for research in the application of mathematical logic to the sciences; James A. Jenkins, for research related to topological mapping problems; Robert Karplus, for work on nuclear research at the Institute for Advanced Studies, Princeton; Alvin I. Kosak, research fellow in the chemistry department, Ohio State University, for research in organic chemistry at Harvard University; Dr. Joaquin M. Luttinger, for work on the theory of the superconductive state; Dr. Paul Olum, who received a Frank B. Jewett fellowship for 1947–48, to continue his work in algebraic topology; Richard N. Thomas, for the study of superthermic phenomena in stellar atmospheres.

British Commonwealth Entomological Conference

The Fifth Commonwealth Entomological Conference is to be held in London during July 22–30. There will be several open meetings at which the following subjects will be discussed: (1) insecticides, including recent developments, mode of action, uses and limitations in the field, mechanical appliances, and application from the air; (2) biological control of insects and weeds; (3) estimation of insect populations in the field; (4) recent developments in the control of insects in stored products; (5) tsetse research; (6) Continental quarantine; (7) locusts and grasshoppers. Programmes will be available in due course on application to the Director, Commonwealth Institute of Entomology, 41 Queen's Gate, London, S.W.7.

Congress of Genetics

A Congress of Genetics is to be held at the Centro di Genetica (Istituto Lazzaro Spallanzani), Pavia, during April 2–4. The first two days of the Congress will be devoted to discussions on work carried out at the Centre on cytogenetics and physicopathology respectively; discussions will also be held on general biological problems such as the relationships between embryology and genetics, genetics and chemical biology, physicopathology and genetics and genetics and systematics. The third day will be devoted to a study of genetics in relation to entomology; it is hoped that entomologists will take part in this Congress as well as geneticists and general biologists. Accommodation will be available at the halls of residence of the University of Pavia. Particulars of the Congress can be obtained from Prof. Carlo Jucci, Centro di Genetica (Istituto Lazzaro Spallanzani), Pavia.

Physical Society: Annual Summer Meeting

The annual summer meeting of the Physical Society will be held in Oxford during July 23–24. The main subject will be "Microwave Spectroscopy", including nuclear resonance. In addition, time will be reserved for a discussion on "Helium 3" and other items of topical interest. The Clarendon Laboratory will be open to visitors throughout July 24. Among the speakers will be Dr. B. Bleaney (Oxford), Dr. N. Bloembergen (Leyden), Dr. R. M. Bozorth (Bell Telephone Laboratories), Prof. J. G. Daunt (Ohio State University), Prof. C. J. Gorter (Leyden), Dr. J. H. E. Griffiths (Oxford), Prof. A. G. Hill (Massachusetts Institute of Technology), Dr. C. Kittel (Bell Telephone Laboratories), Prof. R. V. Pound (Harvard), Prof. M. H. L. Pryce (Oxford), Dr. B. V. Rollin (Oxford), Prof. J. C. Slater (Massachusetts Institute of Technology), Prof. J. H. Van Vleck (Harvard). Those wishing to contribute to the Conference discussion should communicate with Prof. F. E. Simon at the Clarendon Laboratory, Oxford. Non-members of the Physical Society wishing to attend should write for further information before April 1 to the Secretary/Editor, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Congress of Universities of the British Empire

The annual Congress of Universities of the British Empire will be held at Oxford during July 19–23, and a provisional programme has been issued. The topics for discussion include relationship of the State and the universities; inter-university relations; the balance of research and teaching at universities; structural and moral changes produced in modern society by scientific and technological advance; general plans for Colonial higher education; and the extension of the University Secondment Scheme. Further particulars can be obtained from the Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1.

University of London: Appointments

The following appointments in the University of London have been announced: Mr. K. de B. Codrington, keeper in the Indian Section of the Victoria and Albert Museum since 1935, to the University chair of Indian archæology tenable at the Institute of Archæology and at the School of Oriental and African Studies; Prof. E. D. Hughes, professor of chemistry at the University College of North Wales, Bangor, to the University chair of chemistry tenable at University College as from October 1; Mr. Gordon Manley, University lecturer in geography at Cambridge, to the University chair of geography tenable at Bedford College as from October 1.

Special Librarianship

A Study Group on Special Librarianship is being arranged by the Association of Special Libraries and Information Bureaux and will be held at the Library Association, Chaucer House, Malet Place, W.C.1, during April 13–17. The general theme will be "The Compilation of Information in Special Libraries", and the course is designed to help students who have recently started work in such libraries. The programme includes visits to special libraries in London, and lectures by Mr. B. Fullman, information officer of the British Non-Ferrous Metals Research Association; Mr. H. S. Hyland, of the House of Commons Library; Miss A. M. Goodwin, Economic Information Unit of the Treasury; and Dr. W. E. Batten, of I.C.I., Ltd., Plastics Division. Further particulars can be obtained from the Association of Special Libraries and Information Bureaux, 52 Bloomsbury Street, London, W.C.1.

Announcements

The Geographic Society of Sweden has awarded its Vega Medal to Admiral Richard Byrd. This Medal, named after the Swedish *Vega* expedition which, with the Swedish explorer Adolf Erik Nordenskjöld as leader, was the first to sail through the North-East Passage in 1878–80, is awarded annually in recognition of prominent achievements in the field of exploration.

The Manchester and District Branch of the Institute of Physics is arranging a conference, to be held in the Physics Department of the University of Manchester during July 8–10, on "Semiconductors and their Applications". Communications regarding the conference should be sent to Dr. F. A. Vick, Physics Department, University, Manchester 13.

A Conference is being arranged by the Northern Branch of the Association of Special Libraries and Information Bureaux in Leeds during April 2–3. Dr. E. Semister, director of research, Kirkstall Forge, Ltd., will address the opening session on "Research and Information Services for the Metallurgical Engineer and the City Librarian", and Mr. F. C. B. Hutchings will speak on "Training and Practice in Special Librarianship" at the following session; there will be a civic reception in the evening. The morning session on April 3 will be addressed by Mr. Hugh Gaitskell, Minister of Fuel and Power. Visits to the Wool Industries Research Association and the Central Research Department of Brotherton and Co., or to Temple Newsam, complete the programme.

The Ministry of Agriculture and Fisheries invites applications for ten senior scholarships, tenable at university departments of agriculture, or agricultural colleges, for degree or diploma courses in an agricultural subject, or at veterinary colleges for courses in veterinary science; six extended junior scholarships (for those who have already held junior awards), and sixty junior scholarships, tenable at farm institutes or similar institutions, for courses not exceeding one year in duration, in agriculture, horticulture, dairying or poultry husbandry. The scholarships are open to the sons and daughters of agricultural workers and to *bona fide* workers in agriculture. Forms of application, to be returned by April 30, can be obtained from the Secretary of the Ministry, Block 4, Bickenhall Mansions, Baker Street, London, W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

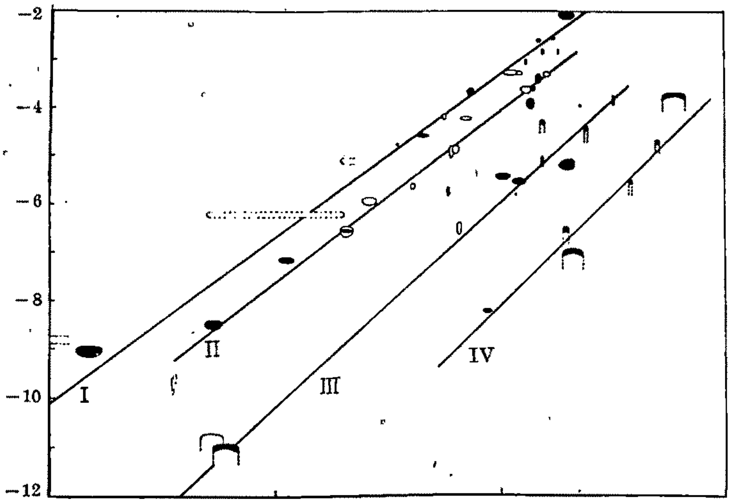
A Revised Sargent Diagram

IN 1938 Dr. Bretscher and I[1] published a Sargent diagram for the 'natural' β-active bodies in a form in which the degree of uncertainty arising from the incomplete state of knowledge at the time was clearly exhibited, and certain 'unobserved' transitions were also represented as in an earlier diagram of Gamow and Teller[2].

Since our first diagram was published, much work has been done on the β-particle spectra of the classical radioelements and many of the previous uncertainties have been resolved; also a great deal of information concerning 'artificially produced' heavy species has accumulated in the interim[3]. Furthermore, various attempts have been made to construct Sargent diagrams covering the whole range of known β-active bodies, both 'heavy' and 'light'[4].

The present note is concerned with the restricted topic of the diagram appropriate to the range of Z (atomic number) from 81 to 93, inclusive: this diagram, containing the newly available information and with outstanding uncertainties represented as before, is given in the accompanying figure. 'Points' are plotted for fifty β-transitions, forty-one 'observed' and nine 'unobserved'. No detailed information is available for possible β-active species with $Z = 86$, 85 or 84, thus the points belong to two groups in Z: twenty-three are for $93 \geqslant Z \geqslant 87$ and twenty-seven for the narrower group having $83 \geqslant Z \geqslant 81$. Of the unobserved transitions, five belong to the group of lower, and four to the group of higher, Z. Points for species with A (mass number) odd are represented by open uncertainty loops; those for species with A even by full loops in the diagram.

Traditionally, two well-defined 'lines' have been recognized on a diagram such as we are discussing, and evidence for lines of higher order has been deduced from the unobserved transitions[2]. Moreover, in recent discussions it has generally been assumed that the well-defined lines correspond to disintegration transitions which are 'allowed' or 'once-forbidden' according to the selection rules of Gamow and Teller[2]. These lines are the lines labelled I and III in the present diagram. A significant fact emerges, however, in that the revised diagram shows quite clearly the presence of another line (II), intermediate between the two lines already recognized, and nearer to the allowed (I) than to the original once-forbidden (III) line. The interpretation of this new line is a matter of interest.



SARGENT DIAGRAM, $80 < Z < 94$. λ IN SEC.$^{-1}$; E IN MEV.

In the first place the suggestion was examined that a doubling of the allowed line was involved, corresponding to the two Z groups of the diagram. This suggestion was rejected after an analysis of the distribution of points on the lines: of the 'points' overlapping line I, four belong to the higher Z group and three to the lower; for line II the corresponding ratio is 4 to 5. Also the separation of the lines ($\Delta \log_{10}\lambda$, $0{\cdot}75$–$1{\cdot}1$) is markedly greater than the separation calculated on the Fermi theory for the extreme values of Z in question. This calculated separation (Z, 93–81) is practically constant ($\Delta \log_{10}\lambda$, $0{\cdot}3$) over the whole energy-range from $0{\cdot}3$ to 3 MeV.

It was therefore assumed, tentatively at least, that a revision of the assignment of orders of forbiddenness was required, the new line (II) representing once-forbidden and line III twice-forbidden transitions according to the Gamow–Teller rules. This revision brings certain definite advantages. Here it will be sufficient to mention the β-disintegration of radium E, which now becomes twice-forbidden. Hitherto, it has been difficult to explain the form of the energy spectrum in this case on the assumption that the transition is once-forbidden only[5]. Other cases will be discussed in greater detail in due course[6].

While the reassignment of order, above described, is definitely put forward as the most probable interpretation of the revised diagram, one further possibility should be mentioned. Itoh[4] has directed attention to a feature of the Sargent diagram for the lightest of the artificially radioactive species (positron- and electron-active) which in its empirical aspect is entirely similar to the feature discussed here. He distinguishes four lines on this diagram at the following intervals of $\log_{10}\lambda$, namely, $\Delta \log_{10}\lambda \sim 1{\cdot}5, 2{\cdot}4, 2{\cdot}5$, respectively. It might appear tempting to identify this structure with the structure of the diagram given in this note. But Itoh gives reasons for supposing that his first line represents 'super-allowed transitions' in respect of the Gamow–Teller classification—or, in the sense of the Wigner[7] theory of the symmetry properties of nuclear states, the only 'truly allowed' transitions, those involving initial and final states belonging to the same symmetry multiplet. Such transitions, according to this theory, would not be expected except when the change in isotopic number in the transition is $(1) \leftrightarrow (-1)$, or in certain cases $(2) \leftrightarrow (0)$, and this condition limits present knowledge of transitions of this type to the mass range $A < 43$.

A final point might be made in this preliminary discussion. It is that there is a very noticeable concentration of the points for A odd on the Sargent lines I and II. Out of eighteen points for A odd, only two fall significantly below line II, whereas there are eighteen points for A even below this line. Similarly, all the points on or below line IV (five 'unobserved' points and the representative point for the 3·5yr. $^{204}_{81}$Tl) are for A even (and Z odd). It would appear that very frequently there is a large difference of spin between the ground-states of initial and final nuclei in these latter cases. This conclusion is not surprising when it is realized that the neutron and proton numbers change from the $\begin{pmatrix}\text{odd}\\\text{odd}\end{pmatrix}$ to the $\begin{pmatrix}\text{even}\\\text{even}\end{pmatrix}$ configuration in such transitions.

N. FEATHER

Department of Natural Philosophy,
University of Edinburgh.
Dec. 18.

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[1] *Proc. Roy. Soc.*, A, **165**, 530 (1938).

[2] *Phys. Rev.*, **49**, 895 (1936).

[3] See, for example, Fajans and Voigt, *Phys. Rev.*, **60**, 619 (1941). Maurer and Ramm, *Z. Phys.*, **119**, 602 (1942). Hagemann *et al.*, *Phys. Rev.*, **72**, 252 (1947). English *et al.*, *Phys. Rev.*, **72**, 253 (1947).

[4] See, for example, Kojima, *Proc. Phys. Math. Soc. Japan*, **22**, 384 (1940). Itoh, *ibid.*, 531.

[5] Konopinski, *Rev. Mod. Phys.*, **15**, 209 (1943).

[6] "Nuclear Selection Rules" (Camb. Univ. Press, in preparation). Feather and Richardson (in course of publication).

[7] *Phys. Rev.*, **56**, 519 (1939).

Electron Tracks in Photographic Emulsions

PHOTOGRAPHIC emulsions have been used to an increasing extent for the recording of nuclear tracks passing through the sensitive layer, in particular by Dr. C. F. Powell and his collaborators[1], and by Demers[2]. Particles of relatively high ionizing power such as alpha-particles and protons give well-defined tracks; those of lesser ionizing power, such as mesons, yield rather tenuous tracks; while electrons do not as a rule produce recognizable tracks in the emulsions available so far, although Demers[2] claims to have seen electron tracks on one of his emulsions.

A new emulsion has recently been evolved in the Kodak Research Laboratories which is sufficiently sensitive to enable electron tracks to be recorded unmistakably.

The emulsion was tested for proton sensitivity by bombardment with neutrons from a radium – beryllium source, with a 17-cm. thickness of lead interposed between the plates and the source to diminish the gamma-ray intensity incident on the sensitive material. Microscopical examination of the plates after processing showed that the background to the proton tracks was of a much more heterogeneous nature than was obtained with exposures to a pure alpha-ray emitter, for example, polonium.

Under high magnification, this heterogeneous background was seen to consist of numerous fairly short, highly curved chains of developed grains. It is believed that these are the low-energy ends of tracks due to photo-electrons and recoil electrons liberated by gamma-rays. Electrons, being particles of low mass and low ionizing power, might be expected to produce just such types of tracks in a photographic emulsion, which remind one strongly of similar tracks obtained in a cloud chamber.

Since they are highly curved, very few of these tracks are in one plane, and satisfactory photomicrographs are therefore difficult to obtain. Figs. 1 and 2 are photomicrographs (× 2,000) showing the type of track obtained. Fig. 3 is a photomicrograph at the same magnification of a plate exposed to light to give approximately the same average grain density as the gamma-ray exposure.

I should like to acknowledge the co-operation of Mr. D. H. Perkins of the Imperial College of Science and Technology, London, and my colleagues in this Laboratory in the evolution of this emulsion.

R. W. BERRIMAN

Research Laboratory, Kodak, Ltd.,
Wealdstone,
Middlesex.
Dec. 3.

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[1] Powell, Occhialini, Livesey and Chilton, *J. Sci. Instr.*, **23**, 102 (1946).

[2] Demers, *Can. J. Res.*, **25**, 223 (1947).

Fig. 1

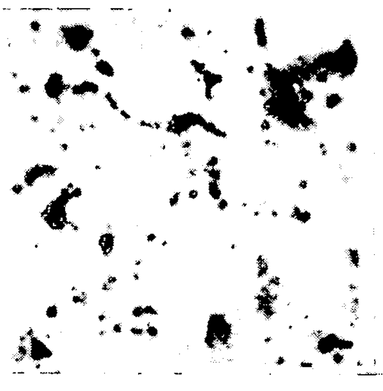


Fig. 2

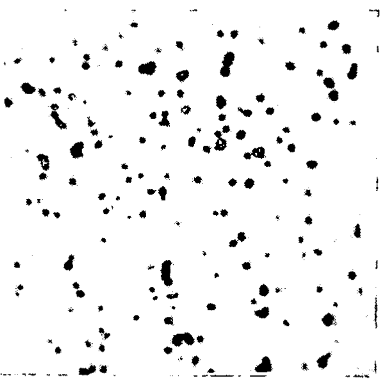
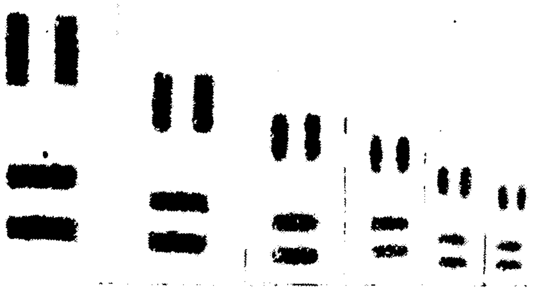


Fig. 3

Resolution Testing in Autoradiography

THE resolution obtainable in autoradiographs has so far been estimated[1] by the sharpness obtainable when photographic emulsions are exposed in contact with biological sections in which radioactive isotopes have been deposited by biochemical processes. The distribution of the radioactive isotope will, however, vary from one specimen to another, and T. C. Evans[2] points out that even successive sections from the same specimen will not be absolutely identical. Strict comparisons of the resolution given by different techniques or photographic emulsions are thus most difficult to make.

Preliminary tests showed that a photographic silver image on a material such as the Kodak Maximum Resolution plate could be converted successively to silver bromide and silver iodide and still give a line separation of 0·5 μ. These reactions can therefore be used to give a deposit of I^{131} with any required distribution, thus forming a radioactive test chart. Such test charts were made by applying about 0·01 c.c. of a solution of I^{131} (supplied by the Medical Research Council) to an area 2 mm. × 2 mm. of the emulsion surface containing a resolution test image which had previously been converted to silver bromide. Fig. 1 shows a photomicrograph of some of the units of the original test chart image, the units from *A* to *F* representing line separations of respectively 4·5 μ, 3·7 μ, 3·0 μ, 2·5 μ, 2·0 μ and 1·7 μ. After washing and drying, a 4-μ thick coating of a highly concentrated 'fine-grain emulsion, prepared in these laboratories for the recording of nuclear tracks[3], was transferred to the surface of the test chart, as described by S. R. Pelc[1]. After the 'exposure', the emulsion-coated test chart was soaked in water for a few minutes, and the emulsion layer was processed in the stripped condition. Fig. 2 shows the autoradiograph images corresponding to Fig. 1. In the original autoradiograph it is apparent that useful resolution is obtained with 2·5 μ (*D*) and perhaps even with 2·0 μ (*E*) separation, but not with 1·7 μ (*F*).



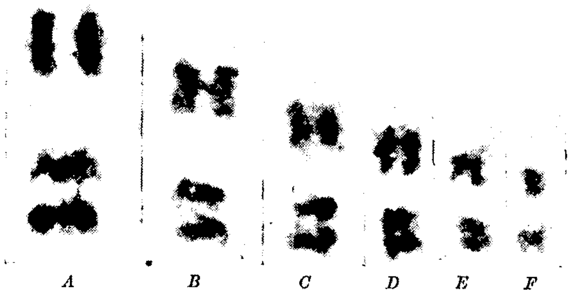


Fig. 1 (above). PHOTOMICROGRAPH (× 700) OF IMAGE FROM ORIGINAL TEST CARD
Fig. 2. IMAGES OF AUTORADIOGRAPH (× 700) CORRESPONDING TO FIG. 1

It would seem that such test charts could be employed for systematically estimating the relative importance of the various emulsion and geometrical factors influencing the resolution of autoradiographs. They might also be used for comparing the effect of electrons of varying energy given by different isotopes. Another possibility is the production of test charts made from microphotographic replicas of tissue sections to aid in the interpretation of autoradiographs made from biological material.

G. W. W. STEVENS

Research Laboratory,
Kodak, Ltd.,
Wealdstone,
Middlesex.
Nov. 21.

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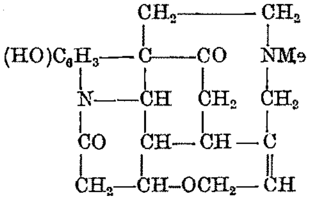
[1] Pelc, S. R., *Nature* [160, 749 (1947)].
[2] Evans, T. C., *Radiology*, 49, 206 (1947).
[3] Berriman, R. W., *Nature* [preceding letter].

Relation of Vomicine to Strychnine and Brucine

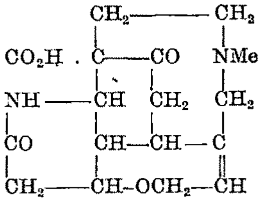
VOMICINE, $C_{22}H_{24}O_4N_2$, a congener of strychnine, $C_{21}H_{22}O_2N_2$, has been investigated by Wieland and his collaborators; but no precise connexion between the alkaloids has yet been disclosed, though many reactions and transformations suggest the close similarity of their molecular structure. On oxidation with chromic acid[1], vomicine yields an acid, $C_{17}H_{22}O_5N_2$, $3H_2O$, which characteristically loses carbon dioxide at 130°, affording a base, $C_{16}H_{22}O_3N_2$. We have now found that the same acid can be obtained by oxidation of N-methyl-*sec*-pseudostrychnine, or better, N-methyl-*sec*-pseudobrucine, by means of chromic acid. The identity has not yet been confirmed by direct comparison*; but there can be little doubt of it from the analyses ($3H_2O$), rotatory power, melting points, and behaviour on heating. The resulting base has the composition, melting point and crystalline form recorded for the product from vomicine.

This result establishes that vomicine is to an *ar*-hydroxystrychnine as N-methyl-*sec*-pseudostrychnine is to strychnine. The probability of this outcome was suggested in a letter from one of us to Prof. Wieland in 1939, and the theory has been mentioned on several occasions since that time. The proof of it which is now available enables us to make use of other aspects of vomicine chemistry, which become directly applicable to the strychnine problem.

Thus the ready formation of the base, $C_{16}H_{22}O_3N_2$, already mentioned, is a clear indication of the site of a carbonyl group in N-methyl-*sec*-pseudostrychnine, and affords strong support to the formulæ advanced on other grounds. In illustration, (I) and (II) represent vomicine and the acid $C_{17}H_{22}O_5N_2$, respectively; (II) is seen to be a β-keto-acid, probably stabilized as $CO_2^- - \ddot{C} - \dot{C}(OH) - \dot{N}Me^+$.



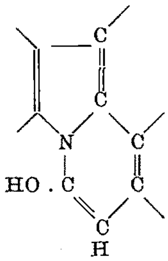
(I)



(II)

The formation of such a betaine is doubtless facilitated by the cyclization which it implies, and explains why (II) is capable of existence under the conditions of its manipulation.

R. B. Woodward and his collaborators[2] have recently suggested, on the basis of ultra-violet spectra, that Leuchs' 'strychnone' obtained by the action of hydrogen peroxide on pseudostrychnine is a true indole derivative. We have reached the same conclusion by a study of the brucones[3]. These have the composition of oxobrucines; the isomeride, m.p. 310°, is a by-product in the preparation of pseudo-brucine; that of m.p. 180° is obtained by action of hydrogen peroxide on pseudobrucine. The former shows normal brucine reactions and probably contains : $N(b).CO{-}\overset{|}{C}{=}CH{-}$, but the latter (m.p. 180°) exhibits



(III)

a unique series of colour reactions and is probably an aromatic indole. It is the only brucine derivative we have encountered which does not give a related cacotheline on treatment with nitric acid. The product, described by Leuchs *et al.*[3] as such, is actually a simple nitro-derivative which has also suffered hydrolysis of : N . CO —, probably : N(*a*) . CO ., to : NH CO$_2$H . .

The intense green fluorescence and yellow-coloured solutions often obtained from strychnine derivatives (and easily from the above brucone) by the action of alcoholic alkalis is attributed to the formation of the structure (III).

A. S. Bailey
R. Robinson
Dyson Perrins Laboratory, University,
Oxford. Jan. 16.

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* *Added March* 13. Thanks to the courtesy of Prof. H. Wieland, the direct comparison of the base $C_{19}H_{22}O_3N_2$ from brucine and vomicine has now confirmed the identity.

[1] Wieland, *Annalen*, **469**, 193 (1929); **491**, 133 (1931).

[2] Nelson, Brehm and Woodward, *J. Amer. Chem. Soc.*, **69**, 2250 (1947).

[3] Leuchs, Tuschen and Mengelberg, *Ber.*, **77**, 403 (1944).

The *C*/*D* Ring Union in Œstrone and Equilenin

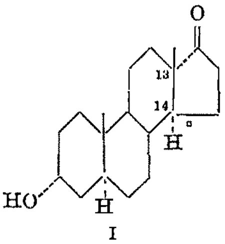
The method of molecular rotation differences which has been applied to other steroid structural problems by Barton[1] throws some light on the nature of the *C*/*D* ring union in œstrone and equilenin recently discussed by Shoppee[2,3] and by Heer and Miescher[4,5]. The evidence thus obtained, which is given below, when combined with that collected by Shoppee[3], indicates that (+)-equilenin and probably (+)-œstrone have the same configuration at the *C*/*D* ring union as the androgens, bile acids and sterols. The data available are few, and the conclusions are therefore drawn with reserve.

Configuration at C$_{13}$. Butenandt and co-workers[6,7] obtained by irradiation of (+)-œstrone and androsterone *lumi*-compounds, which are epimeric at C$_{13}$ with the starting materials. The molecular rotations (M_D) of these compounds and the differences (Δ) between them are as follows (all rotations given in this letter were measured at *c.* 20° for the sodium *D* line except that marked *, which is for 5461 A.):

A = ETHANOL, *C* = CHLOROFORM, *D* = DIOXAN

	Solvent	M_D (Natural)	M_D (*Lumi*)	Δ (*Lumi*—natural)	Refs.
Androsterone	*A*	+275	−290	−565	7,8
Œstrone	*D*	+458	−116	−574	6,9
Œstrone methyl ether	*C*	+486*	−80	−566	6,10

Clearly the change in configuration from 'natural' (+)-œstrone to *lumi*-œstrone is the same as that from 'natural' androsterone to *lumi*-androsterone; 'natural' (+)-œstrone therefore has the same configuration at C$_{13}$ as 'natural' androsterone [I] and all the other 'normal' steroids which are related to it. The work cited by Shoppee[3] shows conclusively that (+)-œstrone and (+)-equilenin have the same configuration at C$_{13}$; (+)-equilenin is therefore a 13-*n* compound.



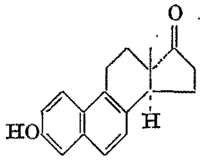
I

Configuration at C$_{14}$. Recent work by Plattner, Ruzicka, Heusser, Pataki and Meier[11] on 14-*iso* compounds permits the calculation of $\Delta_{14} = M_D(14\text{-}iso) - M_D(14\text{-}n)$.

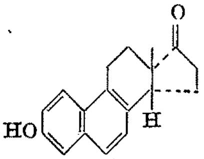
	Solvent	M_D (14-*n*)	M_D (14-*iso*)	Δ_{11}	Refs.
17-*iso*-*allo*-ætio-cholanic acid methyl ester	*D*	−130	+83	+213	11,12
3(*β*)-acetoxy-17-*iso*-ætio-cholanic acid methyl ester	*C*	−105	+109	+214	11,13

The molecular rotations of the four equilenins (in dioxan) are as follow[14]:

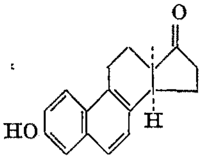
(+)-*iso*-equilenin	+391	(−)-*iso*-equilenin	−391
(+)-equilenin	+224	(−)-equilenin	−224



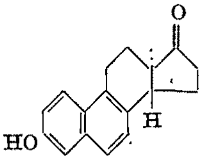
II. 13-*n*, 14-*n*



III. 13-*n*, 14-*iso*



IV. 13-*iso*, 14-*n*



V. 13-*iso*, 14-*iso*

These four compounds must between them have the formulæ II–V. From the evidence given above (+)-equilenin must be II or III. Four hypotheses can be made and tested by the molecular rotation difference method, namely:

A (+)-equilenin is II; (+)-*iso*-equilenin is III.
B ,, ,, II; ,, IV.
C ,, ,, III; ,, II.
D ,, ,, III; ,, V.

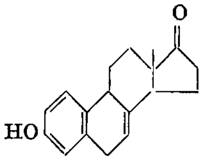
The Δ-values found above for compounds of known structure, and those calculated from the rotations of the equilenins on each of these hypotheses, are given in the following table.

		Δ_{13}	Δ_{14}
Found for compounds of known structure		−565	+214
Calculated from equilenins; hypothesis	*A*	−615	+167
,, ,, ,, ,,	*B*	+167	−615
,, ,, ,, ,,	*C*	−615	−167
,, ,, ,, ,,	*D*	+167	+615

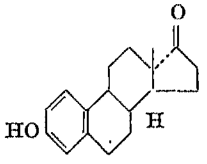
Clearly the only tenable hypothesis is *A*. Thus (+)-equilenin has the formula II, with the same *trans* *C*/*D* ring union as is present in the androgens, bile acids and sterols.

(+)-*iso*-Equilenin is therefore 14-*iso*-equilenin [III]. Chemical evidence for the correspondence of (+)-equilenin and (+)-*iso*-equilenin at C$_{13}$ is also available; (+)-equilin [VI] was converted by Dirscherl and Hanusch[15] into (+)-equilenin and indirectly into (+)-*iso*-equilenin by Hirschmann and Wintersteiner[16] in conditions in which epimerization at C$_{13}$ was most unlikely.

The evidence cited by Shoppee[3] for the stereochemical correspondence of (+)-œstrone and (+)-equilenin is not quite as convincing for C$_{14}$ as it is for C$_{13}$, since epimerization at C$_{14}$ might perhaps have occurred during the dehydrogenation of (+)-equilin [VI].



VI



VII

It is, however, very probable that (+)-œstrone has the 'normal' *trans C/D* ring union as shown in VII.

I have studied the molecular rotations of the doisynolic and marrianolic acids and of their bis-dehydroderivatives[4,5,17] in the hope of obtaining some evidence as to their configurations. The results give no indication in favour of any of the possibilities discussed by Shoppee[2] or by Heer and Miescher[4,5], and show the need for restraint in applying the method of molecular rotation differences, valuable though it is in dealing with certain groups of closely related substances. However, the evidence for a *trans C/D* ring union in (+)-œstrone and (+)-equilenin given in Shoppee's letter[3] and the present communication strongly supports the scheme outlined by Heer and Miescher[5] (at p. 553).

I am indebted to Dr. C. W. Shoppee for sending me a copy of his letter[3] before publication.

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[1] Barton, D. H. R., *J. Chem. Soc.*, 813 (1945); 512, 1116 (1946).

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p-Aminosalicylic Acid in the Treatment of Tuberculosis

The preliminary communication of Lehmann[1] on the treatment of human tuberculosis with *p*-aminosalicylic acid led us to undertake a detailed study of this acid. *p*-Aminosalicylic acid[2] is obtained by the reduction of *p*-nitrosalicylic acid, which itself can be prepared by a variety of methods[3]. These methods are uniformly laborious and we have consequently investigated alternative methods for its preparation. We find that direct carboxylation of *m*-aminophenol, using modified Kolbe conditions, gives *p*-aminosalicylic acid and not *p*-hydroxyanthranilic acid[4].

Clinical experience with the acid, which will be described in detail elsewhere, has amply confirmed and extended Lehmann's findings and has shown that the acid, which is well tolerated by man, is markedly effective in the treatment of pulmonary tuberculosis and of tubercular empyæma. A series of functional derivatives of the acid has been prepared, some of which are extremely active *in vitro* against the $H_{37}RV$ strain of *M. tuberculosis*.

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[2] Seidel and Bittner, *Monatsh.*, **23**, 423 (1902). Kondo and Nakajima, *J. Pharm. Soc. Japan*, **485**, 355 (1922).

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A Modified Technique in Filter-Paper Chromatography

Various adaptations of filter-paper to chromatography have been published[1–4]; the following technique has advantages of simplicity of apparatus, speed, reproducibility, and particular suitability for micro-analysis. (Sensitivity approximately 2 micrograms solute.)

Two parallel cuts, about 2 mm. apart, are made from the same edge up to the centre of an 11-cm. circular filter-paper, and the 'tail' so formed, after bending at the joint perpendicular to the plane of the paper, and cutting down to approximately 1½ cm., is immersed in the solution under analysis, contained in a capsule inside a Petri dish, which supports the filter-paper. A glass plate prevents evaporation.

By capillarity, the solution rises up the 'tail' and spreads circularly outwards. (Alternatively, the solution may be pipetted on.) The paper is then removed, and the 'tail' immersed in developing liquid, rate of development being controlled by tail-width and height of paper above liquid surface. Coloured solutions suitably developed give sharp separation of coloured rings.

In the case of colourless chromatograms, after development, a test sector is cut out and pressed between filter-papers impregnated with reagents giving coloured products with constituents of the chromatogram. Preparation of derivatives on the main chromatogram, which may be undesirable, is thus avoided.

Another method is based on the variation in rate of charring of the paper, caused by adsorbed substances: bands may frequently be detected by holding a test sector above a heated bunsen gauze.

After marking their positions on the main chromatogram and drying, the various bands may be cut out and conveniently eluted by placing both ends of each curved strip on filter-paper soaked in eluent. Capillary action concentrates the adsorbate in the centre of the strip, whence it may be drawn off on paper or by capillary pipette.

A study of modified types of filter-paper in particular separations will be discussed more fully elsewhere.

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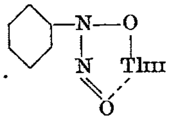
Inner-Complex Salts of Trivalent Thallium

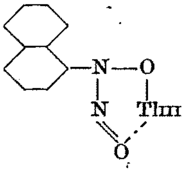
HITHERTO it has seemed that thallium was the only heavy metal with but slight tendency to form water-insoluble normal and inner-complex salts with organic compounds of acid character. Monovalent thallium gave insoluble salts with the mercaptans thioglycollic acid-anilid, thioglycollic acid-β-aminonaphthalid ('Thionalid')[1] and mercaptobenzthiazole[2]. Of these compounds only the first and second can be considered as inner-complex salts. Since thallium belongs to the same group in the Periodic Table as the inner-complex-forming metals gallium and indium, the existence of inner-complex salts of trivalent thallium was to be expected; and it has now been found that inner-complex salts of trivalent thallium with nitrosophenylhydroxylamine, α-nitrosonaphthylhydroxylamine, 8 hydroxychinoline, 5,7 brom-8 hydroxychinoline and 'Thionalid' can be obtained in the following manner.

Sufficient tartaric acid, citric acid or sulphosalicylic acid is added to a solution of thallium (Tl III) sulphate, bromide, etc., in order to avoid, by formation of complex thallic ions, precipitation after addition of ammonia. To the ammoniacal solution thus obtained, a solution of the complex-forming organic compound in alcohol or ammonia is added. Immediately precipitates of the respective thallic inner-complex salts are formed. The precipitations are quantitative, as in the filtrates no thallium can be detected by the usual tests.

Precipitates with nitrosophenyl- and nitrosonaphthyl-hydroxylamine (white amorphous products) are also obtainable from mineral acids, non-masked thallic solutions. In this case the precipitate is mixed with the precipitant. The precipitates with 8-hydroxychinoline and 5,7 brom-8 hydroxychinoline (orange-coloured crystalline products) can also be formed from non-masked, acetate-buffered thallic solutions with alcoholic solutions of the reagents. The composition and constitution of the above inner-complex salts correspond to co-ordination formulæ I–III.



I



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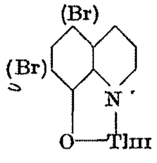
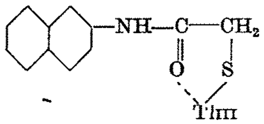
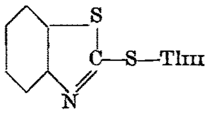


III

The precipitation with 'Thionalide', from ammoniacal-masked thallic solution, is white, whereas thallous 'Thionalid' is yellow. When precipitated with mercaptobenzthiazole, a yellow product (thallic compound) is formed, which in a few minutes is transformed into white thallous mercaptobenzthiazole and the disulphide of the mercaptan. The different behaviour of mercaptobenzthiazole and 'Thionalid' is obviously based on the fact that only the latter forms an inner-complex salt with trivalent thallium. Through chelate-ligation (IV) the trivalent thallium as well as the oxidizable mercaptan are stabilized. In the case of the normal mercaptobenzthiazole-salt V there is no stabilization by chelate-ligation, and therefore a redox reaction occurs, forming thallous mercaptobenzthiazole and the disulphide of the mercaptan.



IV. Stable inner-complex salt



V. Unstable normal salt

It seems that certain inner-complex salts of trivalent thallium can serve as a basis for new methods for the detection and determination of thallium.

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Order of Stability of Metal Complexes

IN a recent communication[1] it was pointed out that the order of stability of a series of internal metal complexes is substantially the same whether the metals are combined with bidentate chelate molecules like salicylaldehyde, glycine or 8-hydroxyquinoline. There is evidence from the results of other workers[2,3] that the same order is to be found with complex cations and with internal complexes formed with quadridentate chelate molecules. Cations containing ethylenediamine have been studied by Bjerrum[2,4] and Carlson, McReynolds and Verhoek[3]. From the accompanying table, which shows the overall stability constants for salicylaldehyde and ethylenediamine complexes, the similarity of order in the two cases is evident.

Bivalent Metal	log K_{sal}	log K_{en}
Pd	14·8	26·9(*a*)
Cu	13·3	19·6(*c*)
Ni	9·2	18·6(*b*), 18·1(*c*)
Co	8·3	13·8(*b*)
Zn	8·1	12·9(*d*), 12·1(*c*)
Cd	7·8	12·3(*d*), 12·1(*c*)
Fe	7·6(*a*)	9·5(*b*)
Mn	6·8(*a*)	5·7(*b*)
Mg	6·8	—

Abbreviations: sal = salicylaldehyde; en = ethylenediamine. (*a*) Recent measurements by the authors; (*b*) measurements by Bjerrum, ref. 2; (*c*) measurements by Carlson, McReynolds and Verhoek, ref. 3; (*d*) measurements by Bjerrum and Anderson, ref. 4. The figures for Cu and Pd in the right-hand column refer to complexes containing two molecules of ethylenediamine; all the other metals listed combine with three molecules of ethylenediamine.

If one metal complex is more stable than another of the same type, we should expect to find that, under suitable conditions, a metal will displace another from a less stable complex. By means of such displacement reactions, Pfeiffer, Thielert and Glaser[5] have investigated the relative stability of compounds formed with *bis*-salicylaldehyde-ethylenediimine. From a systematic study of reactions carried out in pyridine solution, Pfeiffer and his collaborators place the metals in the following order:

$$\mathrm{Cu^{II}} > \mathrm{Ni^{II}} > \mathrm{Fe^{III}} > \mathrm{Zn^{II}} > \mathrm{Mg^{II}}$$

which, with one exception, is identical with the order in the table. That iron appears in a different position is almost certainly due to the fact that here we are dealing with $\mathrm{Fe^{III}}$, whereas the other comparisons (in table) deal with $\mathrm{Fe^{II}}$.

Owing to the fact that the reactions were carried out in pyridine solution, they are more appropriately regarded as exchange reactions, because the displacing metal is already in the form of a pyridine-containing complex ion. A typical reaction is:

$$[\mathrm{Cu(py)_6}]^{++} + [\mathrm{Ni(sal\text{-}en)}] \rightleftarrows [\mathrm{Cu(sal\text{-}en)}] + [\mathrm{Ni(py)_6}]^{++}, \quad . \quad (1)$$

where sal-en = *bis*-salicylaldehyde-ethylenediimine and py = pyridine. This point of view introduces a further complication in so far as the reaction would seem, at first sight, to show that the copper pyridine complex is less stable than the nickel pyridine complex, an order that would not be expected from the table. This raises the question: In what circumstances is one justified in drawing conclusions about relative stability from experiments of this kind?

It may be shown that the equilibrium constant, K_1, for reaction (1) can be expressed in terms of the overall stability constants of the different complexes involved. Thus

$$K_1 = \frac{[\mathrm{Cu(sal\text{-}en)}]\ [\mathrm{Ni(py)_6}]^{++}}{[\mathrm{Ni(sal\text{-}en)}]\ [\mathrm{Cu(py)_6}]^{++}} = \frac{K_{\mathrm{Cu(sal\text{-}en)}} \times K_{\mathrm{Ni(py)_6^{++}}}}{K_{\mathrm{Ni(sal\text{-}en)}} \times K_{\mathrm{Cu(py)_6^{++}}}}$$

It has been observed[5] that reaction (1) goes practically quantitatively from left to right, which means that $K_1 \gg 1$. Under these conditions, we can then be certain that $K_{\mathrm{Cu(sal\text{-}en)}} > K_{\mathrm{Ni(sal\text{-}en)}}$ only if $K_{\mathrm{Cu(py)^{++}}} > K_{\mathrm{Ni(py)^{++}}}$. If, on the other hand, $K_{\mathrm{Ni(py)^{++}}} > K_{\mathrm{Cu(py)^{++}}}$, the relation between $K_{\mathrm{Cu(sal\text{-}en)}}$ and $K_{\mathrm{Ni(sal\text{-}en)}}$ is, from these observations alone, indeterminate. Pfeiffer *et al.* did not take into account the effect of the relative stability of the different pyridine complexes. We have therefore measured the stability constants of the pyridine complexes of copper and nickel, and have found that the copper complex is the more stable.

Although the co-ordination number (n) of $\mathrm{Cu^{II}}$ and $\mathrm{Ni^{II}}$ is frequently four, complex formation curves[2] indicate that as many as six pyridine molecules may be attached to the metal ions in solutions containing a large excess of pyridine. Approximate values of log K, where K is the overall constant, calculated on the assumption that $n = 6$, are 10·2 and 9·8 for the pyridine complexes of copper and nickel respectively. The chief uncertainty in the values of log K arises from the difficulty of measuring the constants for the last steps in complex formation. They are, however, sufficiently accurate to validate Pfeiffer's conclusions about the relative stabilities of the copper and nickel complexes of *bis*-salicylaldehyde-ethylenediimine.

Although it is not yet clear what determines the order of the metals in the series, it is perhaps worth noting that metals forming dsp^2 bonds ($\mathrm{Pd^{II}}$ and $\mathrm{Cu^{II}}$) head the list. So far as the extreme members of the series are concerned, there is a hint that the basicity of the metal may have something to do with stability (the more basic the metal, the less stable its complexes); but owing to the difficulty of assigning numerical values to the basicity of metals[6], no definite statement relating the two factors is possible at present.

We are indebted to Mr. M. L. Hammond for assistance with measurements on the pyridine complexes.

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Polarographic Determination of the Gamma-Isomer of Benzene Hexachloride

WE have found that, of the four known isomers of benzene hexachloride, only the gamma is reduced at a dropping mercury electrode. The insecticidal activity of benzene hexachloride is preponderantly due to the gamma-isomer, so that a method of determining the latter is of value in the analysis of benzene hexachloride and insecticidal compositions based on it. This property of the gamma-isomer, which was first discovered by us in 1945, permitted the development of a reliable analytical procedure. Keller *et al.*[1] showed in 1946 that benzene hexachloride gave rise to a polarographic wave, but did not specifically indicate that the wave was due to the gamma-isomer.

This is the sole instance known to us of only one isomer of a substance being reduced at the dropping mercury electrode, and is considered to be due to the polar structure of the gamma-isomer molecule[2].

The wave obtained is not quite a normal one as it appears to involve the progressive reduction, without a break, of three of the chlorine atoms in the molecule. This results in an extended rise in the current-voltage curve over the comparatively wide potential range of − 1·15 to − 1·55 volts *v.* sat. calomel electrode. Buffering at pH values lower than 7 is without effect on the slope of the wave; the latter is reproducible under standard conditions.

The residual and diffusion currents of the wave both exhibit an appreciable rise due to the presence of traces of other reducible materials in the crude benzene hexachloride. This rise in the residual and diffusion currents necessitates the use of an intersection method for the measurement of the wave height.

The conditions of solvent and base electrolyte which have been found to give the best waves are as follows:

Base solution:	Equal volumes of absolute alcohol and distilled water, containing 1 per cent of potassium iodide as electrolyte and 0·005 per cent of gelatin as maximum suppressor. Before recording, dissolved oxygen is removed from solution by a stream of hydrogen or nitrogen.
Recording range:	$-0\cdot6$ to $-2\cdot0$ volts *v.* sat. calomel electrode. The half-wave potential is $-1\cdot35$ volts *v.* sat. calomel electrode.
Concentration range:	0·005 to 0·04 per cent of gamma-isomer in the base solution.
Galvanometer sensitivity:	1/10 to 1/50 of full sensitivity using moderate damping. (Cambridge Instrument Co., Ltd., polarograph.)

Calibration is carried out by subjecting known concentrations of the pure gamma-isomer to a similar procedure and plotting the resulting wave heights against gamma-isomer concentrations. A straight-line curve is obtained which, when extrapolated to zero concentration, gives a small blank corresponding to a small residual current.

Absolute alcohol has been found preferable for the preparation of solutions, as reducible impurities present in the industrial solvent are liable to cause interference.

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Size of the Brain in the Ape-Man, *Plesianthropus*

THOUGH the brain of the young *Australopithecus* is about 500 c.c. and that of the adult perhaps 600 c.c. or more, the brain of the type *Plesianthropus* about 450 c.c., and of the beautiful female skull about 415 c.c., it has been suspected that some male brains may have been very much larger. The Kromdraai skull has a brain that we estimated may have been about 650 c.c.; but with little more than the temporal bone and the middle line as evidence the determination is not as convincing as one would like.

Recently we found an imperfect skull at Sterkfontein (skull No. 8) which has much of the top of the brain case and the nearly perfect base. Though the front of the frontal region is lost, we have part of one orbit preserved, and can restore the whole brain with considerable confidence. We give a side view of the brain as we restore it (Fig. 1). This restoration gives us a brain of about 530 c.c.

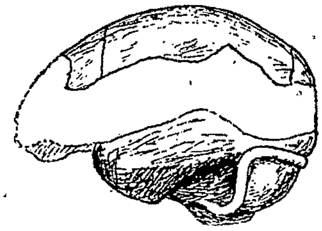

Fig. 1. RESTORED BRAIN OF *Plesianthropus transvaalensis* BROOM, SKULL NO. 8; CAPACITY, 530 C.C. 1/3 NATURAL SIZE

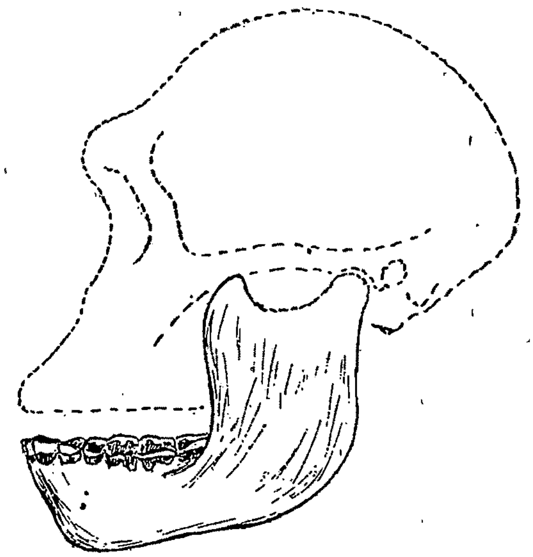

Fig. 2. SIDE VIEW OF MANDIBLE OF MALE *Plesianthropus transvaalensis* BROOM, WITH THE SKULL RESTORED IN OUTLINE. 1/3 NATURAL SIZE

Six months ago we discovered the very fine mandible of a large male. A preliminary account appeared in *Nature* of August 2, 1947. As the jaw is manifestly a male jaw and very much larger than must have been the jaw of the perfect female skull (No. 5), we said: "the male skull that belonged to this jaw must have had a brain of 600 c.c., or perhaps even 700 c.c.". Further development of the jaw shows that it was even larger than suspected. The right ascending ramus is nearly complete though crushed, and shows that it was broader than we had restored it. It is even broader than that of the Heidelberg jaw and much higher.

In skull No. 8, which has the 530 c.c. brain, the measurement from the base of the crown of the third upper molar to the back of the glenoid cavity is 63 mm. The skull belonging to this large mandible must have had a corresponding measurement of about 94 mm. It thus seems probable that the brain belonging to this large jaw had a capacity of well over 700 c.c. and perhaps more than 750 c.c.

From the collection of *Plesianthropus* skulls we now have, it is manifest that there is a very great degree of variation not only in size but also in structure; but as all have been found in a space of about 120 cubic yards, it seems highly probable that all belong to one species. Perhaps we may be right in assuming that the female brains vary from 400 to 600 c.c., and male brains from possibly 600 c.c. to perhaps more than 750 c.c.

We know that *Plesianthropus* had a pelvis that was essentially human, and we can be sure that it walked on its hind feet and used its hands for the manipulation of tools and weapons. If some of the males had brains of perhaps 750 c.c., we can say with confidence that, if *Plesianthropus* was not quite human, it was nearly human.

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Jan. 31.

Nicotinic Acid in Human Blood Cells at Birth

THE nicotinic acid was determined in blood from the umbilical cord, and in blood taken from the mother at the time of birth. The cord blood was obtained by allowing the placental end of the cord to drain into a centrifuge tube containing a mixture of ammonium and potassium oxalates, and the blood was mixed with the oxalates as gently as possible to prevent hæmolysis. The maternal blood was taken from the antecubital vein a few minutes later and mixed with the oxalates in a similar way. The cells were separated by centrifuging the blood for 45 min. at 3,000 r.p.m. and the nicotinic acid was determined in the cell mass by the method of Klein, Perlzweig and Handler[1].

The following results were obtained :

Subject	Nicotinic acid (μgm./c.c. of cells) Maternal blood	Cord blood
A	13·5	12·0
B	12·8	13·4
C	16·2	15·1
D	12·2	12·6
E	12·8	13·0
F	13·0	13·3
G	10·6	12·3
Average	13·0	13·1

No consistent difference was found in the concentration of nicotinic acid in the two kinds of cells. The average concentrations were in the range usually accepted as normal for the blood cells of adults.

The work of Lwoff, Morel and Digonnet[2], who used the *Proteus* technique for their estimations, suggested that the newborn child did not possess any large store of nicotinic acid. These investigators even went so far as to say that the tissues of the infant probably contained smaller concentrations than the same tissues of the mother; but the evidence for this statement was not conclusive. Blood was not investigated, and the present work perhaps throws some doubt on the accuracy of the previous observations, which, as Clements[3] has pointed out, certainly need confirmation.

Human breast milk is a comparatively poor source of nicotinic acid, and the newborn child may need more than it can obtain from this source. If so, it may be able to synthesize the vitamin from tryptophane (Sarett and Goldsmith[4]), or it may have to rely on bacterial synthesis in the gut. An attempt is being made to find out whether such synthesis occurs, and if so, how soon it begins.

This work is being carried out at the Landesfrauenklinik, Wuppertal, through the courtesy of the director, Prof. A. Anselmino, and with his very helpful co-operation.

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Nov. 15.

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[1] Klein, T. R., Perlzweig, W. A., and Handler, P., *J. Biol. Chem.*, 145, 27 (1942).

[2] Lwoff, A., Morel, M., and Digonnet, L., *C.R. Acad. Sci., Paris*, 213, 1030 (1941).

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Effect of Removal of Neurosecretory Cells in the Brain of Adult *Calliphora erythrocephala* Meig.

IN a number of insects neurosecretory cells have been found in the brain[1]; but very little is known of their function. Wigglesworth[2] showed that in *Rhodnius* the moulting hormone is produced by the pars intercerebralis of the protocerebrum, in which part of the brain Hanström[3] had detected neurosecretory cells. Recently, C. M. Williams[4] has found that neurosecretory cells in the brain of *Platysamia cecropia* play an important part in the regulation of the pupal diapause. (I am indebted to Prof. Williams for permitting me to quote this result.)

In the adult insect, the corpus cardiacum and probably the corpus allatum are innervated from the pars intercerebralis of the protocerebrum. In *Leucophæa* (*Blattaria*) B. and E. Scharrer[1] found that colloid could be traced from the secreting nerve cells in the pars intercerebralis to the corpora cardiaca all along the nervus corporis cardiaci. This morphological evidence renders it highly probable that the neurosecretory cells of the brain in some way influence the function of the corpus cardiacum and possibly that of the corpus allatum.

In *Calliphora*[5–8], as in several other insects, the presence of the corpus allatum was found to be necessary for the production of yolk in the egg. If the neurosecretory cells of the brain influence the function of the corpus allatum, it might be expected that removal of these cells would have an effect similar to that of allatectomy.

Owing to their light-bluish colour, the neurosecretory cells in the pars intercerebralis of the protocerebrum can be distinguished in the living *Calliphora*. The neurosecretory cells were removed from forty-nine *Calliphora* females five to eight hours old (at 25° C.) ; thirty-nine flies of the same age served as operated controls. The flies were fed on meat, sugar and water for seven days (25° C.) before they were dissected. The length of the biggest egg-chambers was measured. The result was clear : the egg-chambers of the twenty-two surviving females deprived of the neurosecretory cells measured 0·13–0·17 mm., whereas only two of the surviving twenty-eight controls had egg-chambers measuring 0·17 mm. and 0·18 mm., while of the remaining twenty-six controls, two flies oviposited, seventeen contained ripe eggs, and in seven flies the egg-chambers measured from 0·28 mm. to 1·25 mm., all egg-chambers containing normal yolk. No yolk was present in the egg-chambers of the flies lacking the neurosecretory cells (as a rule no yolk is deposited until the egg-chamber reaches a length of 0·25–0·30 mm.).

In twelve females, allatectomized at the same age and kept for seven days (25° C.), the length of the egg-chambers varied from 0·14 mm. to 0·23 mm., and no yolk was present in any of them (ref. 6, p. 357). Thus it is evident that the ovaries of the flies deprived of their neurosecretory cells only develop to the same, or nearly the same, stage as the ovaries of allatectomized flies. This result seems to indicate that the corpus allatum is activated from the neurosecretory cells, possibly through the corpus cardiacum.

As neurosecretory cells have also been found in the brain of dipterous larvæ, one might go a step further and suggest that the larval corpus allatum likewise is controlled by the neurosecretory cells of the brain. The investigation is being continued.

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Dec. 6.

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Ribose Nucleic Acid in the *Drosophila* Egg

Caspersson and Schultz[1,2] have claimed that the presence of an extra *Y*-chromosome in the female *Drosophila* is correlated with an abnormally high concentration of ribose nucleic acid or allied substances containing the pyrimidine ring in the cytoplasm of oocytes. Their graph, based on quantitative determinations of ultra-violet light absorption, indicates that *XXY* oocytes contain about 40 per cent more ribose nucleic acid than do *XX* oocytes. If confirmed, this claim would be evidence for the control exercised by heterochromatin over the synthesis of ribose nucleic acid: and since this substance seems to be closely associated with protein synthesis, the argument might be extended to include a specific connexion between heterochromatin and growth-rate determination.

Brachet[3] has recently described a simple microchemical method whereby ribose nucleic acid may be estimated quantitatively. The tissue under examination is hydrolysed and distilled in a current of steam. Furfural, the hydrolysis product of ribose sugar which appears in the distillate, is assayed colorimetrically, making use of the coloured compound which it forms with aniline and acetic acid.

Caspersson and Schultz's contention is not directly open to chemical proof since the collection of a homogeneous batch of *Drosophila* oocytes is impracticable. However, freshly laid eggs can be collected in quantity and these assayed for ribose content.

Such eggs were collected over hourly intervals from the matings *XX* × *XYY* and *XXY* × *XY*. They were dechorionated *en masse* and fixed in a mixture consisting of equal parts acetone and 10 per cent trichloro-acetic acid. After prolonged extraction in changes of fixative, the eggs were desiccated at 100° C., extracted with hot ether to remove neutral fat, hydrolysed and distilled. Furfural yields gave the following ribose nucleic acid assays:

	Weight of ether-extracted eggs (mgm.)	Yield of furfural (γ)		Estimated ribose nucleic acid (mgm. per gm.)
	5·9	11·3		6·48
	6·5	13·1		6·82
	6·6	13·5		6·94
Eggs from	6·6	11·6		6·00
XX females	7·0	13·3		6·45
			Average	6·54
	4·9	9·6		6·61
	6·5	11·7		6·11
	6·7	12·7		6·41
Eggs from	7·1	13·1		6·25
XXY females	8·7	19·0		7·39
			Average	6·55

From these figures it is evident that there is no significant difference in the ribose nucleic acid content of newly laid eggs deriving from *XX* and *XXY* parent flies. In keeping with this result it should be further mentioned that in other experiments, to be described in detail elsewhere, no difference either in developmental-rate or in oxygen consumption was found to exist between these two types of eggs.

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Trypanosoma heptatretæ sp. n., a Blood Parasite of the Hagfish

HITHERTO the occurrence of a trypanosome in the blood of the hagfish *Heptatretus cirrhatus* (Bloch and Schneider, 1801) seems to have escaped notice. The type slide of *Trypanosoma heptatretæ* was prepared from the peripheral blood of a hagfish found stranded at Island Bay, Wellington. Seventeen (57 per cent) of thirty hagfish so far examined have been infected with this hæmoflagellate. One infection was so heavy that an average of three trypanosomes were present in each field when freshly drawn blood was studied under oil immersion (1·8 mm.) and a × 10 ocular.

Trypanosoma heptatretæ is of long, slender form, its body tapering to a point posteriorly. Its dimensions, from the measurement of one hundred specimens fixed with 4 per cent osmic acid vapour and stained with Giemsa's stain, are as follows:

	Average	Range
Length of free flagellum	21 μ	18–24 μ
Length of body	61 μ	56–65 μ
Total length	82 μ	75–86 μ
Width of body at nucleus	3·0 μ	2·8–3·1 μ
Width of undulating membrane	2·5 μ	2·3–2·7 μ
Diameter of karyosome	2·3 μ	2·0–2·5 μ

The length of the free flagellum averages 37 per cent (30–43 per cent) of that of the body. The nucleus lies 40 per cent (35–44 per cent) of the body-length from the root of the free flagellum, and occupies almost the entire width of the body. A parabasal body is situated 5 per cent (4 – 7 per cent) of the body-length from the posterior end, and the axoneme terminates at a blepharoplast immediately anterior to this structure.

T. heptatretæ also occurs in a very much scarcer stout form which has the free flagellum much shorter than that of the common form described above. The body is correspondingly lengthened and very markedly widened, but the overall length is not increased. In this stout form the nucleus is appreciably larger than in the slender form, and occupies a more central position. Measurements of the only three specimens encountered to date give the average length of the free flagellum as 12 μ and that of the body as 70 μ. The width of the body at the nucleus averages 6·3 μ, while the diameter of the nucleus itself is 4·6 μ and that of the karyosome 3·3 μ.

In both slender and stout forms the nucleus is of circular shape, and contains a large central karyosome. The space between karyosome and nuclear membrane appears as a clear, vacuolated ring in living specimens. With Giemsa's stain, used either after dry fixation with absolute alcohol or wet fixation with 4 per cent osmic acid vapour, the karyosome takes on a purplish-pink colour. The vacuolated ring between it and the nuclear membrane stains a light pink. Hæmatoxylin-stained preparations show the karyosome as a violet-stained body somewhat smaller in relation to the overall size of the nucleus as compared with Giemsa preparations.

The cytoplasm of the parasite stains a deep blue with Giemsa. It is dense, vacuolated and intensely granular, the granules staining purplish-black. As in *Trypanosoma granulosum* Laveran and Mesnil (1902), a parasite of *Anguilla vulgaris*, the granules are not apparent in hæmatoxylin preparations when the stain is properly extracted[1].

T. heptatretæ resembles *T. granulosum* in the granular nature of its cytoplasm, but is distinguished from this species by its circular nucleus and karyosome. These structures are very prominent in both stained and living specimens.

A more detailed account of *T. heptatretæ* is in course of preparation.

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[1] Minchin, E. A., *Proc. Zool. Soc. Lond.*, 2–31 (Jan. 12, 1909).

Relationship of Glioma to Encephalitis in the Domestic Fowl, and an Associated Parasitic Agent

THE occurrence of glioma in the brain of the fowl was reported by Belmonte[1] (one case) and by Jackson[2] (two cases). Later, Jungherr and Wolf[3] studied two cases and concluded that the tumours were astrocytomas. During the past twelve years I have had the opportunity of studying some fifty cases of the disease from material submitted by Prof. D. Coles of this Institute.

The histopathological observations led me to the following conclusions. (1) In the fowl, all gradations occur between lesions of chronic disseminated focal encephalitis and glioma, often in the same brain. (2) The histopathology of these chronic encephalitic foci is identical with that of the brain tissue at the margin of glioma—hypertrophy and hyperplasia of blood-vessels, perivascular infiltration (chiefly by lymphocytes, plasma cells and monocytes), and overgrowth and proliferation of astrocytes. (3) Avian glioma enlarges chiefly through progressive incorporation of these astrocytes into the tumour tissue—'growth by conversion' (of neighbouring cells to 'tumour cells'). (4) I cannot agree with Jungherr and Wolf (*loc. cit.*) that the multiplicity of the lesions in avian gliomatosis is due to cellular metastasis. I believe that each tumour arises as a focus of encephalitis.

These findings suggested that avian glioma is a response to some noxa which continues to spread in the brain tissue in advance of the tumour; not a 'purposeless' proliferation of cells.

A survey has been made to determine whether this disease might be associated with the presence of a visible biological agent, with the result that the following bodies have to be described briefly, with arbitrary designations for convenience of further communications.

A-bodies (Fig. 1): In sections these appear as oval or circular rosettes composed of an inconstant number of oval units (A^1-bodies), which radiate in orderly fashion around a central space, are readily stainable with nuclear dyes, and are Feulgen-positive. *A*-bodies may measure $10\,\mu$ in diameter (in smears, $18\,\mu$); the A^1-bodies about $2{\cdot}5\,\mu \times 1{\cdot}75\,\mu$. The latter can be seen in process of dispersion from the rosettes into the tissues. *A*-bodies have been seen in glioma and in chronic encephalitis, but are rare and quite unreliable of demonstration. But in two cases of more acute or purulent encephalitis they were present in large numbers.

Fig. 1 Fig. 2

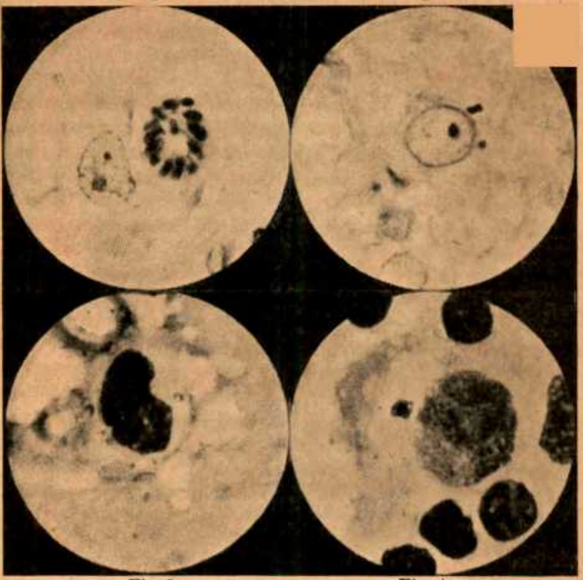

Fig. 3 Fig. 4

Fig. 1. *A*-BODY AT THE MARGIN OF A FOCUS OF CHRONIC ENCEPHALITIS. (ASTROCYTE NUCLEUS NEAR BY)

Fig. 2. *C*-BODIES (OVAL AND DOUBLE OVAL) IN THE CYTOPLASM OF A TUMOUR CELL. (GLIOMA)

Fig. 3. RING-SHAPED *C*-BODIES IN A MONOCYTE; OTHER FORMS ALSO VISIBLE. (SMEAR FROM GLIOMA)

Fig. 4. JUXTANUCLEAR, VACUOLATED *D*-BODY IN A HYPERTROPHIED ASTROCYTE. (BRAIN SMEAR—CHRONIC ENCEPHALITIS)

(ALL STAINED WITH GIEMSA. × 1200)

B-bodies: These represent the immediate precursors of *A*-bodies and there are all transitional stages. A somewhat refractile membrane encloses a central chromatic mass which later resolves into the *A*-rosette. They could be confused with a poorly fixed mitotic metaphase of a tumour cell. Their distribution is similar to that of *A*-bodies.

C-bodies: Much smaller elements, resembling small piroplasms or even *Rickettsiæ*. In both glioma and chronic encephalitic foci they can be demonstrated with considerable constancy if Giemsa-stained sections or smears are carefully searched. Oval, double-oval, piriform, bipolar and ring-forms are distinguishable (Figs. 2 and 3).

D-bodies (Fig. 4): Juxtanuclear, irregularly oval, moderately chromatic, in some respects reminiscent of Negri-bodies. They may be attached by a fine stalk to the nuclear membrane of a tumour cell or of an infiltrating cell. Typically they cause a shallow indentation in the nucleus. Unreliable of demonstration in fowl glioma.

It is my opinion that all the above bodies represent phases of a specific parasite. A pronounced tendency to the emergence of the *A*-body phase is associated with a purulent inflammatory reaction, whereas phases such as the *C*-bodies are associated with a more chronic reaction, the ultimate stage of which is a glioma.

Several additional bodies are strongly suspected of being still other phases of this pleomorphic parasite: *E*-bodies are intensely chromatic, torula-like, and can readily be confused with pyknotic nuclei or nuclear fragments. *H*-bodies are composed of chromatin and cytoplasm, the former with bipolar, tripolar or quadripolar distribution. They are likely to be dismissed as cells undergoing karyorrhexis. Possible filamentous phases are also being studied. Full descriptions, including details of the distribution in the tissues, will be published elsewhere.

I believe that glioma of the fowl will prove to be nothing but a proliferative response to a specific infectious agent.

These findings led me to approach Dr. R. A. Krynauw, head of the Neurosurgical Department of the Johannesburg Hospital, for collaboration in the task of ascertaining whether they have application also to gliomas of man. Results have been obtained which will be communicated in the near future.

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Jan. 15.

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Shrivelled Wheat Grain from Rust-Affected Crop as Seed

IN the Central Provinces and Berar and other regions in peninsular India, recurrent damage is caused to the wheat crop by black stem rust, *Puccinia graminis tritici*. In some years, as in 1946, the destruction of the crop is so great as to result in an acute shortage of seed. To investigate the possibility of utilizing the shrunken grain produced by the rust-affected crop, as seed, germination tests of, and experiments to observe the effect on yield of sowing, such grain were carried out.

Samples of shrivelled grain were obtained from different places and individually sorted into three grades according to grain size: medium, thin and very thin grains. Percentages of each grade in a sample and its 1,000-seed weight were ascertained before testing viability of the grain. Due to high weather temperature (about 115° F.) and for want of a refrigerator at this Station, germination tests were carried out in small earthen pots filled with sand and clay. The pots were partially buried in wet sand and kept in a cool room during the day, and removed to the open towards evening. The results of 120 samples thus tested are summarized in Table 1.

TABLE 1. SUMMARY OF THE RESULTS OF GERMINATION TESTS

(Figures represent the mean for the number of samples tested per lot.)

Lot No.	Number of samples tested	Percentage of grades*			1,000-grain weight in gm. of grades†			Germination percentage of grades		
		A	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*
1	24	19	68	13	18·5	10·9	5·3	79	63	33
2	20	34	58	8	15·3	8·9	3·8	84	80	66
3	11	16	70	14	18·4	10·5	5·1	97	79	62
4	30	27	66	7	16·5	8·6	3·7	94	90	81
5	15	33	56	11	17·9	10·4	4·1	80	81	74
6	9	36	41	23	14·7	8·7	4·6	86	78	71
7	6	41	53	6	22·0	11·2	4·7	69	58	41
8	5	35	57	8	18·0	11·0	5·2	65	51	37
Average of 120 samples		30	59	11	17·7	10·0	4·6	82	73	58

* Grade *A* = medium grain; Grade *B* = thin grain; Grade *C* = very thin grain.

† 1,000-grain weight of normal wheat grain of the varieties tested varies from 36 to 40 gm.

TABLE 2. YIELD OF GRAIN (CALCULATED) PER ACRE (IN LB.)

Year	Variety	Shrivelled seed	Normal seed	Difference	Percentage loss
1944–45	*A*115	377	864	487	56·3
	*A*090	461	755	294	38·9
	*N.P.*52	472	588	116	19·6
		(*S.E.* 64·7 ;	*C.D.* 188·7)		
Average		437	736	299	38·3
		(*S.E.* 37·4 ;	*C.D.* 108·9)		
1945–46	*A*115	693	1205	512	42·5
	*N.P.*52	701*	1092	391	35·9
		(*S.E.* 94·7 ;	*C.D.* 285·3)		
Average		697	1149	452	39·2
		(*S.E.* 66·9 ;	*C.D.* 201·7)		

Critical difference (*C.D.*), at $P = 0{\cdot}05$. The differences are statistically significant.

* There was considerable damage to the plants by termites in these plots.

In order to observe how the crop grown from shrivelled grain would compare with that from normal seed, particularly in respect of yield, the two kinds of grain of three varieties, *A*090, *A*115 and *N.P.*52, were sown in plots, each 10 in. × 7½ in. in size and replicated six times. In the subsequent year, the trial was repeated but with the last two varieties. In both years the early growing period was dry and devoid of rain, resulting in seedling mortality which was approximately 20 per cent greater in plots sown with shrivelled grain. Plants from the normal seed were superior in growth, vigour and tillering. The yields obtained are shown in Table 2.

The results of germination tests indicate that shrivelled grains obtained from the rust-affected wheat crop are tolerably suitable as seed, particularly if the very thin grains are sorted out and rejected. From the point of view of yield, however, sowing such grain would lead to a loss of about 40 per cent as compared to that of the normal seed crop. As the seasons during which the trials were conducted were very adverse, it is probable that the loss would be less under favourable weather conditions. In the present circumstances in India, when good seed is not available, the possibility of importing it from outside is remote and the necessity of growing food crops is supreme, recourse could be taken to the use of shrivelled grain as seed.

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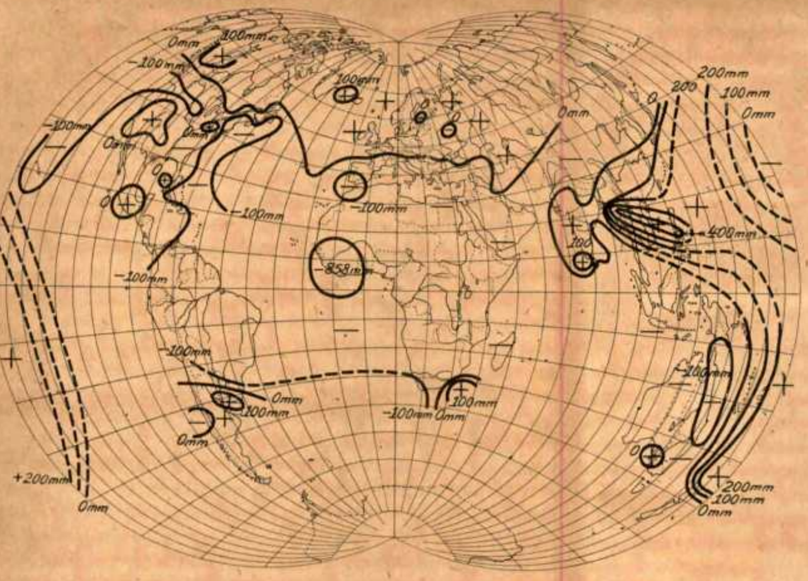
Oct. 1.

Recent Climatic Fluctuations

SOME researches have been carried out in order to elucidate recent climatic fluctuations. Maps have been constructed, showing for the whole earth: (1) the extension of severe winters and mild winters, cool summers and warm summers, cold years and warm years; and (2) the difference $T_{(1911-40)} - T_{(1881-1910)}$, $R_{(1911-40)} - R_{(1881-1910)}$ and $P_{(1911-40)} - P_{(1881-1910)}$ respectively; T, R and P are the normals of temperature, rainfall and pressure for the periods 1881–1910 and 1911–40, January, July and year.

Temperature-, rainfall- and pressure-curves have been worked out for 10-year means and overlapping 30-year normals respectively.

Certain regions seem to be connected in respect of climate, in that considerable positive or negative correlations can be found between the departures from the mean winter- and summer-temperature at the meteorological stations in these regions.



VARIATION OF RAINFALL, $R_{(1911-40)} - R_{(1881-1910)}$, mm.

Over great parts of the earth, especially in temperate and arctic zones, both winter- and summer-temperature seem to have been subject to an appreciable increase, while over other parts, especially in the tropical and subtropical zones, a decrease of temperature has taken place. Also an increase in rainfall is recorded over great parts of the temperate and arctic zones and over the monsoon regions of south-east Asia, while a decrease of rainfall is recorded over other tropical and subtropical regions, such as Africa, Australia, Brazil and the United States (see accompanying map).

A full account of this investigation will probably be published in the *Geografisk Tidsskrift*, Copenhagen, shortly.

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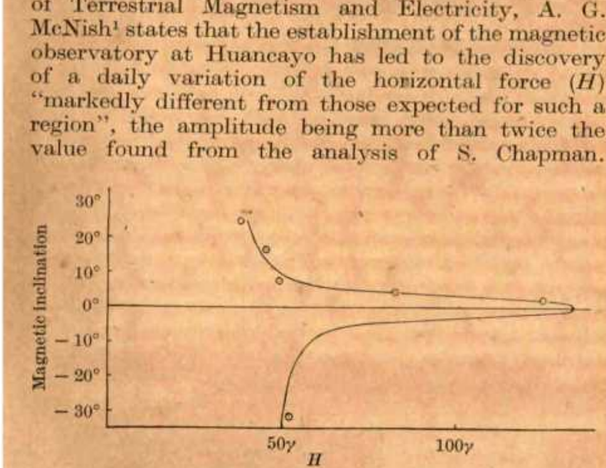
Daily Variation of the Horizontal Magnetic Force at the Magnetic Equator

IN a communication on the daily magnetic variation to the Edinburgh meeting, 1936, of the Association of Terrestrial Magnetism and Electricity, A. G. McNish[1] states that the establishment of the magnetic observatory at Huancayo has led to the discovery of a daily variation of the horizontal force (H) "markedly different from those expected for such a region", the amplitude being more than twice the value found from the analysis of S. Chapman. McNish has based his investigation on the assumption that the daily variation depends on magnetic co-ordinates, and points out that the daily variation of the declination varies considerably in a very narrow region at mag. lat. 0. The great daily variation of H at Huancayo is explained as an augmentation of the normal varying field originating from special circumstances. For Huancayo this augmentation, which is increasing when the distance of the magnetic equator from the geographic equator is increasing, is great.



VARIATION OF TOTAL RANGE OF THE VARIATION OF H WITH MAGNETIC INCLINATION

The present note gives the results from an examination based on the assumption that the daily variation depends on the distance of the place of observation from the magnetic equator (magnetic inclination = 0). The examination is made for H using the total range of the daily variation for all days (September) corresponding to mean sunspot number. The data are given in the table, namely, names of observatories, geographic co-ordinates, magnetic inclination and the total range of H.

TOTAL RANGE OF DAILY VARIATION OF H

Station	φ	λ	Mag. inclination	Total range
Alibag	18·6° N.	72·9° E.	24·4°	38·5 γ
Antipolo	14·6 ,,	121·2 ,,	16·2	45·5
Madras	13·1 ,,	80·2 ,,	7·6	49·5
Kodaikanal	10·2 ,,	77·5 ,,	4·3	82·5
Batavia	6·2 S.	106·8 ,,	− 31·6	52·3
Huancayo	12·0 ,,	284·7 ,,	2·3	125·0

In the accompanying diagram the variation of the total range of H with the magnetic inclination is given. The application of geomagnetic co-ordinates has been avoided in this case, for the magnetic field at the place—and not the magnetic field of the earth as a whole—is the deciding factor.

In accordance with the assumption, the curve has been drawn symmetrically to the line corresponding to the magnetic equator. The curve suggests the range is great only for a strip of land about 300 km. to both sides of the magnetic equator. This augmentation at the magnetic equator of the normal daily variation of H may therefore arise from a varying electric current flowing in a very narrow zone above the magnetic equator at a height of the same order as the E layer. The values of the total range for Huancayo and Kodaikanal are in agreement with the above explanation of the augmentation of the amplitude of the daily variation of H, but this is not the case as regards the values for Madras and Antipolo, for which observatories there seems to be no addition to the normal daily variation.

It should be added that E. V. Appleton[2] in a recent communication has shown the existence of a marked minimum in the F_2 layer critical frequency at mag. lat. 0. Possibly a connexion exists between this phenomenon and the augmentation of the variation of H at the magnetic equator.

However, more observations of the daily variation of H from stations near the magnetic equator are needed before a complete representation of the variation with the magnetic inclination can be given.

Further, it may be desirable to examine the special electric conditions in the atmosphere over the magnetic equator by means of radio investigations.

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Citizenship and Current Affairs in Army Education

THE following observations may perhaps serve to allay certain misgivings expressed in your thoughtful and constructive leading article in *Nature* of February 21, dealing with Army education, at the "undue emphasis" placed by the Army Council on citizenship and current affairs in the recently announced Army Education Scheme (Interim Period).

In any system of education it is inevitable that, for purposes of analysis and administrative convenience, there should be division into categories, and into subjects. Thus, in the new Army Education Scheme, there are the broad divisions of general education and individual education, and the former is itself divided into subjects of primary instruction, with the addition of citizenship and current affairs. Despite these necessary divisions it is not intended that any category or subject shall be dealt with in isolation, but rather that all subjects shall combine to foster the development of the responsible and well-informed soldier-citizen. Training in citizenship, therefore, will be the student's concern not only in periods set apart for that purpose but also in those devoted to the ordinary subjects of the curriculum; conversely, the study of public affairs cannot proceed without, and indeed must to some extent be based on, attention to historical and geographical considerations, to mastery of the basic skills of general education, and to the part which science plays in the modern world.

The distinction is rather one of emphasis. The young soldier joining the Army is given a short initial course in citizenship and current affairs, provided he is not in more urgent need of special instruction in elementary reading and writing. This first course is part of his introduction to the Army. It seeks to explain the need for service and to awaken in him a realization of the responsibilities as well as the privileges of citizenship. Later, the emphasis swings in the direction of consolidating his general education in primary subjects, a process to which two thirds of the time available for compulsory education is devoted. After the first twelve months of service a further change of balance takes place, and for the next two years, for those who are staying on in the Army beyond the period of national service, citizenship and current affairs share together an equal place with instruction in primary subjects. Finally, after the third year of service, citizenship and current affairs remain the only compulsory subjects in the curriculum, though facilities in working hours will continue to be made available for the pursuit of voluntary studies (a position identical with that occupied from the start of their service by those exempt on educational grounds from the provisions of general education).

It will be seen from the above that training in citizenship is in a sense the hard core of the Scheme, forming thereby the most important single factor making for a balanced and integrated curriculum. Certain cogent considerations may be held to justify this choice. First, it is a theme particularly relevant to adult students, for the man, unlike the boy, can quickly be made conscious that he has a stake in the community; matters which in the schoolroom can only be considered in the abstract take on with the approach of adulthood a reality and a seriousness which only maturity and experience can give. Secondly, the war-time experiment of current affairs discussions together with systematic study of the "British Way and Purpose" gave, despite many imperfections, convincing proof that the product of such periods was valuable in the way of improved officer–man relationships as well as increased social awareness.

It is true that discussions of this nature cannot always be divorced from political considerations, since politics is the art or science of living in society. But the discussions must be conducted with good temper and objectivity, and party political bias is not allowed to dominate them. It is true, too, that present educational standards among the majority of young men and young women entering the Army are such as to lay emphasis on the need for careful and accurate presentation of information as a necessary preliminary to any exchange of views. This is not lost sight of, and it may be pertinent to mention in this connexion the valuable contribution in this field made by the B.B.C. in its current affairs broadcasts for the Forces—factual commentaries valuable either as the raw material of discussion or as briefing matter for the instructor.

There are two further, and perhaps less obvious, reasons why current affairs discussions may be considered to play a particularly valuable part in the Army Education Scheme. First, the regimental officer has a special responsibility in acting as chairman at such discussions. This cannot but have a potent effect in driving home his personal responsibility for the educational progress of his men; he has a definite part to play and is therefore in less danger of considering education as something apart from the normal life of the unit, something to be left to the specialist instructor. The basis of the Army is the unit, and the best laid educational plans can only come to full fruition as an expression of unit life and experience. Finally, the current affairs discussion group is not based upon an educational grouping; that is to say, it is not composed of individuals of approximately equal educational attainment but is a cross-section representative of the unit as a whole, since it is composed upon a platoon basis. There are thus brought together individuals differing widely in interest, occupation and intellect but united by the common bond of fellowship within their small community. That throughout the Army men and women should be meeting regularly in small groups, under the chairmanship of their own officers, to discuss together some current topic of common interest is surely expressive of our democratic way of living and is powerful for good in its opportunities for the development of those qualities of tolerance, fair play and understanding on which as a nation we set such store.

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ALKALINE PHOSPHATASE IN TASTE BUDS AND NASAL MUCOSA

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THE application of Gomori's (1939) technique for the demonstration of alkaline phospho-monoesterase to various organs and tissues of the body[1,2,3] showed the enzyme to be located in many hitherto unsuspected sites. In view of its association with the absorptive part of the alimentary tract, and since the process of tasting and smelling appear to involve an absorptive process, it was considered desirable to test for phosphatase in taste buds and olfactory mucosa. Pieces of tongue of bat (*Nyctalus noctula*), mouse, rabbit, monkey (*Cercopithecus griseus*) and human being, and pieces of mouse, rabbit and human olfactory and nasal (respiratory) epithelium were therefore treated by Gomori's technique.

In the bat's tongue, alkaline phosphatase was found in high concentration in patches of basal cells in the stratified epithelium. The only other sites where it was present were the taste buds themselves (Fig. 1), the gustatory pores, the gustatory hairs and, in some places, in the superficial epithelial cells surrounding the gustatory pore. So far as could be seen, all the cells in the taste buds gave a phosphatase reaction of equal intensity.

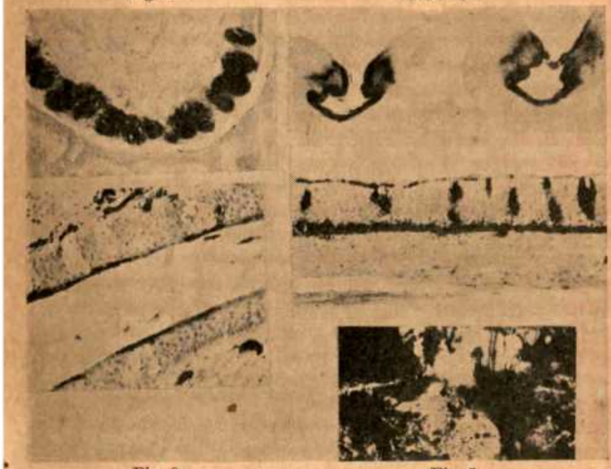

Fig. 1 Figs. 2, 4

Fig. 3 Fig. 5

LOCALIZATION OF ALKALINE PHOSPHATASE IN TASTE BUDS, ETC.: (1) TONGUE OF BAT (*Nyctalus noctula*); (2) BETWEEN PAPILLÆ, FOLIATA OF RABBIT'S TONGUE; (3) EPITHELIUM OVERLYING TASTE BUDS IN HUMAN TONGUE; PHOSPHATASE-POSITIVE CAPILLARIES CAN ALSO BE SEEN UNDER THE EPITHELIUM; (4) INNERMOST LAYERS OF BASAL CELLS IN RABBIT MUCOSA; PHOSPHATASE-POSITIVE STRANDS CAN BE SEEN PASSING THROUGH THE MEMBRANE TO THE SURFACE. (5) ALKALINE PHOSPHATASE IN SMEAR OF HUMAN NASAL MUCUS. SOME PHOSPHATASE-POSITIVE LEUCOCYTES CAN ALSO BE SEEN. ALL REPRODUCTIONS × 75

Serial sections of mouse's tongue were examined but no typical taste buds were seen. Numerous filiform papillæ were present, most of which contained a core which gave a strongly positive phosphatase reaction.

In the papilla foliata of the rabbit's tongue, the epithelium of the folds between the papillæ, in which the taste buds are situated, gave a strong positive reaction localized in the superficial layers of the epithelium overlaying the taste buds (Fig. 2). A reaction also occurred in a layer of cells deeper in the epithelium (shown in figure) in the upper part of the inter-papillary fold.

The monkey's tongue showed (like the bat) alkaline phosphatase concentrated in the taste buds. It was present also in the epithelium on the opposite side of the fold carrying the taste buds. In the bud itself, the central cells gave a stronger phosphatase reaction than the peripheral cells. The gustatory hairs were phosphatase-positive, and in some taste buds the distal ends of the cells gave a strong phosphatase reaction whereas the proximal parts of the cells gave a much less intense reaction.

Human taste buds did not appear to contain phosphatase (Fig. 3). This result might have been due to the fact that there had been some post-mortem degeneration of the cells (the specimen was 12 hours old). It was found, however, that there was no difference in the phosphatase reactions in the tongues of fresh or 12-hours dead rabbits, so presumably the absence of reaction in the human taste buds was not due to post-mortem changes.

The distribution of alkaline phosphatase in the human tongue resembled that of the rabbit, in that the reaction was concentrated in the superficial layers of the epithelium overlaying the taste buds. In those parts where the buds were separated from each other by a short space, it could be seen that the phosphatase was localized only in the epithelium surrounding the taste buds. In regions where the buds were close together, these areas linked up to form a continuous layer. The gustatory hairs appeared to give a positive reaction, and the walls of the gustatory pores gave a very dense reaction.

The distribution of phosphatase in the gustatory apparatus therefore appears to be of two types. Bat and monkey belong to one type, and human and rabbit to the other.

Olfactory mucosa of the rat gave a positive reaction for phosphatase, but the superficial cells of the epithelium gave only a slight reaction. The reaction was concentrated almost entirely in the lower layers of the basal cells. Beneath this basal layer were sparsely arranged phosphatase-positive cells, apparently ganglion cells, which gave off fine, greatly elongated, phosphatase-positive processes. Respiratory mucosa in the nose gave little or no reaction.

The olfactory mucosa of the rabbit was similar. As in the rat, the lower basal cells of the epithelium were strongly positive; but in addition, what appeared to be groups of three or four cells which were in contact with the basal layer extended through to the surface of the mucosa and gave as strong a phosphatase reaction as the basal cells. Parts of these strands can be seen in Fig. 4. There was also a thin line of phosphatase over the distal surface of some of the cells. Bundles of olfactory nerve fibres also gave a moderate positive reaction. (The strand at the bottom of Fig. 4 is such a bundle.) In some parts of the epithelium, these phosphatase strands appeared to be composed of one cell; but in others the strand seemed made up of three or four cells. It has not been found possible so far to differentiate these areas histologically from others in the nasal mucosa; they are not frequent enough to be the olfactory cells and it seems unlikely they represent ducts of Bowman's glands. Perhaps they represent a biochemical rather than an anatomical entity.

In the human olfactory mucosa the basal cells were almost completely phosphatase-negative, but the distal columnar cells (both olfactory and sustentacular) were positive; olfactory hairs were also positive, but no more so than the bodies of the cells. A number of cells immediately beneath the basal cells and which appeared to be of a ganglionic nature gave off elongated processes with a phosphatase-positive reaction. Bundles of olfactory nerve fibres were negative.

In the non-olfactory epithelium, goblet cells were negative; other cells gave a slight reaction. Running along the outside of the free edge of the cells was a thin positive line, which was probably a line of mucus-containing phosphatase. Smears of human nasal mucus fixed in alcohol and incubated with the usual phosphatase substrate mixture gave positive results (Fig. 5).

Bowman's glands beneath the nasal mucosa showed both phosphatase-positive and phosphatase-negative acini. Most of the latter appeared to belong to the mucous category and the former to be of a serous nature.

The significance of these findings is not obvious at the moment. They show, however, that the membranes of the nose as well as those of the mouth are continuously bathed in alkaline phosphatase-containing fluids (saliva has for some time been known to contain the enzyme), and all substances requiring to be tasted or smelled must, therefore, pass through these fluids. Those being tasted must penetrate a further intra- or extra-cellular phosphatase barrier, either in the taste buds themselves or before the taste buds are reached. Such an arrangement may perhaps help to explain the mechanism of tasting of sugar, but it seems scarcely likely to explain why greatly unrelated chemical substances such as saccharine (*o*-benzoic sulphimide), *p*-phenetylurea, cinnamic aldehyde, certain aliphatic chlorides (for example, chloroform) and salts of lead and beryllium also taste sweet.

The piece of human tongue used was taken from the posterior position, a region which, like the tip, is sensitive to all the primary taste sensations; and the arrangement of the phosphatase was similar in all the taste buds examined, so it seems possible that phosphatase is not necessarily restricted to the buds concerned with the detection of any one of the primary tastes.

In view of the supposed similarity between the mechanisms of taste and smell, it is not surprising to find that substances to be smelled appear also to require to be passed through a phosphatase barrier; but the remarkable arrangement of phosphatase in the rabbit's nasal mucosa needs some explanation.

In addition to the chance of some connexion with the mechanism of taste and smell, there exists the possibility that the presence of phosphatase in the naso-buccal fluids may be concerned with some anti-infective mechanism. Thus it is of interest that it is the apparently serous alveoli in the Bowman's glands which contain phosphatase, and that in an acute infection such as a cold there is a great increase in serous secretion in the nose.

Full details of this work will be published elsewhere in due course. I am indebted to Dr. J. W. Sandells for the supply of human material and to Mr. J. King of the Bernhard Baron Institute, London Hospital, for the photomicrographs.

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DIETETIC HEPATIC LESIONS AND PROTEIN DEFICIENCY

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SEVERAL workers[1-14] have studied the hepatic lesions resulting from feeding deficient diets to experimental animals, and often produced fibrosis in the liver similar to that of human 'cirrhosis'. As a result of the recent researches a new orientation has been given to the etiology and treatment of liver diseases in general and 'cirrhosis of the liver' in particular. Himsworth, who has largely contributed to an understanding of this subject, in a recent monograph[17] has summarized the available evidence, both clinical and experimental, regarding nutritional factors in hepatic diseases.

Himsworth and Glynn[15,16] have distinguished two kinds of experimental dietetic injury in the liver, both of which resulted in hepatic fibrosis. Deficiency of protein (cystine) in the diet produced an acute massive hepatic necrosis, the survivors of which developed post-necrotic scarring and nodular hyperplasia. On the other hand, absence or deficiency of lipotropic factors in the diet, such as choline or methionine, resulted in fatty infiltration of the liver, which insidiously developed into diffuse hepatic fibrosis. By carefully devising the experimental diets, these workers were able to produce these two distinct lesions independently of each other. While there is general agreement that heavy prolonged fatty infiltration of the liver, however produced, leads to a diffuse hepatic fibrosis ('portal' or fatty cirrhosis), there is considerable disagreement regarding the production of acute massive necrosis and its sequelæ. Certain workers produce it consistently, others occasionally, yet others not at all. I personally have never been able to produce it in my laboratory in Bombay, although following closely the published directions. Since coming to England, however, I have seen it produced readily, and I have now amply satisfied myself of its occurrence, its dependence upon a low protein diet, and that it is, in fact, a true massive necrosis of the liver. It may, therefore, be of interest to record my experience in the hope of throwing some light upon the discrepancies between the results from different laboratories.

The incidence of 'cirrhosis of the liver' is high in certain parts of India, and it has been pointed out that "dietetic deficiencies appear to be the important factors in the causation" of the disease[18]. In view of its practical importance, an experimental investigation was undertaken under the auspices of the Indian Research Fund Association to study the role of nutritional factors in the production of hepatic cirrhosis. This investigation, which was commenced three years ago and is still in progress in the Department of Nutrition and Experimental Pathology, Haffkine Institute, Bombay, was designed to study the effect of continued feeding of diets containing varying levels of protein (5–18 per cent), and deficient in vitamins of the B$_2$ complex on the histological and biochemical changes in the liver of rats. Studies were also made on the effect of feeding low protein – high carbohydrate and low protein – high fat diets, and the effect of supplementing these diets with choline and methionine. Purified casein was used as the main source of protein, but in some experiments this was completely replaced by yeast protein. Either melted butter-fat, hydrogenated groundnut oil or groundnut oil formed the fat ration in the synthetic diets.

An analysis of the material collected during the last three years showed two prominent features: first, absence of acute massive necrosis of the liver or its sequelæ, in animals fed on low protein diets (including those which received yeast as the main source of protein); and secondly, varying degrees of fatty infiltration of the liver insidiously developing into diffuse hepatic fibrosis with accumulation of 'ceroid'. Full details of this work will be published shortly.

While no explanation is forthcoming regarding the constancy of producing massive necrosis of the liver by dietary means, several factors, such as differences in the susceptibility of different strains of experimental rats, nature of yeast used as the source of protein, climatic factors (hæmorrhagic necrotic lesions, even in England, appear to be more easily produced in winter than in summer), differences in the intestinal flora of experimental animals, etc., have been suggested to explain the difficulties in the production of the lesion. It was further suggested that the presence or absence of tocopherol (vitamin E) in the basal diets may have an important bearing in preventing or inducing necrosis of the hepatic parenchyma[19,20]. The possibility of a superadded infection producing the periportal hæmorrhages and acute massive necrosis of the hepatic parenchyma requires further investigation.

But whatever the ultimate explanation of the causation of massive hepatic necrosis, two things are certain now. First, a lesion in every way similar to human massive necrosis of the liver has at last been produced in experimental animals; secondly, a state of protein deficiency is an essential, if not the only, factor in the development of the lesion. Having these certainties, and considering the great practical implications of this work to medicine, it is of urgent importance to resolve the discrepancies between the results obtained in different laboratories. The first step to this end is for the work to be repeated in all the laboratories concerned using, not merely foodstuffs that are reputed to be similar, but identical foodstuffs directly drawn from the same stocks as are in use in those laboratories where positive results are consistently obtained.

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MEASUREMENT OF 'ENVIRONMENTAL RESISTANCE' IN THE AUSTRALIAN PLAGUE GRASSHOPPER

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LABORATORY and field experiments have shown that the Australian plague grasshopper, *Austroicetes cruciata* Sauss, is well adapted to live in the particular climatic zone where it is found[1]. An obligate diapause in the egg-stage ensures that the grasshopper produces only one generation each year[2]. Eggs are laid during November and December (late spring and early summer), but never hatch before the following August or September. Thus the active stages are present during two or three months in the spring when the physical environment is least severe. For the remaining nine months, comprising the hot dry summer and cool wet winter, the insects are in the soil in the egg stage, which is well adapted to resist desiccation during the summer and high humidity during the winter.

Nevertheless, variability of the weather in the grasshopper belt is such that all stages of the grasshopper are exposed to the risk of occasional heavy mortality from physical causes. It has been possible to assess the chances of heavy mortality due to several components of the physical environment. The calculations are no more than first approximations, since they are based on arbitrarily selected parameters of the weather and not on the whole distribution of records of rainfall, temperature and humidity for the fifty years used in the calculations. But we give them because they may interest ecologists who are concerned with the quantitative study of animal populations. The data on which the calculations are based are given in full in the publications cited.

During heat waves, the soil in which the eggs are laid may reach a temperature of 60° C., and at the same time the relative humidity of the soil atmosphere may be as low as 10–20 per cent. Laboratory experiments and field observations have shown that the probability of high mortality due to the direct effect of such high temperature in the summer is quite small[3]. On the other hand, the chances of death from desiccation is much greater. The severity of the summer dryness makes this the most critical period for the egg, despite the fact that the egg is more resistant to desiccation during the summer than at any other stage of its development[4]. The mortality of the eggs in the summer is related to the longest dry spell within the months November to April. A 'dry spell' is defined as the number of days during which the soil moisture is below the 'wilting point'. In the very dry summer of 1940, there was 90 per cent mortality of eggs in the driest part of the grasshopper belt. There the longest period without rain lasted 80 days, and during this period the total evaporation was 40·6 in. This severity of dryness had been reached or exceeded from one to seven times in the last fifty years, depending on the district. Hence the probability that the mortality of eggs in the summer will exceed 90 per cent is of the order 2–14 per cent[3].

In the winter the eggs are least resistant to desiccation, but the chance of dryness or excessive wetness causing high mortality is quite remote. In the early spring, however, there is a critical period at the time the eggs are hatching. Eggs may hatch in soil well below the 'wilting point', but under these conditions the nymphs are unable to escape from the pod because of the caked lid entrapping them. By methods analogous to those described above, it was estimated that 'high' mortality from this cause might occur about twelve times in a thousand years[3].

Information on the influence of dryness in the spring on the mortality of nymphs and adults was obtained from a detailed study of the weather during 1940. In September of that year the grasshoppers hatched in plague numbers, but by October it was virtually impossible to find a grasshopper anywhere. It was estimated that droughts, as severe as that in 1940 had occurred from three to five times during the past fifty years, depending on the district[5].

The calculations were made for several districts in the grasshopper belt. As an example, the figures for the district of Hammond are given in the accompanying table.

Stage	Cause of 'high' mortality	Probability of 'high' mortality
Egg in diapause	Desiccation during summer and autumn	0·10
Egg developing	Weather during winter and spring	nil
Nymphs in soil and about to hatch	Drought during August–September	0·01
Nymphs and adults (active stages)	Drought during spring and early summer	0·10
	Excessive humidity during spring	Not measured
Any stage	Any of above causes	0·21

Since the probability of a high mortality-rate occurring in any one year from any of the causes which have been measured is 0·21, the probability of this not occurring is 0·79. By expanding the binomial $(0{\cdot}21 + 0{\cdot}79)^n$, we can calculate the probability that any group of n years will contain 0, 1, 2 . . . n years in which high mortality will occur. For example, the probability that a sample of ten years will contain no 'high-mortality' year is 0·09; the corresponding figure for a sample of five years is 0·31. Within the limits of the parameters chosen, these figures give a quantitative measure of the favourableness of the environment for *A. cruciata*.

The table does not include any figures for parasitism or predation. Eggs are parasitized by a Scelionid wasp[6]; in the years studied, this did not exceed 1–2 per cent. Small numbers of eggs are also destroyed by a Bombyliid of the genus *Cyrtomorpha* and an unidentified Dermestid beetle. But the most important predators are birds, which feed on nymphs and adults. In years when grasshoppers are abundant, the population seems so vast in relation to the bird population that the percentage reduction in numbers of grasshoppers through predation is probably small. Observations in drought years suggest that predators may be important in causing heavy mortality in the isolated concentrations of grasshoppers that survive the drought. Food for the predators is then scarce and they are forced to seek out the remaining local situations where any grasshoppers remain. To this extent predation operates in the reverse direction to which parasitism would be expected to operate on a declining population[5].

The remarkable adaptation of the grasshopper to its semi-arid climatic zone enables it to build up a population over a number of years until drought causes a crash in numbers, both through its direct effect of desiccation on the grasshopper and indirectly through its effect on the food supply. The fact that grasshoppers and plants can continue to exist together in this belt must depend largely on the respite the vegetation is given in the ten months of the year in which the grasshopper is in the egg stage. So far as the grasshopper is concerned, the complete annihilation of nymphs in drought years is prevented by the existence of scattered niches, be they ever so small, where some food remains.

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RESEARCH IN INDUSTRY

WORKING PARTY REPORTS

UNLIKE the majority of the reports from other 'working parties' of the Board of Trade, that for the cutlery industry (H.M. Stationery Office, London, 1947, pp. 38. 1*s*. net) makes no specific recommendations for the organisation of research, although it suggests that much research could be co-ordinated with research in other industries, and that the co-operation of such organisations as the Production Efficiency Service of the Board of Trade should be very valuable. Its principal recommendation is the constitution of a tripartite Cutlery Board, all the members of which, including the chairman, would be appointed by the Board of Trade, one third of them from nominees of the employers' association, one third from nominees of the trade unions, and one third from independent persons outside the industry. This Board would presumably call on the assistance of the Department of Scientific and Industrial Research, as the industry is not wealthy and will need financial assistance for effective research. Suggestions for certain specific lines of research are appended to the report.

The 'working party' dealing with rubber-proofed clothing, in its report (H.M. Stationery Office, London, 1947, pp. 40. 1*s*. net), likewise makes no recommendation for the establishment of a fresh research organisation, although exercised both by the need for research in such neglected fields as those of machinery and ventilation, and by the need for rubber-proofed clothing manufacturers to show keener interest in the results of research already carried out, such as that on lighting, productive efficiency, the science of management, industrial psychology, and the development of new fibres. In advance of the setting up of any development council, trade organisations could do much by operating in conjunction with existing institutions, where relevant, such as the British Cotton Industry Research Association and the India Rubber Research Institute, to bring about a new attitude.

The 'working party' also suggests that the industry should consider making an early approach to the Department of Scientific and Industrial Research for advice and practical guidance in this field. An increasingly active interest in textile research and development, particularly new finishing processes, and also in the development of plastics, is a specific recommendation for action by the industry which indicates its past neglect and restricted outlook—defects possibly only to be corrected as the industry becomes conscious that it is a section or part of a larger industry.

The 'working party' for hand-blown domestic glassware, in its report (H.M. Stationery Office, London, 1947, pp. 143. 3*s*. net), devotes rather more attention to technical research and recommends consideration by the glass industry of the expansion of technical research for the whole industry by setting up a glass research association, which should have initially an annual income, including the contribution from the Department of Scientific and Industrial Research, of at least £25,000. The 'working party' recommends that the University of Sheffield should be asked to consider the possibility of permitting this research association to be established initially in the existing buildings of its Department of Glass Technology, and also of leasing some of the land belonging to the University, behind and adjacent to the present building, for the erection of new laboratories, etc., as the work of the Association develops. The research association should be provided with a staff separate from that of the Department of Glass Technology, although for a time the position of director of research might usefully be held by the head of the Department. The annual income of the research association should be increased within five years at most to about £50,000 to enable a machinery research and development section to be created.

From this recommendation there is one dissentient. While agreeing wholeheartedly with the view that greater facilities for co-operative research into glass and glass manufacture are urgently desirable, Prof. H. Moore does not entirely agree that the formation of a glass research association is essential. In his view, the existing Department of Glass Technology at the University of Sheffield, if properly staffed and financed, could make adequate provision for these additional research needs. It is pointed out in the report that the organisation and functions of this Department are very similar to those of a research association, differing chiefly in its constitution as a department of a university and in the inclusion of educational work. The value of this educational work is emphasized in the report, which notes that this Department is the only place in Britain where technical training for the glass industry is available; the close contact maintained with the industry through the other activities of the Department greatly enhance the value of that work, while the long-term postgraduate investigations proceeding in the Department ensure that its activities are not entirely engrossed in the solution of day-to-day problems or in short-term investigations.

The report itself scarcely supplies the data which would enable an outsider to judge between the merits of Prof. Moore's view and that of the majority of his colleagues; but economy considerations, particularly of man-power, might well provide a decisive reason for exploring the possibilities of his view first. Beyond this, however, in spite of the small size of the units in the hand-blown glass industry, development and extension of technical research in the individual factories is highly desirable, and one reason for welcoming the formation of a new trade association comprising all firms in this section of the industry is that it would enable more research to be done on co-operative lines in the factories themselves on their own special problems. In addition to emphasis placed on the early initiation of research on the development of new types of machinery and equipment for the industry, the establishment of a design centre for the industry as a whole, and all possible encouragement and assistance to the scheme for setting up in Edinburgh a department for advanced training and research in design for the glass industry, are other important recommendations; while in common with many of the other 'working parties', that for the domestic glassware urges the industry to refer to the Urwick Report on Education for Management, and make contact with the British Institute of Management, so that it can endeavour to draw its recruits for managerial positions from a wider field. Greater use of glass technologists who have graduated from the Department of Glass Technology at Sheffield, and further support both of the educational side of that Department and of the Society of Glass Technology, are specific recommendations.

FIFTH BRITISH EMPIRE FORESTRY CONFERENCE

GREAT BRITAIN, 1947

THE Fifth British Empire Forestry Conference met in London on Monday, June 16, 1947, and a Summary Report and Results and Reports of Committees have now been published (London: H.M. Stationery Office, 1947. Pp. 56. 1*s*. net). The opening meeting of the Conference was attended by Mr. Tom Williams, Minister of Agriculture and Fisheries, and Mr. Joseph Westwood, Secretary of State for Scotland. Lord Robinson was elected chairman, and Mr. D. Roy Cameron (Canada), Mr. A. P. F. Hamilton (India), and Dr. F. Y. Henderson (director, Forest Products Research Laboratory, England) were elected vice-chairmen. Seventy-one delegates, thirty-eight associate delegates, one honorary delegate and three guests—Mr. G. M. Hunt, director of the Forest Products Laboratory, Madison, United States, and Messrs. S. B. Show and J. D. B. Harrison, of the Forestry Branch of the Food and Agriculture Organisation of the United Nations—attended the Conference.

The proceedings were somewhat similar to previous conferences. A comprehensive agenda prepared by a standing committee on Empire forestry, after consultation with the various Empire forest authorities, was dealt with at sessions held in London and Oxford. Visits were also paid to the Forest Products Laboratory at Princes Risborough and to saw mills and timber yards in the neighbourhood of London. Part of the work consisted of visits to some of the extensive conifer forests under the management of the Forestry Commission, and some private woods in Northamptonshire, Dumfriesshire, and Darnaway, in the County of Moray. The Forestry Commission areas visited were East Anglia, Northumberland, Cumberland, Roxburghshire and the Black Isle in Ross-shire and Cromarty, and the Culbin Sands.

Thirty-six forest authorities presented statements on Empire forests during the War. These statements have been drawn up with the view of giving as much accurate information as is at present available on the subject of the total area of forests; total volume of standing timber and increment; output of home-grown woods and of imports and exports for pre-war years, and each of the war years; and the effect of the war-time exploitation on forest capital and the future increment.

Owing to the very heavy war fellings made in countries both within the British Empire and outside, it is probable that accurate figures will not be available for some time to come. Moreover, in many of the forests under the Colonial Office, which are tropical forests containing numbers of different species of tree, very little is yet known about the actual volume present of commercially utilizable timber, and many of them have had to bear heavy war fellings in the accessible parts.

A most interesting paper was prepared by Mr. Lyle F. Watt, chief of the Forest Service, United States Department of Agriculture, entitled "The Forest Situation in the United States". Reports were made on the steps taken to carry out the resolutions of the 1935 Conference. These resolutions were nine in number, and for the information available the summary report should be consulted.

Technical committees were appointed as follows: (*a*) Land Use; (*b*) Forest Management, Sylviculture and Protection; (*c*) Forest Products Research; (*d*) Survey and Resources; (*e*) Education; (*f*) Timber Supply.

Various resolutions were drawn up by these different committees and submitted to the main Conference at its final meeting on July 19. The next Conference will take place in 1952, either in India or Canada.

MAGNETIC FIELD OF MASSIVE ROTATING BODIES

IT may be permissible to add a footnote to the much-discussed article by Blackett[1], in which he examines the proportionality which seems to exist between the magnetic moment and angular momentum of massive rotating bodies such as the earth, sun and stars. He suggested that this simple result must have some profound physical significance, but that it seemed very probable that a satisfactory explanation would not be found except within the structure of a unified field theory. The purpose of this note is to direct attention to the claim of Prof. J. Mariani, of the Princeton Institute of Advanced Study, to have provided such an explanation and such a unified field theory. Mariani's more accessible publications appeared in *C.R. Acad. Sci. Paris*, **206**, 1247 (1938); **211**, 430 (1940); **218**, 447 and 585 (1944); and "Electromagnétisme et relativité" (Cahiers de Physique Théorique, Paris, 1945), Part 1. However, the present summary has been prepared from his latest work, "Théorie des champs macroscopiques"[2], and a communication submitted to *Nature* for publication among "Letters to the Editors".

Mariani's latest treatment starts from philosophic considerations, akin to those of Kant, concerning the impossibility of knowing 'the thing in itself'. From the point of view of the average physicist, this is unfortunate. Even if he has the patience to read it, he may merely draw the depressing conclusion that no objective scientific measurement can exist. The next section of the work is something like a generalized theory of relativity, but with many coefficients that are quite indeterminate. Then suddenly, by means of a principle of identification, the treatment becomes much more definite. All the equations, except one, reduce to something like the ordinary gravitational theory of relativity. The one exception is the distinctive point of the theory, and its significance seems to be that a gravitational field must necessarily be accompanied by an electrical field.

The application of the theory to massive rotating bodies then proceeds very much on the lines of Sutherland, whose work is discussed in Blackett's article. The earth is supposed to have a positive volume charge compensated by a negative surface charge. This gives the desired proportionality between magnetic moment and angular momentum. The constant of proportionality is worked out for the earth, the sun, and the milky way, and shown to be of the right order of magnitude. It is also shown that for a copper sphere of radius 10 cm. making 200 revolutions per second, the magnetic field is too small to be observed. This agrees with the experiment of Swann and Longacre, also discussed by Blackett.

Those who are interested in the matter will wish to examine Mariani's arguments for themselves; they will probably find the four short papers in *Comptes Rendus* easier to understand than the fuller and more philosophic version.

H. T. H. PIAGGIO

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[1] Blackett, *Nature*, 159, 658 (1947).

[2] Théorie des champs macroscopiques. Par Jean Mariani. Pp. ii+98. (Paris: Centre de Documentation universitaire, 1947.) n.p.

RECENT SOCIOLOGICAL PERIODICALS

APART from the specialized field of economics, Britain has, until recently, suffered from a lack of journals devoted to the social sciences. The deficiency is now being made up by a variety of periodicals. *Pilot Papers*, as their subtitle of "Social Essays and Documents" suggests, usually take a wide sweep; but the number for June 1947 is devoted largely to American sociology. It contains a detailed review, by Dr. E. A. Shils, of recent American contributions to urban sociology, class stratification and race, family and small group problems, for which all students must be profoundly grateful. There is also an admirable study of the American child by Mr. Gorer, stressing the dictatorship of such factors as the 'scientific feeding schedule' and the fear of being thought a 'sissy'.

American-type sociology is distinguished by using induction from collections of observed fact rather than philosophical deduction. Its methods are thus more akin to those of the natural sciences than the methods of the sociology and economics mainly pursued in Europe. The facts observed may be opinions and attitudes; and one welcomes the first volume of the *International Journal of Opinion and Attitude Research*, edited by Prof. Radvany, of the University of Mexico, with contributions from H. D. Lasswell, Henry Link and Tom Harrisson. The facts observed may also be the behaviour of human beings one to another, and to study behaviour as well as attitudes, a new journal, Anglo-American rather than fully international, is being launched under the title of *Human Relations*. The first number contains an intriguing article by the late Kurt Lewin, a leader in sociological thought and technique as yet almost unknown in Britain. To an equilibrium economist his reduction of such social situations as unhappy marriages, restriction of industrial output or aggressiveness among boys to an equation of conflicting forces must be interesting and flattering. *Human Relations* also contains a survey of prejudice in a seaside town, and studies of the civil resettlement of British prisoners of war, and of a scheme for residential management in treating difficult children. The theoretical essays are thus well balanced by articles descriptive of current procedures. Occasionally, as in an unnecessarily complicated account of a fairly simple experiment in industrial training, the writing is wordy and pedantic.

The wide field of contemporary social activity now being approached in the scientific mood is clearly illustrated in these current periodicals. Quite apart from their admirable American articles, *Pilot Papers* contain in the two numbers for June and September 1947 a much-needed analysis of bureaucrat behaviour, of B.B.C. 'third programme' listening and of the conception of progress in general (by Dr. Julian Huxley) and its practice in agriculture in particular. There are also first-hand experiences of service on a jury, the 'closed shop', and rent tribunal procedure. We look forward to further numbers of all these ventures in modern sociology. P. SARGANT FLORENCE

NORTHERN IRELAND FISHING INDUSTRY DEVELOPMENTS DURING THE WAR YEARS

PRIOR to the outbreak of the Second World War, the inhabitants of Northern Ireland exported to Great Britain most of the fish they caught, and imported from Britain most of the fish that they ate. During the war years, however, the consuming public became much more dependent on their own locally caught fish and only surpluses were exported.

In a "Report on Sea and Inland Fisheries", recently published by the Government of Northern Ireland*, these and other war-time changes are reported. As no figures of production and trade exchange could be published during the War because of the statistical 'blackout', this report includes tables for the six-year period 1939–44.

The developments that took place in the Northern Ireland fishing industry during the years under review are indicated by the fact that herring catches in 1944, totalled 50,895 cwt. as compared with 39,467 cwt. in 1938, and whiting catches rose from 17,061 cwt. in 1938 to no less than 64,619 cwt. in 1944. The total value of fish (excluding salmon) landed on the coast in 1944 was £258,427.

Taking all kinds into account, the quantities of sea fish landed in 1944 increased to approximately double the pre-war figure. The total number of fishing boats in Northern Ireland was 508 in 1944, a decrease of 51 boats compared with 1938. Motor boats, however, increased from 314 to 338 in this period, and vessels solely engaged in fishing increased from 109 to 149 in 1944. The number of men employed in sea fishing increased from 898 to 1,031, of which latter figure 555 were whole-time fishermen, the highest number to be so engaged since the year 1930. The chief factor in this increase in the number of fishermen was the main County Down fleet, which increased from 45 vessels in 1938 to 56 in 1944.

The report states that the scheme of loans and conditional grants authorized in 1941, combined with greatly increased earnings by fishermen, gave the necessary incentive for the replacement of older craft by vessels of modern design. By the end of 1944, a substantial number of new craft designed for herring fishing and seine netting was either in commission or under construction in spite of war-time shortages. In the years covered by the report, loans exceeding £24,000 were advanced by the Ministry.

There is also a year-by-year review of inland fishing. Reference is made to the fact that in several hatcheries artificial propagation of salmon was carried out. The year 1943 was the best pollan season in Lough Neagh since 1927. High prices in cross-Channel markets greatly helped to stimulate the activities of the freshwater fishermen. On account of the scarcity of fish in Great Britain, considerable impetus was given to the capture of coarse fish in rivers and lakes in Northern Ireland. In the Lough Erne district alone, the total exports of coarse fish in 1944 increased to almost a hundred tons.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 22

ASSOCIATION OF APPLIED BIOLOGISTS (in the Botany Lecture Theatre, Imperial College of Science, South Kensington, London, S.W.7), at 11 a.m.—Discussion on "Biological Aspects of Water Pollution".*

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—Dr. K. M. Strom: "The Geomorphology of Norway".

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. T. J. Meyrick and Dr. J. T. Watts: "Polyisocyanates—some Applications in Bonding".

Tuesday, March 23

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Miss K. Speight: "Sicily, the Garden of the Mediterranean".

TEXTILE INSTITUTE, LONDON SECTION (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6.30 p.m.—Mr. F. Courtney Harwood: "The History and Science of Washing".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Dr. N. P. Allen: "Some Techniques and Results in Metallurgical Research".

Wednesday, March 24

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Users' Questions on the Universal Decimal Classification Answered.

PALESTINE HOUSE (at 18 Manchester Square, London, W.1), at 5.45 p.m.—Dr. Clay Lowdermilk: "The Jordan Valley Scheme".*

ROYAL MICROSCOPICAL SOCIETY, INDUSTRIAL MICROSCOPY SECTION (at B.M.A. House, Tavistock Square, London, W.C.1), at 6 p.m.—Mr. H. L. Shipp: "The Microscopy of Food".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (joint meeting with the BRITISH DIETETIC ASSOCIATION, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. D. P. Cuthbertson and Miss R. M. Simmonds: "Special Dietary Requirements in Sickness and Convalescence".

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (at the Victoria Station Hotel, Nottingham), at 7 p.m.—Mr. G. H. Lister: "The Absorption of Acid and Chrome Dyes by Wool".

CHEMICAL SOCIETY, ABERDEEN SECTION (joint meeting with the LOCAL SECTIONS of the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, at Marischal College, Aberdeen), at 7.30 p.m.—Prof. E. E. Turner: "Some Stereochemical Problems".

Thursday, March 25

BRITISH INSTITUTION OF RADIO ENGINEERS, MIDLAND SECTION (at the Technical College, The Butts, Coventry), at 6.30 p.m.—Mr. N. E. Head: "Methods of Measuring the Insertion Loss, Phase-Shift and Time Delay of Transmission Networks".

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* Report on Sea and Inland Fisheries, 1942–1944. Pp. 20. (Belfast: H.M. Stationery Office, 1947.) 1*s*. net.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

LECTURER IN ANATOMY—The Registrar, The University, Sheffield (March 27).

ASSISTANT MANAGER (DEVELOPMENT) (Ref. No. F.176/48), SHOP MANAGERS (DEVELOPMENT) (Ref. No. F.177/48), a SHOP MANAGER (CHEMIST) (Ref. No. F.178/48), and a SHOP MANAGER (PLANT MAINTENANCE) (Ref. No. C.131/48), in the Department of Atomic Energy, Springfields Factory, Salwick, Preston—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting relevant Ref. No. (March 30).

STATISTICIAN (No. A92/48A), and a STATISTICAL OFFICER (No. A461/47A), in the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting relevant Ref. No. (March 31).

ASSISTANT DIRECTOR (PHYSICS)—The Director, Gas Research Board, 1 Grosvenor Place, London, S.W.1 (March 31).

SENIOR EXPERIMENTAL OFFICER in the Ministry of Supply, London, to supervise the valve interests of the Signals and Radar Research and Development Establishments and the secretariat of Inter-Service Technical Valve Committees—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting D78/48A (April 3).

SENIOR RESEARCH OFFICER IN THE BIOCHEMISTRY SECTION of the Division of Industrial Chemistry, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1623 (April 10).

SENIOR RESEARCH OFFICER IN THE BUILDING MATERIALS RESEARCH SECTION, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1618 (April 10).

ASSISTANT LECTURER (Grade III) IN GEOLOGY—The Registrar, Queen Mary College, Mile End Road, London, E.1 (April 15).

CHAIR OF GEOPHYSICS in the University of Istanbul—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (April 15).

CHAIR OF ANGLO-SAXON ARCHÆOLOGY at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 16).

STATISTICIAN in the Department of Preventive Medicine—The Secretary and Registrar, The University, Bristol (April 17).

ASSISTANT LECTURER IN BOTANY (if possible with interest or experience in cytology and genetics), an ASSISTANT LECTURER IN ORGANIC CHEMISTRY, a LECTURER IN MATHEMATICS (with special qualifications in pure mathematics), ASSISTANT LECTURERS (2, one in Applied Mathematics and one in Pure Mathematics), an ASSISTANT LECTURER IN PHYSICS (preferably with experience in radar or geophysics), and an ASSISTANT LECTURER IN ZOOLOGY (preferably with experience in experimental cytology or genetics)—The Registrar, University College, Hull (April 17).

AGRICULTURAL ECONOMISTS (2), ASSISTANT AGRICULTURAL ECONOMISTS (3, Grade B), a LECTURER IN THEORETICAL PHYSICS, and an ASSISTANT LECTURER IN THEORETICAL PHYSICS—The Registrar, The University, Manchester 13 (April 17).

ENTOMOLOGIST in the Inter-Territorial Tsetse Reclamation Department, East Africa High Commission (Kenya)—The Under-Secretary of State, Colonial Office (Research Department), Palace Chambers, Bridge Street, London, S.W.1 (April 24).

LECTURERS (2) IN MECHANICAL ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING—The Registrar, The University, Leeds 2 (April 24).

BRITISH COKE RESEARCH FELLOWSHIP tenable in the Department of Physical Chemistry—The Registrar, King's College, Newcastle-upon-Tyne (April 30).

TURNER DENTAL SCHOOL RESEARCH FELLOWSHIP, and the INTERNATIONAL WOOL SECRETARIAT SCHOLARSHIP—The Registrar, The University, Manchester 13 (April 30).

PROFESSOR OF BACTERIOLOGY in the University of Queensland—The Agent-General for Queensland, 409 Strand, London, W.C.2, or the Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Brisbane, May 31).

LABORATORY TECHNICIAN (Grade B.1, histological technique essential) IN PATHOLOGY DEPARTMENT—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff.

AGRICULTURAL ECONOMIST, an ASSISTANT AGRICULTURAL ECONOMIST, and a DEMONSTRATOR IN PHARMACY—The Registrar, University College, Nottingham.

TECHNICAL ASSISTANT to assist in steelworks investigations, mainly in connexion with ingots and moulds—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Ingots'.

SENIOR LABORATORY STEWARD—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

ASSISTANT BACTERIOLOGIST IN VACCINE LYMPH DEPARTMENT—The Bacteriologist-in-Charge, Lister Institute, Elstree, Herts.

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

Memoirs of the Cotton Research Station, Trinidad. Series B, Physiology, No. 18 : Studies on Foliage Hydration in the Cotton Plant, vii. The Size Factor. By T. G. Mason. Pp. 143–152. (London : Empire Cotton Growing Corporation, 1947.) 2*s*. 6*d*. [225

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 20 : Chick Mortality caused by War-Grade Wheat Offals. By Brendan J. Senior and Prof. W. Kearney. Pp. 293–310. (Dublin : Hodges, Figgis and Co., Ltd. ; London : Williams and Norgate, Ltd., 1947.) 2*s*. [225

Scientific Proceedings of the Royal Dublin Society. Vol. 24 (N.S.), No. 18 : On a Recent Addition to the Collection of Irish Meteorites in the National Museum, Dublin. By Prof. H. J. Seymour. Pp. 157–164 + 1 plate. 2*s*. Vol. 24 (N.S.), No. 19 : Irish Salmon, 1945. By Arthur E. J. Went. Pp. 165–178. 3*s*. Vol. 24 (N.S.), No. 20 : Salmon of the Kerry Blackwater. By Arthur E. J. Went. Pp. 179–188. 2*s*. Vol. 24 (N.S.), No. 21 : Effect of Mild Strains of Virus X on the Yield of Up-to-date Potato. By Phyllis E. M. Clinch and Robert McKay. Pp. 189–198. 2*s*. (Dublin : Hodges, Figgis and Co., Ltd. ; London : Williams and Norgate, Ltd., 1947.) [225

Foreign Office. Report of the Interdepartmental Commission of Enquiry on Oriental, Slavonic, East European and African Studies. Pp. 192. (London : H.M. Stationery Office, 1947.) 3*s*. net. [225

Report of the Ministry of Health for the Year ended 31st March 1946, including the Report of the Chief Medical Officer on the State of the Public Health for the Year ended 31st December 1945. (Cmd. 7119.) Pp. vi + 194. (London : H.M. Stationery Office, 1947.) 3*s*. 6*d*. net. [275

Medical Research Council. Special Report Series, No. 260 : The Bacteriology of Spray-dried Egg, with particular reference to Food Poisoning. By Various Authors. Pp. 66. (London : H.M. Stationery Office, 1947.) 1*s*. net. [275

University of Cambridge : School of Agriculture. Memoir No. 18 : A Summary of the Papers published by the Members of the Staff of the School of Agriculture and its Associated Research Institutes during the Period Oct. 1st, 1945–Sept. 30th, 1946. Pp. 28. (Cambridge : School of Agriculture, 1947.) 2*s*. [275

Education (Scotland). Report for the Year 1946 by the Director of the Royal Scottish Museum, Edinburgh. Pp. 16. (Edinburgh : Royal Scottish Museum, 1947.) [275

Ovaltine Research Laboratories. Annual Report (1946). Pp. 8. (London : A. Wander, Ltd., 1947.) [275

Liverpool Observatory and Tidal Institute. Annual Report, 1946. Pp. 14 + 3 plates. (Liverpool : Liverpool Observatory, 1947.) [275

Ministry of Agriculture and Fisheries. Bulletin No. 22 : Practical Soil Sterilization, with Special Reference to Glasshouse Crops. Fourth edition. Pp. iv + 22 + 10 plates. 1*s*. 3*d*. net. Bulletin No. 95 : Strawberries. Third edition. Pp. iv + 38. 2*s*. net. (London : H.M. Stationery Office, 1947.) [285

Other Countries

Indian Forest Bulletin. No. 130 : The Effects of Burning on the Soil as a Preliminary to Artificial Regeneration. By Dr. A. L. Griffith. Pp. iv + 34. 1.4 rupees ; 2*s*. No. 132 : The Price-Age Gradient of Bori (Hoshangabad, C.P.) Teak. By Bakhshi Sant Ram. Pp. v +15+8 plates. 1.4 rupees ; 2*s*. (Dehra Dun : Forest Research Institute, 1946.) [225

Fieldiana : Zoology. Vol. 31, No. 11 : A New Race of Koklas Pheasant. By Robert L. Fleming. Pp. 93–96. 10 cents. No. 12 : Some Neuropterous Insects from Szechwan, China. By Nathan Banks. Pp. 97–108. 15 cents. No. 13 : A New Kinosternid Turtle from Colombia. By Karl P. Schmidt. Pp. 109–112. 10 cents. No. 14 : The Malleus (*Ossiculum auditus*) of the Anthropoid Apes. By Walter Segall. Pp. 113–120. 10 cents. No. 15 : Notes on Philippine Mosquitoes, ii, A New Species of *Tripteroides*. By F. E. Baisas. Pp. 121–124. 10 cents. (Chicago : Chicago Natural History Museum, 1947.) [225

Fieldiana : Zoology. Vol. 32, No. 1 : Phalangida from Tropical America. By Clarence J. and Marie L. Goodnight. Pp. 58. 75 cents. (Chicago : Chicago Natural History Museum, 1947.) [225

Smithsonian Miscellaneous Collections. Vol. 107, No. 1 : The Ethnogeographic Board. By Wendell Clark Bennett. (Publication 3889.) Pp. viii + 135. (Washington, D.C. : Smithsonian Institution, 1947.) [225

Report of the Science Service, Dominion Department of Agriculture, for the Year ended March 31, 1946. Pp. ii+88. (Ottawa : King's Printer, 1946.) [225

Excerpta Medica : Fifteen Journals containing Abstracts of the World's Literature in the Field of Clinical and Theoretical Medicine. Section 1 : Anatomy, Anthropology, Embryology and Histology. 22 dollars ; £5.12.0 a year. Section 2 : Physiology, Biochemistry and Pharmacology. 45 dollars ; £11.3.0 a year. Section 3 : Endocrinology. 15 dollars ; £3.15.0 a year. Section 4 : Public Health and Social and Industrial Medicine. 22 dollars ; £5.12.0 a year. Section 5 : General Pathology, Pathological Anatomy and Bacteriology. 37.50 dollars ; £9.6.0 a year. Section 6 : Internal Medicine. 37.50 dollars ; £9.6.0 a year. Section 7 : Pediatrics. 15 dollars ; £3.15.0 a year. Section 8 : Neurology and Psychiatry. 22 dollars ; £5.12.0 a year. Section 9 : Surgery. 25 dollars ; £6.4.0 a year. Section 10 : Obstetrics and Gynaecology. 15 dollars ; £3.15.0 a year. Section 11 : Oto-, Rhino-, Laryngology. 15 dollars ; £3.15.0 a year. Section 12 : Ophthalmology. 15 dollars ; £3.15.0 a year. Section 13 : Dermatology and Venereology. 25 dollars ; £6.4.0 a year. Section 14 : Radiology. 15 dollars ; £3.15.0 a year. Section 15 : Tuberculosis. 15 dollars ; £3.15.0 a year. (Amsterdam : N.V. Excerpta Medica, 1947). [225

Dermatology and Venereology : Being Section 13 of Excerpta Medica. Vol. 1, No. 1, April. Pp. 96. (Amsterdam : N.V. Excerpta Medica, 1947.) 25 dollars ; £6.4.0 a year. [225

Svenska Hydrografisk-Biologiska Kommissionens Skrifter. Tredje Serien, Hydrografi, Band 1, Häfte 2 : The Piston Core Sampler. By B. Kullenberg. Pp. 46. (Göteborg : Elanders Boktryckeri A.-B., 1947.) [275

Tekniska Föreningen i Finland : Medlemsförteckning. Pp. vi + 56 + xxiv. (Helsingfors : Mercators Tryckeri, 1947.) [275

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NATURE

No. 4091 SATURDAY, MARCH 27, 1948 Vol. 161

CONTENTS

Page
Mobility of Man-Power in Britain 453
Origins of Species and Migrations of Floras. By Prof. I. Manton . 455
Radioelements as a Tool in Scientific Research. By Prof. F. A. Paneth, F.R.S. 456
Ecological Problems of the Highlands and Hebrides. By Prof. A. D. Peacock 457
Political Testament of an Anthropologist. By Dr. E. R. Leach . 457
History of Anæsthesia. By Dr. G. Edwards 458
Pure and Applied Seismology. By Lieut.-Colonel E. Tillotson . 459
Archæology at Oxford. By Miles Burkitt 459
Adsorption and Heterogeneous Catalysis. By Prof. Eric K. Rideal, O.B.E., F.R.S. 461
The Main Geomagnetic Field. By Prof. S. Chapman, F.R.S. . 462
Structure of an Animal Virus. By Dr. I. M. Dawson and Dr. A. S. McFarlane 464
New Fellows of the Royal Society 466
News and Views 467

Letters to the Editors:

A 16-MeV. Betatron.—K. J. R. Wilkinson, J. L. Tuck and R. S. Rettie 472
Applications of the Reflecting Microscope to the Nuclear Plates Technique.—Dr. W. J. Bates and Dr. G. P. S. Occhialini . 473
A New Method for the Determination of the Mass of Mesons.—Dr. C. F. Powell and Dr. S. Rosenblum 473
Interaction of Fast Neutrons with Indium.—S. G. Cohen . 475
Ultrasonic Dispersion in Organic Liquids.—Dr. A. Schallamach 476
Magnetic Susceptibility of Mica.—J. T. Kendall and D. Yeo . 476
A Large Field Compensator for Measurement of Birefringence.—P. E. Jellyman and A. J. Milne 477
New Bands in the Schumann – Runge System of the Oxygen Molecule.—Lalji Lal 477
Meteor Whistles.—H. V. Griffiths, S. E. Martingell and R. W. Bayliff 478
Open-Hearth Furnace Models.—A. R. Philip 479
Effect of Ionic Charges on the Energy and Entropy of Activation of Heterolytic Reactions.—J. Gripenberg, Prof. E. D. Hughes and Prof. C. K. Ingold, F.R.S. 480
Synthesis of Dehydro-β-ionone.—Dr. H. B. Henbest . . 481
The Non-Benzenoid Aromatic Hydrocarbon Pentalene.—D. P. Craig and Allan Maccoll 481
Xanthotoxin from the Fruits of *Ammi majus* L.—Prof. Alexander Schönberg and Aly Sina 481
Active Penetration of Fat into Adipose Tissue.—B. Shapiro, D. Weissmann, V. Bentor and E. Wertheimer 482
Peripheral Action of Botulinum Toxin.—Dr. N. Ambache . 482
Secondary Thickening in Excised Tomato Roots.—Dr. K. J. Dormer and Dr. H. E. Street 483
Second Occurrence and Persistence of the Amphipod *Orchestia bottae* M. Edwards in Britain.—A. J. Cain and D. H. Cushing 483
New Formulation of D.D.T. with Selective Properties.—Dr. W. E. Ripper, R. M. Greenslade, J. Heath and K. Barker . 484
Dependence of Anomaloscope Matching on Viewing-Distance or Field-Size.—R. G. Horner and E. T. Purslow 484
Mr. E. Westlake and the Geology of the Cantal Region, Central France.—G. Maynard and Aubrey T. Westlake . . . 484
Growth of Glacier Crystals.—G. Seligman 485
Disintegration of Highly Excited Nuclei. By D. H. Perkins . 486
Relationships of Vapour Pressure, Capillarity and Temperature in Clays. By B. Vassiliou and Dr. J. White 487
Relation of Manganese and Some Other Metals to the Iron Status of Plants. By Eric J. Hewitt 489
National Research Council of Canada : Annual Report . . 491
British Electrical and Allied Industries Research Association : Annual Report. By J. G. 492
Rh Nomenclature. By A. E. Mourant 492
Proposed Institute of Recorded Sound 493
Recent Scientific and Technical Books . . . . . Supp. ii

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MOBILITY OF MAN-POWER IN BRITAIN

THE broadsheet "Man-power Movements" (No. 276), which Political and Economic Planning issued in January, develops further a theme on which an earlier broadsheet, "Framework of Collective Bargaining" (No. 272), published in October, had touched slightly ; a theme the importance of which has been accentuated by the growing seriousness of the economic situation of Great Britain. The existence of that crisis was not clearly recognized when the "Economic Survey for 1947" (Cmd. 7046) was issued, and even now the imminent risk of a further and still more serious reduction in our standard of living is not widely appreciated. Too little is still known, as this new broadsheet reminds us, about productivity ; it is recognized that redistribution of man-power is essential in order to realize the projected investment and consumption programmes, but the point is clearly made that man-power movements alone are insufficient. Economic planning is equally a matter of management, machines, materials, money and, as the broadsheet says pointedly, ministries ; and the value of man-power policy depends on its appropriateness in relation to other policies and to their general aim, which must contribute towards keeping the economy in balance.

What should be remembered in considering the Control of Engagement Order, 1947, is that no steps were taken in 1945–46, comparable with the measures adopted in war-time, to see that workers went where they were most likely to be needed. Serious political difficulties would have been involved in any attempt to guide more positively the flow of labour from the Armed Forces and from war industries. Various measures of control were, however, retained for a time over the movements of coal-miners, agricultural, building and textile workers, nurses and Civil servants. The real gravamen of the criticism of the policy then adopted is that the public was not made to realize that wider measures of control might be necessary, and nothing positive was done to correct the dangerous tendencies. The smoothness of demobilization was, indeed, partly due to the fact that workers were going where they wanted to go, irrespective of where they might be most needed ; and even the Economic Survey for 1947, in noting the shortage of workers in coal-mining, textiles and agriculture, did not face the fact that transfer from, or restraint of expansion in, other industries might be necessary.

The *Planning* broadsheet maintains that neither the premature exhaustion of the United States loan nor the further deterioration in the terms of trade altered the situation so drastically between February and September 1947 that planning could not last year have been visualized as a problem of securing the acceptance of uncomfortable measures necessary to realize the plans. The main problems of man-power were recognizable two years ago, and very slow progress has been made towards solving them. The present requirements are, first to effect an immediate improvement in the 'bottle-neck' industries; next to expand production (as distinct from productivity) in industries devoted to exports, import substitutes and certain consumer goods; thirdly, to increase the output per man-hour so far as the concentration of investment on the second permits, and where necessary to increase hours of work; and last, to restrict production in those industries which compete for labour and raw materials with the industries already indicated.

In regard to the first, P.E.P. considers that it is doubtful whether enough has yet been done to solve the problems of 'bottle-neck' industries through a more efficient use of their products. There are two other methods of adjusting deficiencies in such industries without inter-industrial movements of man-power. Output per man hour could be increased by better organisation of production by managements, the use of more or better machinery or by a voluntary increase in effort due to improved worker – management relations, national appeals or material incentives—improved quality of the products could also help—but if these methods fail, the working of longer hours may be necessary as a last resort.

Dealing then with the size of the problem, the broadsheet maintains that the whole concept of an absolute, general shortage of labour is dangerous and misleading, tending to distract attention from the fact that the targets are too high and from the need to increase productivity. Furthermore, it points out that difficulties arise not from the fact that large numbers are required, but from the unattractiveness of the jobs, and from such problems as housing in areas where industries urgently need workers. It raises the question whether the Control of Engagement Order should ever have been imposed, even if it were certain that it would solve the immediate problem. Political and Economic Planning maintains that the present problem is exceptional only in degree, not in its nature, and that the maintenance of 'full employment' will always necessitate measures to combat the rigidity of labour distribution. Finally, it attributes the distortion of the labour structure from the pattern dictated by present needs primarily to the fact that for many years Great Britain has been enjoying a substantial proportion of free imports.

Nothing less than the whole future of 'full employment' in Britain is at stake. The broadsheet directs attention to the importance of the workers having complete confidence in the security of employment if mobility is to be secured; and it makes its most important point in insisting here that it is necessary to convince workers also that a degree of mobility between industries is permanently needed if full employment is not to prejudice the efficiency and adaptability of the economy. A fresh approach should be made by the whole Government public relations service, with which the National Joint Advisory Council should co-operate to the full. Labour controls cannot provide the answer to the long-term problem of distributing labour, and some method must be found which will be flexible. efficient, secure, and retain the confidence of both employers and workers, and make use of the natural motives and incentives normally influencing the individual. Our lack of knowledge about these motives and incentives makes the need for research and experiment only the more urgent.

One field for research suggested in the broadsheet is a study of the high degree of mobility which appears to exist among the professional and managerial classes; such a study might yield valuable information for the basis of an incentives policy, which is as essential as some sort of wages policy. Again, the need for research into the statistical, geographical, industrial, social and psychological factors affecting labour distribution and mobility is urgent. The results of the research should be given the widest publicity. There may well be great scope in this field for the British Institute of Management, though official initiative is also important; *Planning* welcomes the recent establishment of a Scientific Committee on Industrial Productivity. One of the most urgent needs is for an inquiry to supply the data on the occupational distribution of the population which would have been provided by the Population Census of 1941. The public needs the fullest possible basis of knowledge to enable judgments to be made on the man-power problems of full employment, and no one concerned to see public policy guided by knowledge and reason rather than prejudice should fail to support P.E.P. in its contention or to press on the Ministry of Labour the opportunity it has there, since the control and co-ordination of the strategy of man-power planning must be centralized in its hands.

The account of collective bargaining which P.E.P. offers in its broadsheet on this subject (No. 272) as a contribution to public understanding is valuable, and forms one of a series of studies in British trade unionism being published. It is primarily factual and descriptive, and brings up to date material contained in the Industrial Relations Handbook published in 1944 by the Ministry of Labour; but it also covers certain subjects, such as wages councils, which are not included in that Handbook. It thus helps to fill the need for a comparatively simple guide to the main varieties of collective agreement and the way in which they have developed.

The broadsheet shows that nearly 90 per cent of the insured workers of Great Britain are covered by negotiating machinery of one kind or another, and of these about one third are in six great key industries, all of which have developed their own characteristic machinery on a voluntary basis. Another third are in industries covered by the Whitley system of national joint industrial councils. The admirable description of this system is the feature of the broadsheet of most interest to the scientific worker; although there is no discussion of the problems arising out of the association of the professional worker or manager with such bodies. The remaining third are covered by statutory wage-fixing machinery; this section of the broadsheet deals with the Wages Council Act of 1945, which renamed and reorganised the old Trade Boards.

Both broadsheets 272 and 276 emphasize the point made in an earlier broadsheet on "The Plan and the

Public", and which Sir Oliver Franks brought out so well in concluding his Sydney Ball Lecture, "The Experience of a University Teacher in the Civil Service", regarding the vital importance of public relations work in securing effective co-operation. Unless the generalities in which Government economic policy is contained can be effectively interpreted and communicated to those required to help in carrying out the policy, methods of reason may break down. The chief responsibility for setting policies before the public must rest with Ministers. But some responsibility must also rest upon Civil servants in their many dealings with the public, and on management. It will often depend on how they expound and administer a policy whether the conception of something 'we' are committed to carry through replaces that of something 'they' have ordained.

ORIGINS OF SPECIES AND MIGRATIONS OF FLORAS

The Genus Crepis

By Ernest Brown Babcock. (University of California Publications in Botany, Vols. 21 and 22.) Part 1: The Taxonomy, Phylogeny, Distribution and Evolution of Crepis. Pp. xii + 198. 3.50 dollars. Part 2: Systematic Treatment. Pp. x + 199–1030 (36 plates). 10 dollars. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1947.)

THE appearance of Babcock's monograph after four years delay in the press, due doubtless to the War, is an event of considerable importance, not only to botany but also to the biological sciences in the widest sense. Familiar as are parts of it to specialists, through the publication of numerous papers during a period of over twenty-five years, the collation of all this work in monographic form should bring it into the hands of a far wider circle of readers.

Part 2, the larger portion, resembles at first sight a systematic monograph of the ordinary type. It contains the morphological background to the cytogenetic work obtained by the use of all the ordinary criteria available to taxonomy; for example, comparison of herbarium specimens, collation of literature, etc., illustrated by outline drawings to a uniform scale of almost all the 185 species which are described. It contains, however, far more than this. For the first time, in a work of this magnitude, cytogenetic information on a scale unknown in any other group of plants or animals, not even excepting *Drosophila*, is included. It is true that from the point of view of pure genetics individual species such as *D. melanogaster* or *Zea Mays* far exceed anything which has yet been attempted in *Crepis*. We have here, on the other hand, a cytological record, in many cases amplified by genetical information derived from inter- and intra-specific crosses, of no less than 113 species of a monophyletic genus which spreads from Eurasia to Africa and America, a genus, moreover, which is exceptional among plants for the low number and large size of its chromosomes. Full credit is given in the introductory paragraph to Part 1 to the early work of Rosenberg, Juel and Digby, who first detected $n = 3$ in *Crepis capillaris* and $n = 4$ in *C. tectorum*. To Babcock is due, however, the credit of recognizing the importance of low chromosome number in 1915, and for having stimulated by his exertions not only a numerous school of collaborators in the United States, but also some outstanding cytological workers in the Old World, notably the Russian school under Nawaschin. The result is a display of cytological information which has never previously been equalled and which will long remain unsurpassed. The incorporation of this knowledge in the systematic monograph places it at once in a class apart.

Scarcely less important are the geographical data included in the numerous distribution maps appended to the various sections of the genus. Until quite recently information about the floras of large tracts of country, notably in central and north-eastern Asia, was so meagre as to preclude an effective treatment of the plant geographical development of the floras of the northern hemisphere considered as a whole, with the result that an over-emphasis on Europe led to very widespread misconceptions on the order and importance of events which are only now becoming apparent. Recent phyto-geographical exploration of these missing regions, notably by Hultén[1], is profoundly altering previous concepts, and it so happens that north-eastern Asia turns out also to be of fundamental importance in the evolution of *Crepis*. The collation of the geographical evidence on plant migrations with the cytogenetic evidence on the order of evolution of species is not the least important part of the whole work. The detailed discussion of endemism in this context, enriched with the certain knowledge as to which endemics are relics and which innovations, knowledge which is impossible without the type of cytogenetic and morphological data here assembled, also enables the author to discuss not merely plant migrations and the origin of the floras of four continents, but also cognate matters such as the theory of 'age and area', with effectiveness and, in part at least, with the semblance of finality.

These matters are dealt with in Part 1 of the work under review, and their close perusal is much to be recommended to geographers, zoologists and botanists interested in other groups inhabiting these regions. Part 1 also contains, among other things, the summary of the main cytogenetic conclusions on the mechanism of evolution in *Crepis*, a statement which may profitably be amplified for the general reader by perusal of a still more recent summary by Babcock in another connexion[2]. From the analysis of 113 species and very numerous interspecific hybrids, *Crepis* is seen to be a genus which, on the whole, has evolved with little aid from polyploidy and by a process of reduction rather than increase in chromosome numbers. Polyploidy has affected less than 8 per cent of species. Interspecific hybridization has been involved in some 20 per cent of species, and primary importance has to be assigned to the internal action of segmental interchange and genic mutations, aided by genetic, geographic or ecological isolation, in making possible the morphological and physiological differentiation of the rest. Detailed information is provided about the mode of operation of both the latter processes in the speciation of various parts of the genus, and the importance of work such as that of Tobgy[3] and Gerassimowa[4] in revealing how segmental interchange can alter chromosome morphology and set up sterility barriers without other genetic changes is very clearly brought out, especially in Babcock's later article[2], and in doing so a very important gap in our knowledge of evolutionary mechanisms is partially filled, with fact instead of surmise.

Finally a survey is given of the numerous outstanding lines of work which could be further pursued with profit. It is to be hoped that this work will indeed be continued, and this seems the more probable in that it has already been supported for more than a quarter of a century by a State (California) Agricultural Research Station, although *Crepis* is a genus of no economic importance. It is fitting to express appreciation of such an enlightened policy, and the world is no less indebted to the University of California for providing in its "Publications in Botany" a medium admirably suited in format and style to the issue not only of individual research papers of the usual kind, but also to an extended work of pure scholarship of the dimension of a large book such as that under review. International co-operation and disinterested support of fundamental research on this scale cannot easily be found even to-day in this age of planned science, and this is perhaps not the least important of the issues raised by Babcock's work. I. MANTON

[1] Hultén, E., "Outline of the History of Boreal Biota during the Quaternary Period" (Stockholm, 1937).

[2] Babcock, E. B., *Advances in Genetics*, 1, 69 (1947).

[3] Tobgy, H. A., *J. Genet.*, **45**, 67 (1943).

[4] Gerassimowa, H., *C.R. Acad. Sci. U.R.S.S.*, **11**, 143 (1937); **25**, 148 (1939).

RADIOELEMENTS AS A TOOL IN SCIENTIFIC RESEARCH

Radioactive Tracers in Biology

An Introduction to Tracer Methodology. By Prof. Martin D. Kamen. (Organic and Biological Chemistry, a Series of Monographs, Vol. 1.) Pp. xiii+281. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 5.80 dollars.

AT the beginning of this century, one of the facts most intriguing to chemists was the impossibility of concentrating some of the radioactive elements. Radium D, for example, a substance well characterized by its radioactive properties, proved to be completely inseparable from the large quantities of lead with which it was always burdened when extracted from minerals. Early in 1913 it was realized that the strange inseparability observed in radiochemistry, and the atomistic complexity of inactive elements as revealed by mass spectroscopy, were aspects of one and the same phenomenon, for which the new Rutherford–Bohr theory of the atom provided a convincing explanation. But even before this recognition of the nature and importance of 'isotopy', attempts had been made to turn the negative results of the separation experiments into a positive service to science: the solubility of sparingly soluble lead salts was determined by mixing them with radium D and using the imparted radioactivity for the electroscopic measurement of the invisibly small quantities of dissolved lead.

In those days there were only half a dozen or so suitable radioelements available, all of them in the last two rows of the Periodic Table. Therefore, 'radioelements as indicators', while a great help for a variety of investigations in inorganic and physical chemistry, were scarcely applicable to biological experiments—although so early as 1923 G. von Hevesy made some interesting observations about the intake of lead by plants by means of such an indicator. For the most important biological elements like carbon, hydrogen, oxygen, phosphorus, sulphur, or sodium, unfortunately no radioactive isotopes were known. Now the 'labelling' of an element should be possible also with inactive isotopes, though the methods of their detection and measurement are necessarily different and, in general, less simple; but in those days this way was barred too, as no means were known of preparing the inactive isotopes in more concentrated form than they occur in Nature, let alone in a pure state.

To-day in both directions the situation has completely changed. The discovery of the artificial radioelements in 1933 soon made radioactive isotopes of most of the elements available, and the development of several methods for isotope separation also put inactive atomic species at the disposal of scientific workers. As a consequence, the use of 'tracers', as they are now usually called, became a much more important practice in biological as well as non-biological research. Of special influence in this development was the erection during the War of big plants in the United States for isotope separation and for plutonium manufacture, the products and by-products of which can now be used for peaceful purposes. Similar plants will soon be operating in Great Britain and Canada; but in the meantime the American Government is willing to provide scientific workers all over the world with the invaluable materials, under the same conditions as laid down for American laboratories.

In these circumstances, many scientific workers who have otherwise no contact with radioactivity are anxious to make themselves acquainted with the powerful new method. By far the best way is, naturally, a course of instruction in one of the radioactivity centres; but as the principles of the method are simple, and the apparatus as well as the tracer material can be bought, training by books is certainly possible. It is therefore a pleasure to find that an excellent guide to the tracer technique with radioelements has been published by one of the most successful workers in this field. Prof. M. D. Kamen calls his manual "Radioactive Tracers in Biology"; but he is so thorough in making the reader well acquainted with the physical and chemicals aspects of radioactivity and with the theory of the measuring instruments before discussing biological applications, that those who intend to use radioactive tracers for non-biological research will also find in the book a wealth of useful information. In points of detail there may be some disagreement. Thus the author defines 'specific activity' (p. 33) as the ratio of the number of radioactive isotope atoms to the total number of isotope atoms; while later (p. 152) he uses as specific activity the number of counts per minute per milligram. Most workers in this field will probably prefer the second definition; and they may also not share the author's predilection (p. 91) for the term 'rutherford' instead of 'curie' (compare, *Nature*, **160**, 778; 1947).

Biologists will find the final chapters of particular value, for here the author deals, one by one, with the principal radioactive tracers as applied to metabolic studies. Very frequently he can draw on personal experience, and his descriptions display all the freshness which only first-hand knowledge can impart. In conclusion, we would like to express the hope that the other branches of radioactive and inactive tracer methodology will soon find authors as competent and literarily gifted as Prof. Kamen has proved himself to be in the very important field he has chosen as his own. F. A. PANETH

ECOLOGICAL PROBLEMS OF THE HIGHLANDS AND HEBRIDES

Natural History in the Highlands and Islands

By Dr. F. Fraser Darling. (New Naturalist Series.) Pp. xv+303+64 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1947.) 16*s.* net.

THIS is a notable book about Scotland north and east of the Highland Border Fault, where much that is wonderful and unique in Nature still flourishes; its case for a new deal for the Highlands and Hebrides, because it is developed on detailed ecological considerations, and its humanism (without 'bogus romance'), also make it a different kind of book. The author, rightly esteemed for his biological researches in the region and for his present labours as director of the West Highland Survey, is almost certainly the one man possessing the qualifications to attempt it.

The first three chapters deal with geology, climate, relief and scenery, the other nine with human and animal factors: forest, moor and farm; hill summits; shore, sea, loch and shallow seas; islands; fresh-waters; red deer; grey seal; and reflexions on main issues. There follow a long bibliography, index and fifteen distribution maps by Dr. James Fisher.

The book merits the compliment of searching criticism. The reviewer and biological colleagues agree that, much though they welcome its advent, a longer gestation and more consultation with specialists would have given it better proportion and minimized the number of blemishes. The citation of even typical slips and errors regarding altitudes, distribution, nomenclature, cross-references, etc., would occupy too much space here; such will be communicated to the author. Those using the book scientifically require, therefore, to be warned of the necessity for checking details by reference to authoritative sources.

Certain matters of printing craft cannot be so passed over. The plates, mostly, are original and very attractive; everything possible has been done with many of the coloured photographs, but it is disconcerting to see two-colour plates (18 and 23, review copy) half an inch out of register. Regarding the black-and-white illustrations, perhaps the paper used is the best obtainable now; but it does not appear to be the most suitable, the plates often being flat and dense (for example, III, review copy). Another copy shows duplication of bibliography, one index page, and maps.

The sentiments and style of the fine concluding chapter deserve applause. The author speaks of his loved country "with its power, colour, variety and movement; the diversity of living forms and the delicacy of their inter-relations"; of its sufferings and despoliation following the two revolutions that struck it—the coming of the sheep after the destruction of the forests, and the delight in game preservation which practically meant the killing of common mammals and birds without reference to their life-history. "Let us," he says, "give beast and bird and flower the place to live *in its own right* unless pest or obnoxious parasite."

What is being done about it all? Promise of much lies in the concern expressed by those in high place (the Secretary of State for Scotland and others) for schemes of forestry, national parks, crofting and hydro-electricity. But progress would be speeded and intensified by the co-ordination of such schemes, by the education and "active work of ordinary folk, of people who visit the Highlands and of those who live there"; and, with all this good will, by the institution of "a trained wild-life service, a corps of men working on natural history, studying phenomena and forecasting consequences and gaining a knowledge of the dynamics of natural populations".

Despite its shortcomings of detail the book is a gallant effort, much needed, stimulating and highly successful. Its appreciation by the reviewer and a colleague (neither Scottish) is measurable by the fact that between them they bought a dozen copies as gifts to laymen and younger naturalists.

A. D. PEACOCK

POLITICAL TESTAMENT OF AN ANTHROPOLOGIST

Freedom and Civilization

By Bronislaw Malinowski. Pp. xiv+338. (London: George Allen and Unwin, Ltd., 1947.) 16*s.* net.

BRONISLAW MALINOWSKI died in the United States in 1942 leaving a number of unfinished manuscripts in various stages of development. Two of these, "A Scientific Theory of Culture" (reviewed in *Nature* of August 25, 1945) and the present work, to some extent overlap. "Freedom and Civilization" may be regarded as a war-time political manifesto superimposed on the body of anthropological theory expounded in the earlier volume. This topical quality is manifest in the introductory section, "Political Prelude", and in the first chapter of Part 2 entitled "What we are fighting for". It is therefore unfortunate that the book-wrapper of the present English edition should give the impression that the book is an 'objective' contribution to political philosophy.

Objectivity was never Malinowski's method. Like all great teachers, he was prone to generalize recklessly from a special instance in order to drive home a point of principle. Some of the categorical assertions of this book are startling and would be hard to justify by any 'objective' criterion; for example, "a regular, systematic or tyrannical abuse of authority is not to be found under primitive conditions" (p. 118), or "in primitive communities the magician . . . always inspires the community with a consciousness of discipline and with the faith in leadership" (p. 213), or again, "headhunters and cannibals cannot loot because there is no portable or accumulated wealth at that stage" (p. 281). But such statements seem to me to be not so much unverifiable assertions as decorations to the general argument.

This argument is the declaration of a political *credo*, a statement of liberal positivist faith in the human spirit which belongs to the tradition of J. S. Mill's treatise "On Liberty" or Condorcet's "Esquisse d'un tableau historique des progrès de l'esprit humain". The latter perhaps is a particularly appropriate parallel, for it was written in the war-time Paris of 1793, a few months before its author's death.

Approximately one third of the book is devoted to a critical examination of the concept of freedom, and to the selection of a range of meaning for this emotionally overloaded term which will satisfy the author's requirements. This long discussion of what is largely a problem of semantics could with advantage have been well pruned in final draft. The sequence of the argument thereafter appears to rest on the following set of premises: (*a*) the concept of freedom can only be judged against a background of fundamental human needs which are served by the necessary restrictions on the individual imposed by human culture (pp. 89, 100); (*b*) the evolution of the practice of warfare since archaic times is manifested in the culturally defined behaviour of various grades of modern 'primitives' (Part 5, Chapter 5); (*c*) the Anglo-Saxon concept of democracy, as interpreted by Malinowski (p. 231), is a logical development from the ideology of "the earliest human cultures known to anthropology"; (*d*) the mutual interaction of institutions in a primitive 'tribe-nation' is normally such as to inhibit the development of civil war (pp. 262, 279); (*e*) totalitarian political organisation is an aberration from the normal because it has, as its inevitable concomitant, total war, which is a civil war within the body politic of world civilization (pp. 293, 309, 317).

To achieve this 'scientific proof' of the villainy of Hitlerism is something of a *tour de force*. In the context of 1942 it was perfectly justifiable; but it needs to be stressed that resort is had to some very question-begging definitions and assumptions. The important argument on pp. 252–255, which insists that 'a tribe' can be equated with 'a culture', and that such discrete units are always readily identifiable on the ground, strikes the present writer as highly questionable. Or again, the restriction of the meaning of 'war' to "an armed contest between two independent political units carried out by means of organised military force in the pursuit of a tribal or national policy" (p. 277) leads to the somewhat artificial inference that the aggressive activities of "the lowest primitives . . . headhunters and cannibals cannot be regarded as real war" (pp. 277, 281); moreover, by implication, they cannot be regarded as civil war either (pp. 281, 293). But by much the same argument a pedant might argue that the current unpleasantness in Greece and Kashmir is also neither real war nor civil war.

Another consequence of the political objective of the book is that the anthropological content is backed up by evolutionary doctrines which no longer find any place in ordinary anthropological academic discussion. As a teacher, Malinowski was always at pains to stress that the speculative reconstruction of long-term history could form no part of a scientific anthropology, and it is a shock to find him here discussing various groups of modern primitives in strictly parallelist evolutionary terms. But though the attempt to blend anthropological theory and political philosophy is not entirely successful, it raises wider issues. Anthropological acclamation of freedom is no novelty. So early as 1843 Klemm conceptualized the three stages of human progress as *Wildheit*, *Zahmheit* and *Freiheit*. The social scientist can never hope to be entirely detached, and it is arguable how far he can, or should, avoid imposing his own value-judgments upon the material of his study. My own feelings, in the present instance, are that it would need only a slight recasting of Malinowski's argument to demonstrate that totalitarian Russia rather than democratic America is the true heir to the 'proto-democracy' of archaic primitives, and this makes me suspicious of the whole procedure. Yet in some ways the attempt is magnificent. Towards the end of his book Malinowski claims that "the scientific indication of freedom attempted in this analysis vindicates all our personal preferences, the dictates of our common sense, and of our moral sense also, since it shows in cold dispassionate analysis that our democratic regime is a sound mechanism of progress, while totalitarianism must inevitably kill not only freedom, but also the gift which it has given humanity, that is, culture" (p. 317). The analysis is neither cold nor dispassionate; yet it is dogmatic optimism of this sort which will one day make possible a true humanist civilization.

E. R. LEACH

HISTORY OF ANÆSTHESIA

Victory over Pain

A History of Anesthesia. By Dr. Victor Robinson. Pp. xiv+338+30 plates. (London: Sigma Books, Ltd., 1947.) 16*s*. net.

THE discovery of anæsthesia, the centenary of which has just been celebrated, was one of the most important happenings in the history of mankind. The publishers of the volume under notice did well to produce it with such care and in such satisfying style; Dr. Robinson has appreciated the magnitude of his task and has magnificently overcome many of the difficulties that beset the historian of his subject. Indeed, the first two thirds of his book are excellent. Rapidly reviewing and rightly dismissing the stories of classical and medieval 'anæsthesia', he describes the unhappy years between 1799 and 1846 in graphic studies of Davy, Hickman and Wells, each of whom scored a 'near miss' on the target of painless surgery. Then follows the triumphal story of Morton's demonstration on the morning of October 16, 1846. This was a tremendous event; Dr. Robinson presents it calmly but with firm insistence on its importance. There follow descriptions of Jackson, the would-be 'spiritual father' of the discovery, and of Long, who had practised etherization as early as 1842 without troubling to inform a pain-racked world. These are a mild anticlimax as compared with the actual descent from the heights into the infamous and damnable 'ether controversy' which arose between Morton, Jackson and Long. As a storyteller, Dr. Robinson is no doubt right to dismiss what is beneath contempt as also beneath notice; as a historian, he is wrong.

It appears that we have heard too much of how Simpson over-stated his claim to be the 'discoverer' of chloroform (and, by an implication natural in Great Britain, of anæsthesia itself). Dr. Robinson treats these pretensions very gently indeed; so much so, that we are scarcely surprised later to find that Benjamin Ward Richardson is given more space and praise than the recorded facts would seem to justify. ("Is there no offence in't ?" "No offence i' the world.") New matter, new at very least to histories of anæsthesia, appears in the account of Samuel Guthrie, the backwoods chemist who apparently should share the chloroform glories of Dumas, Liebig and Soubieran. Dr. Robinson proceeds to develop his general theme by particular accounts of the men who led the way. Excellent though this method was in the beginning, it is hopelessly inadequate as the subject expands and ramifies. So many men took part in discovering agents, devising instruments and developing methods that there is no middle way between a catalogue of names or an inconsequent selection; in this instance we are presented with the latter.

In the end, Dr. Robinson gives us an inadequate description of anæsthesia's newest ally, the muscular relaxation obtainable by the use of curare. This is followed by a rhapsodic and almost incoherent epilogue of praise and exhortation. Had the author contented himself with describing pre-anæsthetic days and the events which led up to the discovery of ether anæsthesia, he would have given us a notable work. We have, however, one which starts well, continues magnificently, but ends in an inconclusive and aimless flurry.

G. Edwards

PURE AND APPLIED SEISMOLOGY

When the Earth Quakes

By the Rev. James B. Macelwane. (Science and Culture Series.) Pp. xiii+288. (Milwaukee: Bruce Publishing Co., 1947.) 5 dollars.

In 1944 the Institute of Geophysical Technology was established at St. Louis, U.S.A.; in co-operation with the University, and Father Macelwane was chosen as its dean. For one so well versed in the basic subjects of geology, physics and mathematics, this was a well-merited honour; and in so short a time as 1944–47 dividends have been paid. "By their fruits ye shall know them" has been well borne out, for out of the St. Louis Institute of Geophysical Technology, based on work by J. J. Shaw in England, has come the new use of the seismograph as a meteorological instrument via the study of microseisms by Father Ramirez. Father Macelwane and his colleagues at St. Louis are about to take this work a step further by setting up sensitive microbarographs at the angular points of a triangle of several hundred feet side in order to trace the paths of microbarographic storms, and for this work the weather-minded U.S. Navy has assisted with a grant of 25,000 dollars.

After writing so many technical papers and books on geophysics and its associated subsidiary subjects, Father Macelwane, while in the midst of his work, has at last been persuaded to write a book on seismology for the general reader. Seismology deals not only with earthquakes as they are felt, but also with the nature and causes of earthquakes and their relation to other geological processes in the earth. It deals with the effect of earthquakes on structures built by man and with all the problems of engineering that arise from them. It includes the physics of earthquake waves propagated through and round the earth, and the knowledge these give us of the earth's interior. It treats of man-made earthquakes, the vibrations caused by blasts of explosives, and their use in determining the hidden make-up of the earth's outer shell, thereby assisting in the location of valuable mineral deposits, especially petroleum. The book covers the whole field of pure and applied seismology, and Father Macelwane is to be congratulated on compressing so much material, while keeping it readable, into so small a space. Many natural earthquakes, their supposed causes and their effects are described, together with the manner in which they are studied macroseismically in the field and by means of instruments. Sea quakes and seismic sea waves are discussed, and there is a chapter on earthquake noises following Davison. The engineering aspect in such subjects as earthquake-proof design is not overlooked, and there are chapters on rock bursts and also on seismic prospecting.

A glossary is provided to enable the reader to come to grips with some technical terms, and this will undoubtedly help. There are a full list of references in addition to acknowledgments, and a good index. The text is interspersed with numerous good clear diagrams as well as photographs as illustrations in a book which is a joy to handle after the 'austerity' books of present-day Britain.

E. Tillotson

ARCHÆOLOGY AT OXFORD

Archæology and the History of Europe

An Inaugural Lecture delivered before the University of Oxford on 28 November, 1947. By Prof. C. F. C. Hawkes. Pp. 24. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 2*s.* net.

It is indeed excellent that the University of Oxford has created a chair of European archæology, and that Christopher Hawkes has been selected as its first occupant. The University will gain lustre from his learning, and he will have scope to work out in practice the very definite ideas about the orientation of his subject which he sets forth in this lecture. It is indeed well that the various universities interested in archæology should not all place it in the same setting or look at it from the same point of view. Prof. Hawkes says, for example, that archæology "is not a subject in its own right, as are History, Philosophy, or, say, the Biological Sciences". As a Cambridge archæologist, I can only ask, "Why not ?" Biochemistry is considered as a separate subject, and yet it only recently hived off from its parent sciences. Prehistory and archæology have similarly hived off from geology and early history, but surely can by now be classed together as a single subject worthy of an honours school.

Again, Prof. Hawkes says that for him archæology belongs to history, not simply in operational practice but in philosophical theory likewise. It is excellent that this aspect of the subject should not be forgotten, and Oxford is probably the appropriate place where it should be particularly enunciated. But there is also the possibility that archæology—more especially in its early phases—can be considered scientifically, and that it is the scientific approach to the subject which should be stressed and which indeed adds much to its charm.

As was to be expected, Prof. Hawkes has given a most interesting and thought-provoking inaugural lecture, couched in the inimitable literary style we have come to expect from him and his University, and enlivened by some charming touches, as when he self-deprecatingly refers to himself as being pegged out over so large an acreage of professorial territory that he fears his thinly outspread vitals will offer but little sustenance to the birds ! But when we have considered his ideas on the scope and disciplines and duties of his subject, we can only reassure him that his fears are groundless. We look for great things from him in this new chair with his particular way of surveying his domain. For the last thirty years the Cambridge school has stressed the scientific and anthropological approach to archæology : it will be interesting and valuable to see a school grow up at Oxford on the lines suggested in this lecture. If our sister university is late in the field with her chair, she could not have dignified it with a more happy choice of a first occupant.

Miles Burkitt

Microcalorimetry

By Prof. W. Swietoslawski. Pp. x+199. (New York: Reinhold Publishing Corporation, 1946.) 4.75 dollars.

THE author is professor *in absentia* of physical chemistry of the Institute of Technology, Warsaw, and senior fellow, Mellon Institute, Pittsburgh.

In the monograph under notice he reviews the methods which have been used for measuring small amounts of heat. Such methods find application in physics, physiology and kindred subjects. The reader will find it a valuable reference work when faced with a problem in micro-calorimetry, for in successive chapters information is given on the micro-calorimeters used in radiology; the use of the ice calorimeter in microthermal measurements; calorimetry of processes of short duration; adiabatic micro-calorimeters; and labyrinth flow calorimeters. To facilitate references to original sources of information, the author has collected 130 references to published work on the subject.

Throughout the book, stress is laid on the value of comparative measurements. Such methods may involve: (1) using twin calorimeters and in compensating the heat developed in one calorimeter by electrical energy introduced into the other; (2) carrying out two successive measurements in one calorimeter, so as to produce the same thermal effect by an electric current as that developed by the object under examination; (3) using two series of successive measurements as mentioned above, with the difference that in one experiment the heat is developed by the object only, and in the other by the object and an electric current; (4) comparing the heat liberated by the object with that produced by a standard substance. The use of all these methods is described in the book.

The author has had an extended experience in the development of micro-calorimeters, and his critical comments on the various designs constitute a substantial contribution to the subject.

EZER GRIFFITHS

Between the Planets

By Fletcher G. Watson. Pp. v+222.

The Story of Variable Stars

By Leon Campbell and Luigi Jacchia. Pp. v+226.

Galaxies

By Harlow Shapley. Pp. vii+229.

(Harvard Books on Astronomy.) (London: J. and A. Churchill, Ltd., 1947.) 18*s*. each volume.

THESE three volumes belong to the well-known series of Harvard Books on Astronomy. The first and second were published in 1941, the third in 1943; reprints of all three have been required, and some additions have been made to the second. The Harvard College Observatory is to be congratulated on its enterprise in arranging for the publication of a series of eight books, all by members of its staff, which together provide a comprehensive and up-to-date survey of astronomy. Each book is written by an authority in its particular field, is abundantly illustrated, and is well printed. The series has gained a well-merited success. Though intended primarily for students, teachers and amateurs, the books are useful also to the working astronomer for reference purposes, as recent developments in the respective fields are dealt with.

The first of the three volumes under notice is concerned with the minor planets, comets, meteors and the zodiacal light. The second deals with variable stars, including novæ and eclipsing variables. The third includes a detailed account of the Magellanic Clouds, of the Milky Way considered as a galaxy, and of the neighbouring galaxies; the more remote galaxies are then dealt with, and finally the problem of the interpretation of the red displacements of the lines in the spectra of the distant galaxies is discussed.

H. S. J.

A Text Book of Physical Chemistry

By Dr. N. C. Sen Gupta and K. C. Sen. New edition. Pp. xv+526. (Calcutta: Mondal Brothers and Co., Ltd., n.d.) 10 rupees.

THIS is an interesting survey of physical chemistry up to the pass B.Sc. standard and a little beyond in places. It deals with the usual subjects, thermodynamics being given special prominence. In the section on electrolytes, activity coefficients are developed and used, and the treatment is modern. The sections on atomic and molecular structure are good. There are collections of questions and problems, with answers, and suggestions for further reading.

Although intended primarily for Indian students, this book is a very useful review of modern physical chemistry in reasonably small compass which would be quite suitable for most courses in the subject elsewhere. No serious errors were noticed beyond the statement (p. 98) that no work is done in Joule's experiment because the gas rushes into a vacuum. This is a common error; the fact is that the change occurs in a rigid vessel and so external work cannot be done. The book is well printed and illustrated on good paper, the production being Indian, but the binding is not so good.

The Theory of Valency and the Structure of Chemical Compounds

By Prof. P. Rây. (Cooch-Behar Professorship Lectures for 1941.) Pp. vii+82. (Calcutta: Indian Association for the Cultivation of Science, 1946.) n.p.

THESE lectures deal with the development of the theory of valency from its origin to the latest quantum-mechanical views on the subject. The subject is discussed concisely, but the exposition is clear and interesting. Some of Prof. Rây's own work is dealt with, and there is a useful bibliography.

Wonder of Wings

A Book about Birds. By Nancy Price. Pp. 253+16 plates. (London: Victor Gollancz, Ltd., 1947.) 14*s*. net.

A PLEASANT book is this, a volume of chat, gossip and discussion concerning birds, bird matters and problems. It is a book that can be picked up and put down, and picked up again, to dip into here, there and anywhere, the reader each time finding something new, readable and interesting. Many of the chapters are dialogues between Miss Price and her neighbour, "the Birdman", their discussions ranging over a wide variety of bird topics, from how the gods punished the raven for its sins by turning it a sombre black, to legends concerning the wren, and the story of the willow pattern plate. The author is a little confused with regard to Capt. Knight's well-known eagle, "Mr. Ramshaw", which she refers to as a martial eagle. Capt. Knight had a martial eagle; but "Mr. Ramshaw", hero of many travels and adventures, was a golden eagle of Scottish origin.

FRANCES PITT

ADSORPTION AND HETEROGENEOUS CATALYSIS*

By Prof. ERIC K. RIDEAL, O.B.E., F.R.S.

We now recognize two forms of adsorption: that in which the dispersive forces alone are operative—the so-called van der Waals or physical adsorption—and adsorption in which an electron switch has taken place between adsorbent and adsorbate—chemi-sorption. It is important to obtain criteria for distinguishing between these two forms so that we can identify the type or types involved in any particular case of heterogeneous catalysis.

The literature concerning adsorption is very voluminous, and we may refer to Brunauer's recent volume on physical adsorption to get an idea of its magnitude and extent. Here we merely observe that if we are to obtain a complete picture of such adsorption, more attention will have to be paid to the forces operative with different and definite substrates. A commencement has already been made, but we require more systematic investigation of the adsorption of polarizable and non-polarizable adsorbents on substrates which are respectively iónic, covalent and metallic in lattice structure. One may cite as an example of the former the adsorption of the rare gases on one hand, and of iodine on the other, on crystalline potassium chloride, whereby the theoretical treatment can be examined in the light of experimental data. As an example of the latter, we may mention the experimental work on the adsorption of vapours at the surface of liquid mercury, which reveals the shortcomings of the various theoretical expressions which have been derived for such interactions with metallic surfaces.

Apart from the complications introduced by the fact that the adsorbing surface is scarcely ever uniform, it is by no means improbable that many cases of physical adsorption on what is believed to be a metallic substrate may well be taking place on the top of a chemi-sorbed monolayer such, for example, as hydrogen on tungsten, on which there is already a chemi-sorbed monolayer of gas such as tungsten oxide or tungsten hydride. The slow uptake of gas which results on the admission of a gas to a bulb containing finely divided reduced metal, or other solid, may be due to the formation of a chemi-sorbed layer on its surface, or to a process of solution and diffusion into the interior of the solid. The data derived from a study of the kinetics of such processes have been interpreted on a basis both of 'activated' adsorption and of 'activated' diffusion. It is clearly important to be able to distinguish between these two different processes, since either of them might prove to be the controlling reaction in a case of heterogeneous catalysis. Valuable information may be obtained by studying the processes on surfaces freshly prepared *in vacuo*. So far, tungsten wire and mirrors of other metals deposited by thermal evaporation have been employed.

Different physical methods are available for examining the surface properties of a wire or a mirror. Thus the accommodation coefficient for a gas, the heat change, the thermionic and photo-electric properties all provide information on the presence or absence and, indeed, on the structure also of chemi-sorbed monolayers.

Such experiments reveal the fact that many cases of slow uptake of gas, which had been attributed to the chemi-sorptive process, possessing a definite and large energy of activation, were in reality due to other causes; for example, solution or displacement of one surface layer by another, since the chemi-sorptive process proceeded on the clean metal surface without any appreciable energy of activation.

While there may be some doubt in particular cases as to the exact magnitude of the energy of activation involved, it is relatively small compared to the bond-strengths of the ordinary diatomic gases which undergo dissociation on chemi-sorption. The metal-electron substrate must act in a manner analogous to a free radical. That an electron switch has taken place during chemi-sorption is revealed by the strong dipole character of the chemi-sorbed complex; for example,

$$\overset{-}{\mathrm{W}}\,\mathrm{C}\overset{+}{\mathrm{S}} \text{ or } \overset{+}{\mathrm{W}}\,\overset{-}{\mathrm{O}},\ \overset{+}{\mathrm{W}}\,\overset{-}{\mathrm{H}}.$$

In several cases, for example, oxygen and ethylene, the reacting electron is probably the π-electron of the adsorbate; whereas many catalytic metals, for example, those in the transition group, have a narrow *d*-band overlapped by a broad *s*-band of electron-levels, and it is possibly an electron-level in this band which is involved. While a number of experiments have been carried out to determine the thickness of metal required for the emergence of 'metallic' characteristics, the great experimental difficulties involved in maintaining the substrate, in the effects of surface tension, in formation and preservation of a thin continuum in lattice form, have so far hindered progress in this direction. It is possible that further advances in our knowledge of the nature of the chemi-sorbed complex may come through physical examination of such systems, for example, the determination of specific heats of surface films, of the dielectric constant and para- or dia-magnetic susceptibilities. Experimentally, such investigations are proving to be within the compass of modern technique.

One of the most important problems connected with adsorptive phenomena is that concerning surface mobility. Under what conditions are adsorbed layers, held by dispersive forces and chemi-adsorbed layers respectively, mobile over the surface? The surface field is an undulating periodic one, and movement from one site to another may involve evaporation and recondensation, or movement over a potential hill. The adatom or adion may be raised into a migratory level. Here it may be free to move all over the surface, or may be limited to flight in one line only. It may move only into the next trough, or have a relatively long range of flight. We can develop equations to satisfy each of these conditions, but the experimental evidence so far is too inexact and too scanty to make any decision.

In the case of the alkali metals on tungsten, the data favour the view that the ion in the migratory level is restricted to a linear path and can traverse several tungsten atoms before terminating its flight. The growth of crystals from the vapour phase and the migration of organic molecules and metallic atoms over glass surfaces provide further evidence for lateral mobility. Such evidence as is available at present suggests that lateral mobility of physically adsorbed molecules, but not of the chemi-sorbed species, can occur within the range of temperature at which the catalytic reactions occur. We cannot, however, eliminate the possibility of some mobility even in the chemi-sorbed species.

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* Substance of a course of three lectures delivered at the Royal Institution on February 12, 19 and 26.

Several hypotheses concerning surface catalysis involve the concept of two-dimensional gas reactions. The experimental evidence available suggests that in surface reactions chemi-sorbed reactants, and not physically adsorbed reactants, are involved; thus the question of mobility becomes one of great importance. Apart from the fact that this mobility for the chemi-sorbed species appears to be non-existent or extremely limited, we must note that the adatoms have dipole moments, and as a result strong repulsive fields exist between them. It is interesting to compare this repulsive or spreading pressure of a film of adatoms where the pressure is due to a free two-dimensional gas, that is, one which obeys the formal relationship

$$F = \sigma KT,$$

where σ is the surface density of adatoms, with the pressure due to a free two-dimensional array of dipoles, that is,

$$F^1 = 4{\cdot}51\, \mu^2\, \sigma^{5/2},$$

where μ is the dipole moment. At values of $\sigma = 0{\cdot}8 \times 10^{14}/\text{cm.}^2$ and $4{\cdot}6 \times 10^{14}/\text{cm.}^2$, the values of F and F^1 are for formic acid on mercury 14 and 52 dynes/cm. for F, and for potassium on tungsten 26·0 and 307 dynes/cm. for F^1 respectively. The value of the dipole moment μ likewise changes as we alter the surface density of the film, due to mutual interaction.

Examination of the heats of adsorption gives us some indication as to the extent of mutual interaction which is repulsive in the chemi-sorbed layer, as well as on the mobility of the film. It is interesting to note that, in the physically adsorbed layer, below the critical temperatures attractive forces appear to predominate; for example, in the condensation of metallic and other vapours on glass.

In the chemi-sorption of a diatomic gas such as hydrogen on the surface of a metallic lattice, the molecule undergoes dissociation to form a pair of metallic hydride molecules. If the film be immobile during the process of filling up the lattice, some eight per cent of the lattice points will be left isolated as singlets. These singlets may play an important part in heterogeneous catalysis. Two of the simplest cases of heterogeneous catalysis are the ortho-para conversion of hydrogen or deuterium and the exchange reaction between hydrogen and deuterium at the surface of non-paramagnetic metals. The reactions proceed smoothly at quite low temperatures with small but definite energies of activation. In the cases which have been examined, the metal is covered with a chemi-sorbed layer of hydride broken only by the gaps already referred to. The formal kinetics of the reaction and reference to the corresponding homogeneous reactions preclude the possibility of the reaction proceeding by a two-dimensional bimolecular gas reaction in a mobile physically adsorbed phase on the top of the chemi-sorbed atomic or hydride layer. One of the current views is that the reaction proceeds by interaction of two neighbouring adsorbed hydrogen adatoms with subsequent evaporation of the newly formed molecule. In view of the repulsive forces which we have shown to be operative and the great heat of adsorption even in a closely packed film, it is clear that many difficulties have still to be overcome before this hypothesis as to the mode of action can be freely accepted.

An alternative proposal involving an interaction between a physically adsorbed molecule situated over one of the vacant sites, and a neighbouring chemi-sorbed adatom to form a transition complex, presents us with a mechanism involving exchange of valence forces rather than rupture of any primary bonds, and goes far to overcome the difficulties associated with the other two proposed mechanisms. Many of the heterogeneous catalytic reactions can be readily interpreted by means of such a mode of action, but experimental re-examination of some of the catalytic exchange reactions is necessary before an unequivocable decision is possible.

The mechanism proposed, it will be seen, involves what is, in fact, the half-hydrogenated state which in the catalytic chemistry of the hydrocarbons has proved such a useful concept. The hypothesis of vacant sites inaccessible to particular reactants suggests their accessibility to other species, and provides us with an explanation of the broken linear character of the curves connecting poisoning with catalytic activity, an explanation alternative to a series of patches of different activity. Dissociation in chemi-sorption involves not only an electron switch, but also the problem of interatomic spacing; the relation of both these factors to the energetics of surface action provides yet another field of inquiry as yet almost unexplored. Provisional theoretical examination of the effects of surface spacing on the activation energy have not taken the electron distribution in the substrate into consideration; while attempts to evaluate energies of activation by examination of metals which form a continuous series of solid solutions and thus provide a gradual change in the mean lattice spacing, require a more detailed examination of the composition of the Gibbs surface layer and its dimensions before we can draw justifiable conclusions.

THE MAIN GEOMAGNETIC FIELD

THE main geomagnetic field and its secular variation were the subject of a Geophysical Discussion held at the Royal Astronomical Society on February 27. The largely attended meeting, at which the Astronomer Royal was chairman, was addressed by Dr. E. C. Bullard, of the Department of Geodesy and Geophysics, Cambridge (who is shortly to take up the post of head of the Department of Physics in the University of Toronto), Dr. J. McG. Bruckshaw, in charge of the sub-department of applied geophysics at the Imperial College of Science and Technology, London, Mr. D. W. Bishopp, director of the Geological Survey of Eire, and Mr. S. K. Runcorn, of the Physics Department in the University of Manchester.

Dr. Bullard outlined a new theory of the secular magnetic variation. He first recalled the main character of this variation, as exemplified by the longest series of observations, for London, which suggests a cycle of change of magnetic direction, of which about three-quarters has been completed in four centuries. Other places, however, show variations that suggest shorter periods. The accumulated data discredit the hypothesis, formerly advanced, that these changes are due to a rotation of the geomagnetic axis about the geographical axis. Bartels has shown that the secular variation is regional in character, differing from the main field itself, which is planetary. The secular variation studies made by Fleming and Fisk, and more recently by Vestine and his collaborators, at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, show that at any one epoch the secular variation is most active in certain limited regions, but that such activity may die away in the course of a few decades, new centres of activity appearing elsewhere. These characteristics are substantiated by the occasional rather rapid changes of rate and direction of the secular variation at magnetic observatories, where the field is most accurately determined.

This time scale of the secular magnetic variation is one of its most remarkable features. Cycles of change of a few centuries in duration, and still more the observed changes during a few decades, are very rapid for a phenomenon that undoubtedly originates within the body of the earth; ordinary geological changes require millennia or even millions of years for their evolution. The rapidity of the secular magnetic variation excludes any theory based on motions or thermal changes in the solid outer portion of the earth. A deeper source must be sought, in the liquid core, the existence of which is inferred from the failure of transverse seismic waves to pass through or near the earth's centre.

Dr. Bullard discussed particularly the rapid secular variation in and near South Africa during recent decades. The isoporic charts, which show the lines of equal rate of secular change, are somewhat complicated; a clearer conception of the variation over this region is obtained by plotting the rate-of-change vectors for the horizontal component, and indicating beside them the positive or negative rate of change of the vertical component. It is still better to draw the (inclined) rate-of-change vectors of the secular variation (vertical as well as horizontal) in the median vertical plane through the region, in the direction of the horizontal change—roughly the north-west to south-east direction. Taking the region to extend over 25° or 30° in this direction (over which range the curvature of the earth is, of course, important), the vectors at the north-west end slope upward, those at the south-east end slope downward, while intermediately they are nearly horizontal.

Dr. Bullard finds that these vectors for surface points correspond approximately, in magnitude and direction, to the field of a nearly horizontal magnetic dipole situated near the surface of the earth's liquid core, below the centre of the region. The estimated moment of the dipole for the change in one year is $3 \cdot 5 \times 10^{22}$ gauss (Γ) cm.^{3}. If the change continued for a century, the equivalent dipole moment would be $3 \cdot 5 \times 10^{24}$ Γ cm.^{3}—about 4 per cent of the moment (8×10^{25}) of the earth's main field. The dipole of the secular variation may not attain this value; it may die away again within a century from the commencement of secular activity in this region, a possibility to be confirmed or negatived only by future observation in this region.

The origin of the secularly evolving magnetic dipole is attributed by Dr. Bullard to an electric current circuit, flowing in the mass of an eddy near the surface of the core; the current is supposed to be produced by electromagnetic induction by the circulatory motion in the eddy, in the presence of the permanent magnetic field. Dr. Bullard is inclined to infer that at that depth the magnetic vector is more nearly vertical than at the surface point directly overhead. He has considered, to a degree of detail not possible to reproduce here, various numerical values pertaining to the dipole mechanism; a few of his illustrative estimates may be cited. If the radius of the eddy is 300 km., the electric current intensity must be of the order 4×10^{-5} amp./cm.^{2}, the total current being about 3×10^{11} amp. The time of circulation in the eddy may be of the order 0·3 year. Under the conditions supposed to prevail at the surface of the core, where the electrical conductivity can be roughly estimated, these would be a possible set of values. The Reynolds number is estimated as 5×10^{11}; Dr. Bullard suggests that the eddy would disappear by break-up rather than by frictional decay. He considers that developing dipole fields of eddies more than a few hundred kilometres below the surface of the core would be shielded by currents induced in the upper part of the core, so that the observed secular variation at the earth's surface will be due to the uppermost core eddies.

This fascinating theoretical discussion was followed by Dr. J. M. Bruckshaw's account of some observations of great theoretical interest on the magnetic anomalies associated with the main tholeiite dykes of the north of England, a system of volcanic dykes extending from the Isle of Mull to the north-east coast of England. This work was done in conjunction with E. I. Robertson, a New Zealand research student, aided by a team of student observers. The dykes are tertiary igneous intrusions, perhaps fifty million years old; they are nearly vertical, and only 10–25 yards thick. Since their formation they have remained undistorted by any major earth movements, though displaced slightly here and there by local faults.

The vertical magnetic intensity (V) was measured at points along sixty-five traverses across the dyke; pronounced anomalies were observed, of amounts up to 2,500 γ. Each traverse gave a graph of the variations of V. Rock specimens were also taken, their orientations *in situ* being carefully noted; laboratory measurements of their susceptibility and permanent intensity of magnetization (I) thus enabled the magnitude and direction of the resultant I for the dykes to be determined. The observed anomalies in V agree well with those calculated from the size, form, position and magnetization of the dyke at various places along it. The outstanding feature disclosed by the investigation is that the dyke is magnetized in a direction nearly opposite to that of the present geomagnetic field in the locality.

Observations in volcanic regions to-day show that the magnetic lavas that well upwards as a molten magma become magnetized by induction in the earth's field as they cool through the Curie point. Mercanton, Thellier and others have shown that in many cases such rocks have great magnetic retentivity, and most of the rock specimens collected in this investigation show the same property, though in a few cases their magnetization declined appreciably within a few months. The simple interpretation of the observed data is that the earth's field in this region fifty million years ago was opposite in direction to that which now exists there. The poor retentivity of a minority of the rock specimens may explain the few cases in which the magnetization has the present direction of the field. In general, the observed anomalous I is two to eight times as intense as the present field would induce.

Such anomalous magnetization has previously been observed in Germany, in the Arctic (by Mercanton), in New Zealand, and (perhaps the most striking case) in the Pilansberg dykes in South Africa, which are palæozoic, perhaps two hundred to five hundred million years old. Mr. D. W. Bishopp, in his account of a recent survey of the vertical force (V) over Eire (from which two magnetic maps, not yet published, have been prepared), added further examples, also of tertiary intrusions, showing the 'wrong' sign of magnetization.

The Pilansberg dykes are not too far from the equator to exclude the possibility of explanation, in their case, by the hypothesis that in the course of the secular variation the *magnetic* equator has passed across this region, corresponding to a reversal of the local value of V. But this explanation could not be applied to regions so far north as the Border or as Eire. It is difficult also to see how Dr. Bullard's explanation of the secular variation could account for a local reversal of the field. Geologists present at the discussion remarked that in tertiary times the molten layers seem to have come unusually near the surface; but it is not clear how this could help to explain a reversal of the field. A very extensive continental drift carrying great land masses across the equator is another possible but unattractive hypothesis that would obviate the conclusion that the earth's field as a whole was once of opposite polarity. This conclusion would, of course, be quite inconsistent with any 'fundamental' theory associating magnetization with rotation in the case of large rotating masses, such as Prof. P. M. S. Blackett has advocated.

The fourth contribution to the discussion, by Mr. S. K. Runcorn, bore on this hypothesis. When Prof. Blackett in May last read his paper on the 'fundamental' theory of magnetization by rotation, Dr. Bullard pointed out that the variation of the magnetic intensity with depth within the earth should provide a crucial test between such a theory, and the usual 'core' theories which assign the source of the earth's field to some cause within an inner core of the earth. Any core theory, which regards the overlying portion of the earth as non-magnetic, implies that V and H both vary as $1/r^3$ at distance r from the earth's centre, outside the core. On the fundamental theory, in which every element of mass contributes in some way to the field, the intensity might be expected to decrease downwards. The depth-variation of intensity on the fundamental theory, for different distributions of density within the earth, has since been calculated by Mr. Runcorn and also by Chapman; it appears that near the surface V varies as $1/r^3$ whatever the density distribution (assumed spherically symmetrical), so that measurements of the depth variation of V cannot distinguish between the fundamental and the core theories. The 'fundamental' depth-variation of H, however, is a downward decrease, depending on the density distribution; this therefore, as Dr. Bullard suggested, offers a possibility of deciding between the two theories.

Observations of H in South Africa at an effective depth of 4,800 ft. in a Witwatersrand mine have recently been reported in *Nature* (**160**, 746; 1947); they show a decrease, favouring the fundamental theory; but there is great need of further measurements in regions less disturbed magnetically than the Witwatersrand. Mr. Runcorn gave a preliminary account of such measures in a coal-mine at Leigh, in Lancashire, in a region apparently devoid of any appreciable magnetic anomalies. He, Mr. A. C. Benson and Mr. S. Goldsack, of the University of Manchester, have measured both V and H at a depth of 4,000 ft., in a disused working, well removed from any iron or steel mining structures. Comparison with V and H measured at the surface show the expected downward increase of V, and a *decrease* in H; $\Delta H = -45\gamma$ approximately, as against $\Delta H = +13\gamma$ as expected on the core theory. An intensity of magnetization of $0\cdot08\ \Gamma/\text{cm.}^2$ in the top layer 4,000 ft. deep would be needed to account for this value of ΔH, and this layer is certainly not so magnetized (and if it were, V would also be affected by it).

Prof. Blackett pointed out the great importance of such observations, which if verified would indicate a hitherto unrecognized property of matter which is not magnetic in the ordinary sense of the word. Prof. T. G. Cowling remarked on the indefiniteness of the concept of angular momentum in connexion with fundamental theories of magnetization by rotation, and Prof. Blackett agreed that such theories must at present be regarded only as provisional.

The whole discussion showed that this relatively old science of geomagnetism remains lively and vigorous, and the new contributions made by Prof. Blackett and Dr. Bullard will undoubtedly provide much stimulus to further observations and their interpretation.

S. CHAPMAN

STRUCTURE OF AN ANIMAL VIRUS

By Dr. I. M. DAWSON and Dr. A. S. McFARLANE
National Institute for Medical Research, Hampstead, London

BECAUSE of their crystallinity, a great deal is known about the ultimate chemical structure of the plant viruses, whereas little or no corresponding information is available for the animal viruses. Efforts to obtain X-ray diffraction patterns have not been successful, and attention has been turned in recent years towards the electron microscope as the tool most likely to solve the problem. For obvious reasons attention in the first instance has been directed to the larger animal viruses, but with the exceptions of nuclei-like bodies in the Rickettsiæ[1] and less definite internal bodies in the pox group[2,3], this technique has also proved disappointing. It is clear on the practical side that the size and density of the infective particles is such that 100-kV. electrons can only just penetrate them, and any internal differences in electron density which may exist must be of a low order—probably less than 20 per cent.

In the pox group of viruses, outlines of a central body were first seen by Green *et al.*[2], with vaguer indications of the presence of four satellite bodies occupying the corners of the brick-shaped particles. The viruses of this group are all purified by differential centrifugation from dilute buffer suspensions, and it is a common experience[4,5], especially with vaccinia, to find structureless material present in the background of the electron micrographs—sometimes linking neighbouring particles as if by gelatinous bridges—which persists after repeated differential centrifuga-

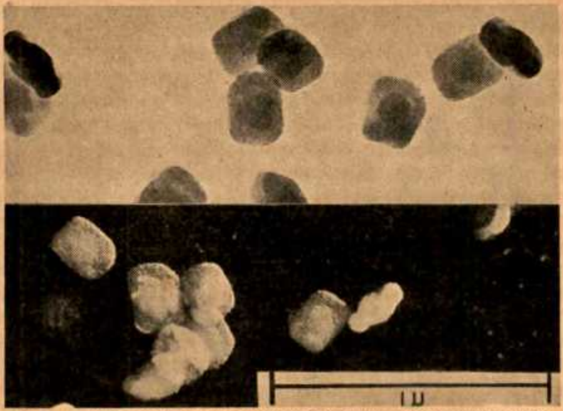

Fig. 1. VACCINIA VIRUS PURIFIED BY SALT FLOCCULATION AND FIXED WITH OSMIC ACID. ABOVE, UNSHADOWED; BELOW, LIGHTLY SHADOWED WITH GOLD TO REVEAL SURFACE STRUCTURE. SCALE INDICATES 1μ

tion. Increase of salt concentration leads to flocculation of the virus, which with vaccinia in molar sodium chloride in the cold is complete in one to three days. As an indication that some purification has been effected, the flocculum which settles out is free of the slight but tenacious pigmentation of the original virus. The supernatant is still faintly turbid and contains in particulate and soluble forms 30–40 per cent of the original virus, with roughly proportionate amounts of nitrogen, phosphorus and desoxyribonucleic acid. After repeated washing with distilled water to remove the last trace of salt, the flocculated virus can be quantitatively redispersed into dilute buffer with the aid of sonic or ultrasonic vibrations[6]. The infectivity is not seriously reduced by the treatment, the virus having been passed through several host animals with exhaustive sodium chloride extraction and sonic resuspension at each passage.

Electron micrographs (Figs. 1, 3) show a complete absence of background material in the salt-extracted virus. Occasionally one or two particles are visible standing on edge (Fig. 1) and revealing a thickening at the centre and smaller ones at the corners. Consideration of the blackening caused by one particle overlapping another in conjunction with the shape of the particles suggests that the dark areas seen in the transmission pictures at the centres and corners of the bodies can be explained sufficiently by the geometry of the particles without invoking internal differences in scattering capacity. The relative sharpness of the edges of the central areas, however, is difficult to reconcile with this view.

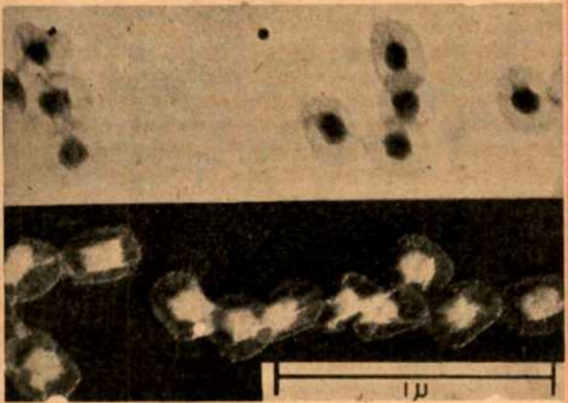

Fig. 2. SAME AS FIG. 1, BUT AFTER PEPTIC DIGESTION OF THE VIRUS

Digestion with pepsin is known to be a useful adjunct to alkali in removing the nucleic acid from vaccinia[7] and we have, therefore, made an electron microscopical investigation of the action of this enzyme. Incubation of the virus at pH 3·0 and 37° C. for several hours causes no visible alteration in it; but in the presence of a few micrograms of crystalline pepsin three-quarters of the virus substance goes into solution in half an hour. Micrographs of the residual particles (Fig. 2) show that the central body is certainly not an artefact. No traces of satellite bodies are seen, however, indicating that the dark areas in the corners are to be identified with local thickenings of the virus substance, or with intracellular particles which, unlike the central ones, are hydrolysable with pepsin.

The action of pepsin is complete in half an hour, practically all the phosphorus and desoxyribo-nucleic acid of the salt-extracted virus being retained in the residue. Incubation of this with desoxyribo-nuclease (kindly supplied by Dr. M. Kunitz, Rockefeller Institute, Princeton, N.J.) at pH 7·5 for 1 hr. results in liberation of the nucleic acid in soluble form. This treatment does not seriously alter the architecture of the residual cell, but some loss of density occurs in the central body. These observations show that this body has some, at least, of the characteristics ordinarily attributed to a nucleus, and seem to justify the use of this term for it. It is, of course, of an altogether lower order of size (c. 90 mμ diameter) than anything hitherto designated as such, and the term is used without any implication that this virus nucleus is capable of subdivision in any genetic sense.

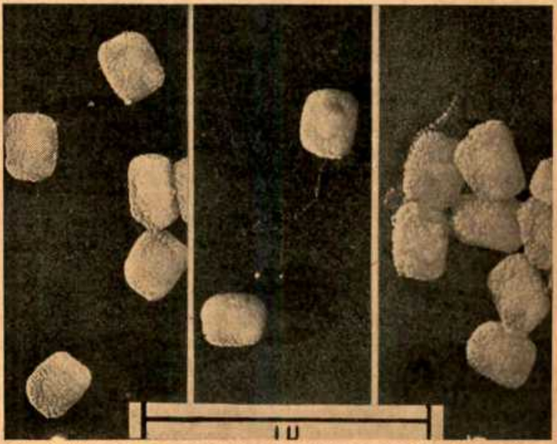

Fig. 3. SAME AS FIG. 1, BUT MORE HEAVILY SHADOWED WITH GOLD

Folds are clearly visible in the perinuclear part of the pepsin-digested virus (Fig. 2) and also in ghosts of the virus obtained by the action of sodium hydroxide[2]. These are similar to the folds seen in erythrocyte ghosts[8] and seem to argue convincingly in favour of the presence of a thin limiting membrane. The resolution of the electron microscope is not sufficient to identify a pattern in the substance of the membrane with any certainty. Gold-shadowed pictures (Figs. 1, 3) of the salt-extracted virus, however, show a granularity of a higher order than that seen in the background and which at some places on the virus surface is remarkably regular in arrangement—presumably reflecting a close packing of protein macromolecules. We have observed occasionally in several pictures (Fig. 3) chains of apparently similar 'macromolecules' which may have been stripped accidentally from virus particles, but without any signs of correspondingly deficient areas or strips on virus bodies. These in conjunction with photographic density considerations suggest that the granularity is not restricted to the surface but has a bulk distribution throughout the perinuclear space.

Since the envelopes collapse after removal of the protein within (Fig. 2), they cannot alone be responsible for the characteristic cuboidal shape of the virus. Something more is necessary, and we may consider in this connexion two suggestions which have been put forward[9] to explain shape in larger cells, and in particular the biconcave shape of the mammalian erythrocyte. On one hand, a submicroscopic network or reticulum is envisaged into which the molecules fit and upon which they confer a rigidity; and on the other, intermolecular attractions of the kind which hold a protein crystal together are invoked. The fundamental difference between the two views is the chemical one that in one case only protein removable by hæmolysis (or peptic hydrolysis in the case of the virus) is present, while in the other this protein is interspersed with resistant stroma protein. Practical differentiation by chemical or physical means is extremely difficult, and at least in the case of the red cell has not been satisfactorily achieved. Ponder has to conclude a recent paper[10] with the statement: "Changes in a membrane alone seem inadequate to account for the varied phenomena observed in connexion with red cell behaviour, the explanation of which appears to require a more detailed knowledge of the molecular architecture of the cell interior". At the same time he is able in this paper to provide experimental support for Teitel-Barnard's demonstration[11] of para-crystallinity in the red cell. He finds local areas of birefringence in rat red cells preserved in citrate, and this observation may be of interest in relation to the patchy distribution of particle regularity which we observe in the virus. It suggests that our first impression that a partial disorientation occurs on drying may be wrong, and, in fact, the cytoplasm of the native virus contains protein phases of different degrees of orderliness, from the loose molecular arrangement which holds in protein gels up to the perfect regularity of a protein crystal.

With regard to the alternative stroma hypothesis, evidence is available, mainly from studies of form birefringence, for the existence of submicroscopic fibrils in the cytoplasm of cells, for example, of retinal rods[12] and egg cells[13]. Two pieces of evidence, neither of them conclusive, favour the existence of a fibrillar arrangement in vaccinia. It is noticeable after peptic hydrolysis that the nuclei are almost always centrally placed in the cell as if held there by an invisible net. The second point is derived from considerations of the shrinkage which occurs on drying. Virus particles from which the water has been sublimed at −70° C. have major dimensions 250 mμ by 200 mμ with ± 5 per cent individual variations. The mean thickness as measured at the periphery from profile views and shadow lengths is estimated to be 110 mμ. Drying at room temperature causes a reduction in the mean thickness to one half without giving rise to any appreciable alteration in the other two dimensions. Treatment with osmic acid, on the other hand, followed by drying at room temperature, causes a uniform shrinkage of 20 per cent in all dimensions. The latter behaviour is explained by protein fixation on any hypothesis of particle architecture; but the conception of a supporting network helps to explain the manner of subsidence of the particle when dried above zero without fixation. Contact with the supporting surface prevents shrinkage in the horizontal plane, while a concertina-like contraction of the network takes place in the vertical plane.

Whereas the facts outlined here do not provide a complete picture of the structure of vaccinia, they establish that it is definitely more complex than that of the fully crystalline plant viruses. On other grounds, Anderson[14] is inclined to identify this virus structurally with the bacteria. A major difficulty which we have in accepting this is that so little is known about the internal organisation of bacteria in spite of their much larger size. It is doubtful, for example, whether the controversy surrounding the existence of nuclei in the accepted cytological sense in bacteria has ever been livelier than at present[15], and curious new structures are coming to light as a result of phage studies[16]. In a preliminary way we have subjected a bacterium (*Proteus vulgaris*) to the action of molar sodium chloride followed by pepsin, and observed that the effects are different both qualitatively and quantitatively from those encountered with vaccinia.

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NEW FELLOWS OF THE ROYAL SOCIETY

At the meeting of the Royal Society on March 18, the following were elected to fellowship:

Dr. T. E. Allibone, director of the Research Laboratories of Associated Electrical Industries, Aldermaston, Berks, distinguished for his contributions to the application of high-voltage phenomena.

Dr. F. P. Bowden, lecturer in physical chemistry, University of Cambridge, distinguished for his contributions to the study of friction and lubrication.

H. Constant, deputy director (research), National Gas Turbine Establishment, distinguished for his studies in the applications of thermodynamics and aerodynamics to aircraft engines.

Dr. S. F. Dorey, chief surveyor, Lloyd's Register of Shipping, distinguished for his contributions to marine engineering.

E. H. Farmer, assistant director and senior organic chemist of the British Rubber Producers' Research Association, Welwyn Garden City, distinguished for his experimental studies of complex unsaturated hydrocarbons and related natural products.

Prof. O. R. Frisch, Jacksonian professor of physics in the Cavendish Laboratory, Cambridge, distinguished for his researches on fission processes in nuclear physics.

Sir John Fryer, secretary of the Agricultural Research Council, distinguished for his services to agricultural science and his contributions to applied entomology.

Prof. T. M. Harris, professor of botany in the University of Reading, distinguished for his researches in palæobotany.

Prof. W. H. Heitler, senior professor in the School of Theoretical Physics, Institute for Advanced Studies, Dublin, distinguished for his contributions to theoretical physics.

A. L. Hodgkin, assistant director of research in physiology, University of Cambridge, distinguished for his researches on the nature of nervous conduction.

Dr. G. M. Lees, chief geologist to the Anglo-Iranian Oil Company, distinguished for his contributions to stratigraphical and structural geology, particularly in relation to oilfields.

Prof. R. A. McCance, professor of experimental medicine, University of Cambridge, distinguished for his contributions to metabolic studies of human beings.

Dr. K. Mahler, senior lecturer in mathematics in the University of Manchester, distinguished for his researches in the theory of numbers.

Dr. Sidnie M. Manton, lecturer at King's College, London, distinguished for her work on the Crustacea and other invertebrates.

Dr. Dorothy M. Needham, of the School of Biochemistry, University of Cambridge, distinguished for her researches on the biochemistry of muscle.

Prof. J. H. Orton, professor of zoology, University of Liverpool, distinguished for his investigations in marine biology.

Sir Leonard Parsons, emeritus professor of diseases of children, University of Birmingham, distinguished for his studies on child health and the wasting disorders of children.

Dr. Stanley Peat, reader in organic chemistry, University of Birmingham, distinguished for his contributions to the constitution and synthesis of carbohydrates.

Prof. G. W. Robinson, professor of agricultural chemistry, University College of North Wales, Bangor, distinguished for his contributions to the study of soils.

Dr. W. A. H. Rushton, university lecturer in physiology, Cambridge, distinguished for his researches on the effect of electrical stimuli on muscles and nerves.

J. W. Ryde, senior physicist in the Research Laboratories of the General Electric Company, Wembley, distinguished for his contributions to pure and applied physics.

G. R. S. Snow, fellow of Magdalen College, Oxford, distinguished for his work on plant hormones and growth.

Dr. E. W. R. Steacie, director, Division of Chemistry, National Research Council, Canada, distinguished for his researches on gaseous chemical reactions.

Dr. J. A. Todd, lecturer in mathematics, University of Cambridge, distinguished for his researches into the geometry of figures.

Dr. F. Yates, chief statistician, Rothamsted Experimental Station, distinguished for his contributions to the statistical analysis of agricultural problems.

NEWS and VIEWS

Mathematics at Leeds: Prof. S. Brodetsky

THE retirement has been announced of Prof. S. Brodetsky, professor of applied mathematics and head of the Department of Mathematics in the University of Leeds. It must be but rarely that the career of any distinguished scientific man borders on the romantic, but the career of Prof. Selig Brodetsky certainly furnishes one of these rare cases. He was born sixty years ago of orthodox Jewish parents at Olviopol, a village in Russia near Odessa. The prevalence of pogroms against the Jews in the Russia of those days decided the father to seek an asylum for himself and his family in England. He left Russia by himself first of all, and after he had established a means of livelihood in London, he sent for his wife and four children to join him. It was an adventurous journey across Europe for a young woman with four young children, and Brodetsky has frequently told how, as a child of four years of age, he clung to his mother's hand while crossing a frontier, while she pushed a corner of her shawl into the mouth of his little sister in arms to prevent her crying and so attracting the attention of the frontier guards. The number in the family increased steadily in London and the *res angusta domi* was never far absent from their home. But Brodetsky's father was a man mighty in the Scriptures and particularly well-versed in the Talmudic writings, so that young Selig was reared in a home pervaded with traditional Jewish culture and an intellectual outlook although in a restricted field. The result was that several of the children overcame all obstacles and entered universities.

Brodetsky was educated at the Jews' Free School and at the Central Foundation School, London. He entered Trinity College, Cambridge, and was Senior Wrangler in 1908, a feat on the part of a Russian-born boy which evoked much interest and astonishment at the time. After five years as a lecturer in the University of Bristol he joined the mathematical staff at the University of Leeds and became professor of applied mathematics there in 1924. Prof. Brodetsky's twin interests through life have been applied mathematics, particularly aerodynamics, and the cause of the Jewish people. He has been an indefatigable worker for Zionism. As a university teacher, he was a brilliant expositor of mathematical subjects, both on the academic platform of the university and to lay bodies outside its walls. He carried out much research work and wrote several mathematical treatises. Brodetsky is a man of great bodily vigour and unquenchable vitality. His knowledge of Europe and foreign affairs generally made him invaluable in shaping university policy both inside Leeds and more generally in consultation with his colleagues in other centres of learning. His fruitful activities in university life will be seriously missed.

Prof. H. S. Ruse

Prof. H. S. Ruse, who has succeeded Prof. S. Brodetsky as head of the Department of Mathematics in the University of Leeds, was an undergraduate at Jesus College, Oxford, during 1924–27. After spending nearly ten years as a lecturer on the mathematical staff at the University of Edinburgh, he became professor at University College, Southampton, in 1937 and he remained there until he went to Leeds in 1946 as successor to Prof. W. P. Milne on his retirement from the chair of mathematics. In 1931 Ruse spent a period in Rome working with the late Prof. Levi-Cività, and in 1933–34 he was on leave of absence from Edinburgh working with Prof. Oswald Veblen at the University of Princeton. Prof. Ruse's main interest is relativity and tensor analysis and he has published a great many original papers in this field in the leading mathematical journals.

In the University of Leeds with its large number of applied science departments, the Department of Mathematics occupies a focal position, and it has a great contribution to make to the work and development of the technological departments. There is a long tradition in the University of a close and cordial co-operation between the Department of Mathematics and the applied sciences, and *ad hoc* courses in mathematics suitable for the individual needs of the technological departments and the Medical School have, so far as the size of the mathematical staff permitted, for long been provided. Prof. Ruse is in complete sympathy with this liaison between the pure and applied sciences, and intends to develop it still further. The Department of Statistics under the readership of Dr. B. L. Welch is within the Department of Mathematics, and this fruitful relationship is already being felt throughout the University in the development of statistical methods. There is a movement afoot for co-operation being established between the universities of northern England in the systematic pursuit of mathematical research, and this activity also has Prof. Ruse's warm support. It need scarcely be said that, in addition to the above affiliations, the cultivation of the science of mathematics for its own sake will be vigorously pressed forward under the leadership of the new head of the Department of Mathematics in the University of Leeds.

Prof. T. G. Cowling, F.R.S.

Prof. T. G. Cowling, who succeeds Prof. Brodetsky in the chair of applied mathematics at the University of Leeds, received his mathematical university training at Brasenose College, Oxford, and in 1931 was awarded the D.Phil. degree for a thesis dealing with the magnetic field of the sun and the radiative equilibrium of a spherical star. Afterwards he held lectureships in the mathematical departments at the Imperial College of Science and Technology, London, the University Colleges at Swansea and Dundee, and the University of Manchester, before being appointed to the chair of mathematics at University College, Bangor, in 1945. In 1947 he was elected a fellow of the Royal Society. He has written a large number of original papers on difficult problems of mathematical astrophysics, the kinetic theory of gases, the physics of the lower atmosphere and also of the ionosphere, and the magnetism of the earth, the sun and sunspots. His principal astrophysical papers deal with the stability of stellar models, the point source model of a star, convective equilibrium in stellar interiors, and the density distribution within stars as deduced from the motion of the apsidal line in close binary stars. He is also joint author with Prof. S. Chapman of the treatise "The Mathematical Theory of Non-Uniform Gases", and of a memoir on gaseous diffusion in a rare gas mixture. In this field one of his most important papers treats the problem of the electrical conductivity of an ionized gas in the presence of a transverse magnetic field. His work is characterized by great critical insight combined with constructive power.

University Representation in the House of Commons

When the Representation of the People Bill now before Parliament (see *Nature*, February 21, p. 259) came up for consideration on March 16 by the House of Commons in committee, Mr. O. Peake, member for Leeds, N., moved an amendment which was one of a series designed, he said, in accordance with the words of the unanimous recommendation of the Speaker's Conference, to maintain university representation and methods of election, and to ensure that registration of university graduates should in future be automatic and free. Some of the grounds for the retention of the university vote were set out in the article referred to above, and the support they obtained, not only from university representatives but also from other members of various shades of political opinion, showed that a case could well be sustained. The Government's spokesmen, however, Mr. Herbert Morrison and Mr. Chuter Ede, confined themselves practically to two points, namely, that the Speaker's Conference recommendation, having been made during a previous Parliament, was not binding on the present Government, and that the principle of plural voting was fundamentally wrong and "not in accord with a properly conceived democracy". Mr. Ede referred to the measure as one designed to redress electoral anomalies resulting from the Act of 1918 ; he said he had never believed in university representation, which he described as the last of the fancy franchises. The amendment was negatived by 328 votes to 198, a majority of 130.

Institute of Metals : Past and Future

The new president of the Institute of Metals, who took office on March 17 is Sir Arthur Smout, a director of Imperial Chemical Industries, Ltd., with special responsibility for the Company's metal and ammunition interests. A member of council of the University of Birmingham, and during 1942–45 director-general of ammunition production at the Ministry of Supply, he has had a life-long experience of the non-ferrous metal industries.

As this was the fortieth annual general meeting of the Institute, Sir Arthur, after paying a well-deserved tribute to his predecessor, Colonel P. G. J. Gueterbock, devoted the first part of his presidential address to its early history. The germ of the idea of such an Institute originated with a young engineer, W. H. A. Robertson—who was present at this meeting—in a letter in *Engineering*. A preliminary meeting held in Manchester in March 1908 was adjourned to London in June of that year, when the decision to go ahead with the plan was taken. This delay proved all to the good, as otherwise the trivial and clumsy title of "Copper and Brass Institute" might have been accepted. The fear of these pioneers that the Institute might fail through the disinclination of manufacturers to allow their technical staffs to present papers or take part in the discussions has fortunately proved groundless, and possibly one of the greatest services that the Institute has rendered to the industry is the breaking down of such prejudice and by providing a bridge across which scientific men and practical men can come into contact. The work of Shaw Scott, the first secretary and editor, received from the new president, who is in a position personally to appreciate his work, the fullest and most well-deserved praise. To Shaw Scott's guidance and devotion the Institute owes much. Among the papers read at the opening meeting in Birmingham in November 1908, Echavarri spoke of aluminium and its uses, and referred to the "enormous" demand for aluminium in 1906 and 1907 when the world production was 15,000 and 23,600 tons respectively; these figures are interesting in comparison with that of 1,890,000 tons a year at the peak of production during the Second World War.

The concluding part of the address was devoted to the future. As one concerned with both the metallurgical and the chemical industries, Sir Arthur contrasted the essentially continuous processes characteristic of the chemical industry with the 'batch' process normal in non-ferrous metal production. "To any industrial metallurgist laying down a new plant, I would commend the technical approach of the industrial chemist as worthy of close consideration." This represents the crux of the plea made for the reduction or, if possible, complete elimination of 'idle time'. Coming from one who is essentially an industrialist, it is of the greatest interest that he pleaded for the encouragement "of those who are engaged on investigations which may at present be of little or no commercial value, but which are calculated to establish the underlying general principles of the science of metallurgy". As an instance of what can be done in this direction, the aluminium light-alloy industry was quoted as a practical example.

The Royal Air Force School of Education

A NEW Royal Air Force School of Education has been opened at Wellesbourne Mountford, near Leamington Spa, and one of its main purposes is to prepare newly appointed education officers for their professional duties in the R.A.F. The School is housed for the present in temporary accommodation because in view of the nature and the importance of the work a start could not be delayed. It is intended, however, to move the School to a more permanent location when this is feasible. Education in the R.A.F. differs little in its background from education in the civilian world. Its immediate purpose is to develop those qualities of mind and character which, while adapting the officer, the airman or the boy apprentice to the exercise of particular duties, yet helps him to achieve a worthwhile personal and social life and to appreciate the duties and privileges of citizenship. On the technical side, too, it is the task of the Education Branch to contribute a theoretical content towards technical and air-crew training of R.A.F. personnel for their day-to-day duties. Naturally the means and conditions through which these tasks are performed in the Service so far differ from those outside as to involve the young education officer in a period of some difficulty until he finds his feet. It is a function of this new school of education to minimize this period, and to orientate the professional qualifications and experience of the newly appointed officer (normally a university graduate and a trained teacher, and preferably with some initial teaching experience) towards his new duties. To this end he is given instruction over a period of four weeks in the organisation and administration of R.A.F. education, in certain aspects of the theory and practice of Service teaching, in the part played by education in maintaining high standards of training and of morale, and in the methods to be employed for education in citizenship and current affairs. In addition to the lectures given by the permanent staff provision is made in the School programme for visiting lecturers of eminence in the civilian world.

It will be noted that the School lays emphasis on the scheme for the education of Service personnel in citizenship and current affairs. Indeed the School will play a part of growing significance in the further development of this scheme, and in the near future a series of courses will begin at Wellesbourne Mountford which are designed for the benefit of officers of branches other than education who may volunteer to assist in the running of discussion groups on their stations. These courses will train the officers in the technique of discussion-group leadership, and will include a factual background in citizenship and current affairs. Until the machinery of recruitment gets into its full stride, there will for some little time ahead be an acute shortage of education officers in the R.A.F. As a temporary expedient, suitable officers and others of the Service who have lesser qualifications but a liking for the work, and who volunteer for temporary duty in the Education Branch, will be accepted for duty as educational assistants—and to prepare them for this work special short courses are to be arranged for them at Wellesbourne Mountford almost immediately. They will follow the lines of the main course as for education officers, but on a somewhat lower plane. In the case of airmen volunteers, since they will be given acting non-commissioned officer rank on the successful completion of the course, training will also be given in disciplinary and other duties appropriate to the rank. Finally, it is intended that the School will, from time to time, provide specialized courses of a refresher nature to keep education officers up to date in the development of new educational techniques and of educational research.

Conference on Scientific Information Services

THE Royal Society is arranging a Conference on Scientific Information Services to be held in London during June 21–July 2. The Conference, which will consider information services from the point of view of the scientific user, in accordance with the recommendation made in 1946 by the Royal Society Empire Scientific Conference and the British Commonwealth Scientific Official Conference, will be attended by representatives of countries providing information services in English. Editors-in-chief, who will prepare memoranda as bases of discussion, have been appointed as follow for the four sections into which the Conference will be divided: Section 1, publication and distribution of papers reporting original work (Prof. J. D. Bernal); Section 2, abstracting services (Sir David Chadwick); Section 3, indexing and other library services (Dr. J. E. Holmstrom); Section 4, reviews, annual reports, etc. (Prof. H. Munro Fox). It is hoped to cover all scientific subjects, including agricultural, medical and engineering sciences. Material suggested for discussion should be submitted as soon as possible to the appropriate editor-in-chief c/o Assistant Secretary, Royal Society, Burlington House, London, W.1. Contributors are asked to emphasize the practical steps that should be taken to implement their suggestions, including the provision of finance and the requisite personnel. Admission to the Conference will be by ticket only; applications should reach the Assistant Secretary of the Royal Society before June 1.

Institution of Mechanical Engineers: Clayton Awards

THE Institution of Mechanical Engineers has divided the Clayton Prize for 1947 in equal moieties. One half, valued at £650, has been awarded to Mr. J. E. Sears, formerly superintendent of the Metrology Department of the National Physical Laboratory, for his services to engineering science and manufacture by researches and development in metrology and gauging; the other half, to the value of £650, to Mr. T. E. Beacham, consulting engineer, for his contribution to the development of the variable-pitch propeller and high-speed hydraulic pumps and other hydraulic devices by way of research, invention and design.

A number of Clayton Fellowships are to be awarded during 1948; funds for this purpose have been derived from money bequeathed to the Institution by Mr. James Clayton, who died in 1944. Mr. Clayton was chief engineer of Messrs. Courtaulds and was closely associated with the development of equipment for the rayon industry. The Clayton Fellowships will in general be awarded for a year of postgraduate study or experience in mechanical engineering or a related science, and will be worth £250–£500. Candidates must be British-born subjects not less than twenty-three years old, and must possess an approved engineering degree or similar status.

Marketing Agricultural Produce

THE written evidence submitted to the Lucas Committee on the Marketing of Agricultural Produce by Mr. Thomas Shaw, on which that Committee largely based its recommendations for setting up a system of marketing for meat when the present rationing scheme and control by the Ministry of Food ends, has now been published, together with a foreword by Dr. John Hammond (from the author, Brettenham House, Lancaster Place, London, W.C.2). Insufficient attention has yet been given to the recommendation that producer marketing boards should continue to function only up to the point of procurement where the guaranteed price under the Agriculture Act applies, and that any participation in the functions of processing and marketing beyond that stage should fall within the ambit of a national slaughterhouse board or commission. Mr. Shaw's evidence details clearly the measures which the livestock industry most needs for efficiency, including complete reorganisation of the existing slaughterhouse set-up; utilization of all by-products and elimination of unnecessary profit margins, grading, division of poorer quality meats from the fresh, the manufacturing market and measures to mitigate seasonal variations in supplies. The proposed public corporation would be given powers to approve central factory abattoir schemes; to determine the terms and conditions under which such schemes should operate; to operate grading services at the abattoir and a price-governing formula; to authorize public funds required to implement the Government guarantee of prices, and linking that guarantee with qualities of the product; to make levies covering the cost of administration and the finance of industrial research in connexion with the abattoir; and to make loans to central factory abattoir schemes. The scheme, which is intended to lead to the effective closing of the wide gap between producer and consumer prices, to relieve the State in increasing measure of its financial liability under the terms of its guarantee and lay the foundations for an efficiently operating home meat industry, has thus features in common with the development councils to be established under the Industrial Organisation and Development Act, 1947, as the functions listed for the New Cotton Board, the first of such councils to be established, clearly shows.

Royal Scottish Museum, Edinburgh

A NOTABLE feature of the activities of the Royal Scottish Museum during 1946 (Ann. Rep. 1946) was the record number of temporary exhibitions that were organised. These, all of topical interest and of strong public appeal, included the "Meet Scotland" Exhibition (which ran from August 1945 until March 1946), organised by the Museum itself; "Other Peoples Jobs", organised by the Ministry of Fuel and Power, and a special health exhibition in connexion with the City of Edinburgh's Health Week. This was divided into sections dealing with maternity and child welfare, tuberculosis, school medical services, water supply, etc. A unique aspect of this particular exhibition, and one which must certainly be unique in the history of the Museum, was the presence of nursery school infants, "who," in the words of the report, "performed their exercises and ablutions, played their games and demolished their meals, completely unaffected by the mass of admiring onlookers". In reference to these and the several other special exhibitions which were provided for by various outside organisations, Dr. D. A. Allan, director of the Museum, writes: "The scope and variety of the Museum's offerings are largely determined by the possibilities of outside assistance, and the record for 1946 provides food for thought regarding museum developments in the years ahead". The attendance figures for the various exhibitions shown on p. 3 of the report certainly justify this observation. Important donations to the Museum during the year included the Fyfe collection of Japanese *netsuké* (presented by Mrs. E. J. Fyfe). A full list of acquisitions appears at the end of the report.

British Bee Plants

MANY people are interested in learning the sources of the pollen and nectar collected by bees; others are more concerned with the pollination of flowers; while the bee-keeper often wants to know the most suitable plants for extending pastorage for his stocks. To all of these, to botanists and to other readers we can commend the booklet "British Bee Plants" as a storehouse of useful information. All the best bee-plants are dealt with, whether they are in the flower or vegetable garden, orchard, farm or countryside. Often useful hints are given regarding cultivation of particular plants, their uses and other details. Edited by A. F. Harwood, it is issued by the Apis Club, The Ways End, Foxton, Royston, at 3*s*.

British Social Hygiene Council: Summer School

"THE SCHOOLS AND THE LAND" is to be the theme of a summer school that the British Social Hygiene Council is organising at the Seale-Hayne Agricultural College, Newton Abbot, Devon, during July 30–August 13. The school will be concerned with the place of agriculture in the life of the nation, with special reference to the soil, its cultivation and improvement, grassland and arable crops, livestock husbandry, the processing and distribution of farm products, and the social and economic conditions of rural life. The school should appeal particularly to all teachers of biology, and social workers and others will be able to extend their knowledge of and sympathy with the work, outlook and social conditions of the rural community.

At the evening sessions, lectures will be given by visiting speakers, each expert in his special field. Among those who have already accepted invitations to speak are the Rt. Hon. R. K. Law, Prof. A. W. Ling, Prof. T. Wallace, Prof. D. B. Johnstone-Wallace, Mr. L. J. F. Brimble, Mr. J. H. Anderson, Mr. E. Ford, Mr. G. F. Kingston, Mr. K. C. Vear and Dr. D. A. MacPherson. The resident staff will consist of Mr. A. Roebuck, Miss H. R. Chapman, Mr. W. L. Sumner, Mr. E. Lucas, Mr. L. E. Morris, Mr. R. Weatherall and Dr. M. B. Gibbons. The fee for the School is £14 14*s*. (including £1 1*s*. enrolment fee—not returnable). This covers board and tuition. Further information can be obtained from the Secretary, British Social Hygiene Council, Dept. S.J.1, Tavistock House North, Tavistock Square, London, W.C.1.

University of Leeds: Appointments

THE following appointments in the University of Leeds have been announced: Dr. J. W. Baker, formerly senior lecturer and honorary reader in organic chemistry, to the newly established readership in the mechanism of organic reactions; Dr. C. S. Whewell, lecturer in textile chemistry, to be honorary reader in textile finishing and lecturer in textile chemistry.

University of Sheffield

THE following appointments in the University of Sheffield have been announced: O. I. Butler, senior lecturer in charge of the Department of Electrical Engineering; H. J. Cowan, lecturer in civil engineering; G. Wiseman, assistant lecturer in physiology; A. G. Macgregor, research assistant in the Department of Pharmacology and Therapeutics.

Prof. Douglas Knoop, who is retiring from the chair of economics at the end of the present session, has made a gift of money to the University to endow an economics prize, to be associated with his name, to be awarded to the student whose work in economics in the final examination for the Special Degree of B.A. has shown most distinction and promise.

Colonial Service: Appointments

THE following appointments in the Colonial Service have been announced: D. D. Campbell, agricultural officer, Uganda; H. Irving, agricultural chemist, Nigeria; D. C. Todd, agricultural officer, Uganda; G. H. Pinfield, inspector of mines, Tanganyika; L. F. Edgerley, assistant conservator of forests, Mauritius; B. R. Fuller, assistant conservator of forests, Nyasaland; S. T. Hoyle, senior agricultural officer, Lilongwe Experimental Station, Nyasaland; J. Sinclair, curator of the Herbarium, Singapore; S. Gillet (senior coffee officer, Kenya), director of agriculture, Kenya; J. T. Moon (agricultural officer, Kenya), senior agricultural officer, Kenya; C. C. Parisionos (agricultural officer, Northern Rhodesia), agricultural officer, Cyprus; A. Pickles (entomologist, Trinidad), entomologist, Nigeria; F. W. Thomas (agricultural officer, Tanganyika), senior agricultural officer, Tanganyika; J. P. Edwards (conservator of forests, Malaya), deputy director of forestry, Malaya; R. O. Roberts (chemist and petrologist, Uganda), mineralogist, Nigeria; D. F. Macpherson (senior veterinary officer, Kenya), chief veterinary officer, Nyasaland; F. L. Vanderplank (research officer, Tanganyika), entomologist, West African Institute for Trypanosomiasis.

The Night Sky in April

NEW moon occurs on April 9d. 13h. 16m., U.T., and full moon on April 23d. 13h. 28m. The following conjunctions with the moon take place: April 7d. 18h., Mercury 2° N.; April 13d. 08h., Venus 1° N.; April 18d. 02h., Saturn 4° S.; April 18d. 10h., Mars 3° S.; April 27d. 18h., Jupiter 4° N.; Mercury, in superior conjunction with the sun on April 29, is too close to the sun during the month for favourable observation. Venus is an evening star, setting at 22h. 56m. and 23h. 45m. on April 1 and 30 respectively, and shines with stellar magnitude −4 approximately during the month, about one half of the illuminated portion of the disk being visible. The planet attains its greatest easterly elongation on April 15. Mars, in the constellation of Leo, can be seen throughout the greater portion of the night, setting at 4h. 25m., 3h. 23m., and 2h. 41m., at the beginning, middle and end of the month, respectively. Jupiter, in the constellation of Sagittarius, is not visible until the early morning hours, the times of rising being 1h. 25m. on April 1 and 23h. 30m. on April 30. The planet is stationary on April 15. Saturn, in the constellation of Cancer, is visible during most of the night, setting a little before Mars, and is stationary on April 17. Occultations of stars brighter than magnitude 6 are as follows: April 13d. 20h. 31m., *k* Taur. (*D*); April 26d. 00h. 16m., 19 Scor. (*R*); *D* and *R* refer to disappearance and reappearance, respectively, and the latitude of Greenwich is assumed. There will be a partial eclipse of the moon on April 23, invisible at Greenwich, but visible over a large portion of the southern hemisphere and also over the extreme western and north-western portion of North America. The Lyrid meteors can be seen during April 18–24, but moonlight will partly interfere with the observations of this shower.

Announcements

THE governing body of the Imperial College of Science and Technology has appointed Air Chief Marshal Sir Roderic Hill to be rector of the College as from October 1, in succession to Sir Richard Southwell, who has held that office since 1942.

DR. J. CYMERMAN, lecturer in organic chemistry in Charing Cross Hospital Medical School (University of London), has been appointed lecturer in organic chemistry in the University of Sydney.

THE following have been elected officers of the Royal Photographic Society: *President*, Percy W. Harris; *Vice-Presidents*, L. V. Chilton, I. D. Wratten; *Treasurer*, H. Abbott; *Ordinary Members of Council*, Gilbert Adams, J. Allan Cash, K. H. Gaseltine, R. N. Haile, Dr. P. Hansell, T. Midgley Illingworth, Dr. S. D. Jouhar, Mrs. Rosalind Maingot, R. H. Mason, H. S. Newcombe, Alec Pearlman, Anthony Peacock, Oliver G. Pike, B. Sinkinson, A. L. M. Sowerby.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A 16-MeV. Betatron

DURING the past few weeks, a betatron which has been under construction by the British Thomson-Houston Co., Ltd., has come into operation, and we give some preliminary account of its properties. The magnet and coil arrangement is shown in Fig. 1. The main features of the machine are:

Maximum orbit radius	20·75 cm.
Orbit space section (where $0 < n < 1$), radial	2 ,,
axial	3 ,,
Average value of the index n	0·5
Total weight	0·85 tons
Operating frequency	50 c.p.s.
Excitation	400 volts r.m.s. 200 amp. r.m.s.
Input power	4 kW.
Peak volts per revolution at the orbit	22
Peak flux density at the orbit	2750 gauss
Electron energy at peak flux density	16·3 MeV.

The weight and kVA. are low for a betatron of this energy. This results from having a narrow orbit space and a closed central leg which leaves the annular guide-field as the only major flux in air. The accelerating and the guide fluxes are produced by two coaxial windings which lie radially on either side of the orbit. These are excited in parallel, their turns being chosen so that the accelerating flux, most of which is in the closed central leg, bears the necessary betatron relation to the guide flux. Thus the betatron is like a transformer with a loaded inner secondary winding, the core flux of which corresponds to accelerating flux, and the leakage flux of which provides the guide field. Analogous arrangements have been proposed by Kerst[1] (flux forcing) and Wideröe[2], while the General Electric Company of America has reported[3] the successful operation of such a machine. All core components are kept in contact under pressure, and we believe that this is responsible for the quietness of the machine in operation. At 400 V. excitation, the noise level is 75 phon.

Fig. 2 shows in radial section the disposition of the guide-field pole-pieces, the vacuum chamber, and, as dotted lines, the boundaries of the region of stability. The pole-pieces were designed by an electrolytic tank method which takes into account the proximity of current-carrying conductors[4]. The field fall-off exponent n in $B_r = B_0\ (r_0/r)^n$ was chosen to be $\frac{1}{2}$, making the radial and vertical oscillations of the same frequency and favouring an orbit space of circular cross-section. The space available for acceleration is partly blocked at one point by the gun, which at present reduces the radial width to 1·6 cm. A high degree of uniformity in the field around the orbit is called for in this machine on account of the limited orbit space, and so the pole-pieces are divided into quadrants, each capable of separate movement. By adjustment of the quadrants, variations in field around the orbit were reduced until their resultant was equivalent to an error of less than 0·3 per cent over one radian of circumference.

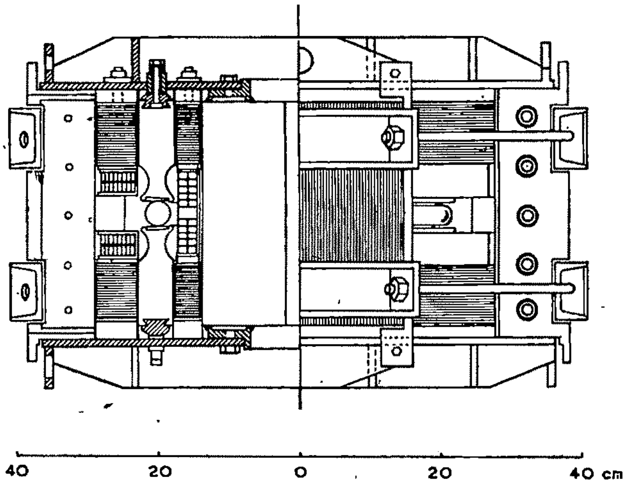

Fig. 1. GENERAL ARRANGEMENT OF A 16 MEV. BETATRON

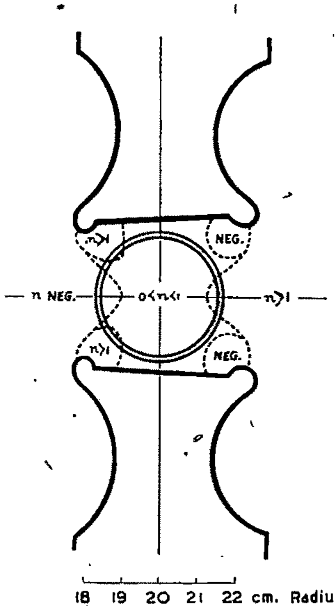

Fig. 2. GUIDE FIELD POLES, SHOWING REGIONS OF ORBIT STABILITY ($0 < n < 1$)

At the time of injection, circumferential variations in the quadrature components of the guide field are important, and, to compensate for these, coils were attached to the pole faces and fed with appropriately phased A.C. By this means the field variations at injection were reduced to the equivalent of 1 per cent (0·27 gauss) acting over one radian. Such a disturbance is estimated to produce a maximum radial oscillation amplitude of 1 cm.

Auxiliary transformers in series with one of the betatron windings supply small orbit-control voltages. An in-phase voltage controls the equilibrium orbit radius by changing the ratio between the accelerating flux and the guide flux, and a quadrature voltage serves to vary this radius during the acceleration. Due to winding resistances, there is a phase difference between the two fluxes of 0·04 radian acting in such a sense that the orbit tends to expand. This phase difference can be reduced by adjustment of the quadrature voltage; or, alternatively, the orbit radius can be allowed to drift into the target at any stage of the acceleration without using the orbit expansion pulse.

In the preliminary tests, 5 microsec. pulses were injected at 25 kV. in the orbit plane; and an output of about 0·1 r./hr. was measured at 1 metre, using an ionization chamber screened with 3 mm. of lead. Adjustments of injection voltage and timing, of orbit position, and the phase control of orbit position, were found to have the effects generally expected.

On the other hand, the gun filament current showed distinct optimum settings, above which the output decreased rapidly, suggesting that space charge may play some part in the acceptance process. The appearance at times of two stationary Geiger kicks among the random ones observed during the acceleration suggests that the orbits have a complex structure as reported for the synchrotron[5], or that some electrons, drifting to the wall, can survive and continue to be accelerated.

This acceptance and acceleration of electrons in so limited an orbit space may encourage designers to consider narrower guide-fields, more especially in very large machines.

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Rugby.
J. L. TUCK
R. S. RETTIE
Clarendon Laboratory,
Oxford.
Feb. 24.

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[1] Kerst, *Phys. Rev.*, 68, 233 (1945).

[2] Wideröe, "Verlaüfige Berechnung der 200 MV. transformators", a manuscript dated March 5, 1944, referred to in B.I.O.S. Report 148, p. 4.

[3] Westendorp, *Phys. Rev.*, 71, 271 (1947).

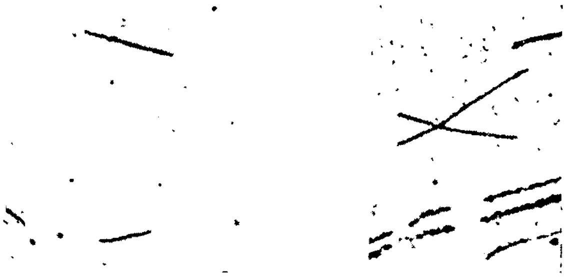
[4] Peierls, *Nature*, 158, 831 (1946).

[5] Elder, Gurewitsch, Langmuir and Pollock, *J. Appl. Phys.*, 18, 810 1947).

Applications of the Reflecting Microscope to the Nuclear Plates Technique

WE have found it instructive to reverse the normal microscope procedure in the examination of nuclear emulsions ; invert the plate, feed light in through the cover slip, and observe through the backing plate. With high magnification, normal objectives and ordinary glass-backed gelatine, this is not possible; but it may be done by using a reflecting microscope[1]. In this way, with oil immersion, we observed several multiple stars, and found heavy fragments which were not visible by the normal mode of examination because they were obscured by the central body of the star. In some doubtful cases, this mode of examination proved decisive in the interpretation of the event.

It was but a step to sandwich two plates, with immersion oil or Canada balsam between them (emulsion inwards), and verify that we could observe right through both emulsions with unimpaired image quality. A plate, soaked in thorium nitrate, was dried and placed against an uncontaminated plate for three days. After separation, the plates were processed in the normal way, realigned by an X-ray marking grid, and the sandwich reconstituted. The accompanying microphotograph shows two tracks which originate from a star in one emulsion and end in the other.



Since this experiment was performed, the examination of sandwiches exposed at the Pic du Midi has proved that with a normal microscope it is comparatively easy to follow the passage of particles from one plate to another with separate examination of the two plates, but only if the density of events is low. Although in our case the density of stars in the soaked plate was rather high, of the order of 20 per sq. mm., we have been able to identify the mother star of every alpha particle investigated in the second plate. These conditions provided such a stringent test of the applicability of the method in the photographic technique that we feel confident some applications, such as the dosage of radioactive substances, biological research with the auto-radiographic technique, and the measurement of long-range particles emitted by elements embedded in one of the two plates, are feasible.

The accompanying photograph shows that intimate contact between the plates was not obtained but that an air gap existed, mainly due to the large size of the plates used. With a known gap and known pressure of the gas, the 'magnification' of range thus obtained can be used for extending the field of application of the photographic plate. For example, the absorption of particles in the gas can be measured and the sign and mass of light charged particles determined by magnetic deflexion. Such an experiment is being carried out by Dr. C. F. Powell and Dr. S. Rosenblum (see following communication).

The long working distance of the reflecting microscope, which is proving useful in biological fields, will permit the examination in depth of emulsions so thick as to be beyond the range of ordinary objectives.

In the new nuclear plates the emulsion shrinkage on processing is of the order of 50 per cent, as compared with 15 per cent for the old half-tone plates, and the grain size is becoming smaller. Observation of such plates can be facilitated by using ultra-violet instead of visible light, a technique for which this instrument, being focally achromatic, is well suited.

We wish to express our gratitude to Dr. Burch for the use of the microscope, and to Dr. Burch and Dr. Powell for helpful discussion.

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[1] Burch, C. R., *Proc. Phys. Soc.*, 59, 41 (1947).

A New Method for the Determination of the Mass of Mesons

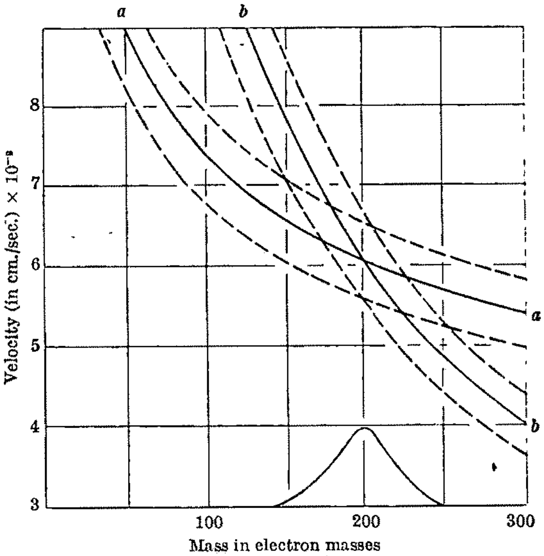
WE have recently installed at the Jungfraujoch High-Altitude Research Station an apparatus for the determination of the masses, and the signs of the electric charge, of the various types of mesons observed in photographic emulsions exposed to the cosmic radiation. In view of the importance of obtaining reliable information on this subject, and of the desirability that similar experiments should be made by other investigators, we present a brief account of the main features of the method. In doing so, we also have in mind the possibility that charged mesons may be generated artificially in the near future by means of the large synchrotrons and synchrocyclotrons now approaching completion in the United States ; and that our methods may be of use for mass determinations in this field of investigation also.

It is well known that it is not possible, at the present time, to make magnetic deflexion experiments with photographic emulsions—analogous to those which have been so successful with the Wilson expansion-chamber in experiments on cosmic radiation—by observations on the curvature, due to a magnetic field, of the trajectory of a particle in an emulsion. In examining tracks at high magnification, a measurable deflexion would correspond to such a small value of the radius of curvature that a field of the order of 10^6 gauss would be required; a field which, for work with cosmic-ray particles, it would be necessary to maintain over long periods of time. In addition, small-angle Coulomb scattering would greatly complicate the interpretation of the results. In these circumstances, we have chosen to make observations on the change in direction suffered by a particle in its passage through a gas, or a vacuum, in a magnetic field. For this purpose we have considered a number of possible geometrical dispositions of the photographic plates relative to the field; the following appears to be the most appropriate for the present experiments.

It has been observed by Bates and Occhialini that it is possible to detect and identify the tracks of single particles in two separate plates placed with their emulsions face to face[1]. A particle, moving with sufficient energy in a suitable direction, and originating in one emulsion, can leave the surface and cross the narrow air-gap to enter the second emulsion. The two component parts of the track of the same particle can be identified under the microscope. We therefore arrange two plates, in a suitable plate-holder, with their emulsions face to face, and separated by a distance of 3 mm. This assembly is placed between the pole-pieces of a permanent magnet giving a field of 8,600 gauss, so that the planes of the emulsions are normal to the magnetic field. A meson which enters the emulsion of one of the plates will, in general, have emerged from the emulsion of the other; and, in the space between the plates, it will have moved in a spiral path. If we can identify the track of the same particle in the two emulsions, then the observed change in the direction of motion in traversing the air gap, and the distance between the points of exit and entry of the particle in the emulsions, allows us to calculate $H\rho$ for the particle; the magnitude of its momentum in the plane perpendicular to the field is thus determined. Further, if the particle comes to rest in the emulsion, its observed range gives a measure of its velocity as a function of its mass. The two observations taken together define the mass of the particle.

For the successful application of this method, it is clearly necessary to define the geometrical relationship of the two plates during the exposure. For this purpose we expose the plates in their holder, before development, to a fine pencil of X-rays, and produce a succession of corresponding points, on the two plates, in the form of a geometrical grid. The relative positions and orientations of the two portions of the trajectory of a single particle, relative to the common grid, can thus be determined. The identification of the two portions of the trajectory of a particle is facilitated—and the probability of attributing two unrelated tracks to the same particle is greatly reduced—by the fact that the angles of 'dip' of the trajectory at the two surfaces must be equal; and that, for a given distance between the points of exit and entry of a single particle at the two surfaces, there is a relationship between the directions of motion at the two points. If we observe the direction of the projection of the trajectory, on a plane parallel to the surface of the emulsion, at the point of entry into one emulsion, the corresponding direction at a given point of exit in the other is determined.

In making observations, we first search one of the plates until we find the track of a meson which enters the surface; which stops in the emulsion after traversing a distance between 100 μ and 400 μ; and which has an angle of dip, β, on entering the emulsion, of less than 15°. From the observed angle of dip, we can determine the approximate position of the point of exit of the particle from the other emulsion, assuming an approximate value for its mass and that (*a*) it is positively and (*b*) negatively charged. We then search the regions of the second plate in the areas thus located, until we find a track which has the characteristics of a meson of the correct energy, and which emerges in the necessary direction.



To estimate the precision which we can expect to obtain with the method, we consider the analysis of an event in which a meson has a range of 200 μ in one emulsion; a value of $H\rho$ of 70,000 gauss-cm.; and an angle of dip of 10°. The observed range allows us to draw a curve (*a*) (see graph), showing the relation between the mass and velocity. Owing to straggling, this line must be replaced by a band, as shown. Similarly, the value of $H\rho$ defines the momentum of the particle, which allows us to construct curve (*b*). Here again, the line must be replaced by a band corresponding to an uncertainty in the determination of the change in the direction of the particle in passing between the plates, which we estimate to be ± 1°. The mass of the particle is determined within the limits corresponding to the region of overlap of the two bands, and a detailed analysis indicates that, in favourable circumstances, the 'probable error' in the determination of the mass of an individual particle will be less than 10 per cent. This result suggests that the method should be capable of a precision not inferior to that achieved in the best applications of the Wilson chamber.

It has previously been pointed out by Lattes, Occhialini and one of us that the failure to observe π-mesons, and the process of μ-decay, in an expansion chamber may be associated with the very short half-value period, τ_π, of these particles. For the successful determination of the mass of these particles by the present method, it is necessary that τ_π should exceed about 3×10^{-10} sec.

For other experiments, it is possible that a different disposition of the plates and the field would prove more suitable; but the arrangement we have employed has the advantage that the determinations of the mass do not depend critically on a knowledge of the shrinkage of the emulsion; and that, apart from losses at the edges of the plates, the track of every meson entering the surface of one emulsion must have emerged from the other.

We are greatly indebted to Prof. von Muralt, Mr. H. Widerkehr and Mr. Saige for much kindness and assistance in the establishment of the apparatus at this Station.

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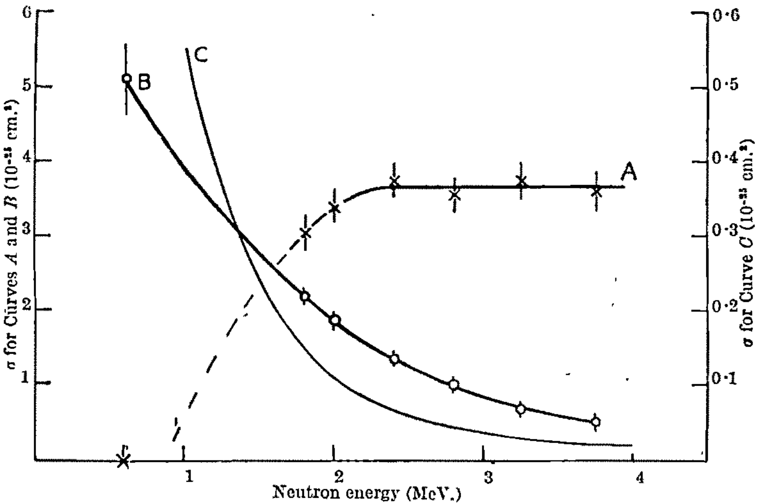
Jan. 6.

Interaction of Fast Neutrons with Indium

INDIUM has two stable isotopes, In^{115} (95·5 per cent) and In^{113} (4·5 per cent). In^{115} can be excited by an (n,n) process to a metastable-level (In^{115*}) at 340 keV. and returns to the ground-state by a strongly internally converted γ-transition with a half-life of 4½ hours[1]. Fast neutrons may also be captured in In^{115}, leading to two isomeric activities of In^{116} with periods of 54 min. and 13 sec. Both these processes may be regarded as competing in the initially highly excited compound nucleus In^{116}, and it was considered of interest to examine the absolute magnitude of the respective cross-sections as a function of neutron energy.

Indium foils were irradiated with fast neutrons from the C—D and D—D reactions produced by the Cavendish 1 MeV. high-tension set. The absolute flux of fast neutrons during irradiation was measured with a recoil ionization chamber filled with hydrogen and argon[2]. The decay of the indium after irradiation was followed with a thin-window Geiger counter, and the 4½-hr. and 54-min. activities were easily separable. During irradiation, the indium was surrounded by cadmium and boron to minimize the 54-min. activity produced by slow scattered neutrons. The remaining background activity was determined from inverse square plots. The absolute efficiencies of the β-counter for the two activities were determined by observing coincidences between the conversion electrons and the accompanying K X-rays in the 4½-hr. decay, and between the β-particles and the succeeding γ-rays in the 54-min. activity.



Curve A: Cross-section for production of In^{115*} by the (n,n) process as a function of neutron energy.
Curve B: Experimental results for the cross-section for capture in In^{115} leading to the 54-min. activity of In^{116}.
Curve C: Theoretical results of Weisskopf and Ewing for neutron capture in tin

Although there is some evidence for irregularities in the variation of inelastic scattering cross-sections with energy[3], curve A, showing the cross-section for the (n,n) process leading to In^{115*}, is smooth and flat above 2·2 MeV. The curve also indicates that a threshold for this reaction probably exists in the neighbourhood of 1 MeV. If we assume from the theory of Weisskopf and Ewing[4] that the inelastic scattering cross-section above 1 MeV. is $\sim \pi r^2$ (r is nuclear radius), that is, $\sim 2 \times 10^{-24}$ cm.^{2} for indium, then the graph shows that for primary neutrons between 2 and 4 MeV., about 20 per cent of the transitions from the excited levels in which In^{115} is left immediately after inelastic scattering lead to the metastable state. The value $\sigma = 3 \cdot 6 \times 10^{-25}$ cm.^{2} between 2 and 4 MeV. may be compared with the rough value $\sigma = 3 \times 10^{-25}$ cm.^{2} obtained by Reddeman for the excitation of the metastable-level Sr^{87*} with 2·5 MeV. neutrons[5,6]; both In^{115} and Sr^{87} have a spin 9/2 in the ground-state, and the metastable-level of Sr^{87*} is at 370 keV. above the ground-state.

Curve B shows the variation of the cross-section for the production of the 54-min. activity with neutron energy, and curve C the capture cross-sections deduced by Weisskopf and Ewing[4] for the neighbouring element tin, on the basis of the Bohr model of the compound nucleus. The general shapes of the curves between 2 and 4 MeV. are in fair agreement; but absolute values are widely divergent, by a factor of at least 20 (this is a lower limit as attention in this work was confined to the 54-min. capture activity) near 4 MeV.

In^{113} has very similar nuclear properties to In^{115}. It has a metastable state at 380 keV. with a half-life of 104 min. During this investigation, the excitation of In^{113*} by an (n,n) process has been detected by following the decay of the K X-rays accompanying conversion electrons of the isomeric transitions with a krypton-filled counter. Electrons were stopped by a layer of polythene which transmitted the X-rays, and these were distinguished from γ-rays by their strong absorption in a thin molybdenum foil; the 54-min. capture period which would conceal the 104-min. period of In^{113*} was thus eliminated. The cross-sections for the excitation of In^{113*} and In^{115*} by the (n,n) process with D—D neutrons were found to be of the same order of magnitude, just as in the case of direct excitation with X-rays[7]. The similarity in the properties of the low metastable levels of the two stable indium isotopes is analogous to the behaviour of the metastable levels[8] of the two stable odd silver isotopes $Ag^{107,109}$.

A fuller account will be published later.

I am indebted to Mr. D. West for initial discussions which led to these experiments, to Mr. K. W. Allen for his advice in the neutron flux measurements, and to Prof. M. H. L. Pryce for his comments on the results.

S. G. COHEN

Cavendish Laboratory,
Cambridge.
Dec. 10.

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[1] Goldhaber, Hill and Szilard, *Phys. Rev.*, **55**, 47 (1939).

[2] Method developed by Mr. K. W. Allen in this Laboratory; to be published.

[3] Grahame, *Phys. Rev.*, **69**, 369 (1946). Nonaka, *Phys. Rev.*, **59**, 681 (1941).

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[5] Reddeman, *Z. Phys.*, **116**, 137 (1940).

[6] Dubridge and Marshall, *Phys. Rev.*, **57**, 348 (1940).

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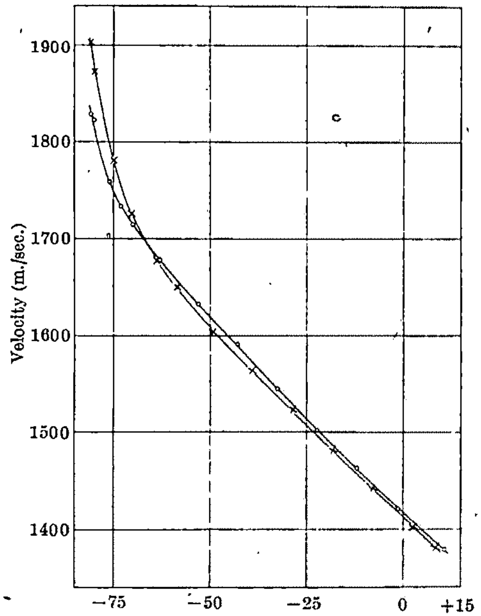
Ultrasonic Dispersion in Organic Liquids

I HAVE measured the velocity of sound, v, at frequencies between about 700 and 3,000 kc./s., and at temperatures between about + 15° and − 80° C., in the following liquids: *iso*-butyl alcohol; geraniol, $(CH_3)_2.C : CH.(CH_2)_2 . C(CH_3) : CH.CH_2OH$; di-dihydrocitronellyl ether $[(CH_3)_2 . CH . (CH_2)_3 . CH(CH_3) . (CH_2)_2]_2O$. There is evidence of negative dispersion ($\partial v/\partial f < 0$) in all three liquids, and of positive dispersion ($\partial v/\partial f > 0$) in geraniol and di-dihydrocitronellyl ether near the lower end of the temperature-range. The negative dispersion in *iso*-butyl alcohol is very small and near the limit of experimental error, but it is more pronounced in the other two liquids.



VELOCITY OF SOUND IN DI-DIHYDROCITRONELLYL ETHER AS A FUNCTION OF THE TEMPERATURE AT 689 kc./s. (○) AND AT 2102 kc./s. (×)

The accompanying graph, which refers to di-dihydrocitronellyl ether, is an example of the ultrasonic behaviour of these compounds. It will be seen that the onset of positive dispersion is marked by a more rapid increase of the velocity of sound with falling temperature than at higher temperatures.

A full account of this work will be published elsewhere.

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Magnetic Susceptibility of Mica

THE magnetic susceptibilities of various natural micas have been measured by Wilson[1] and Nilakantan[2]; the latter also measuring the anisotropy. It was found that for micas which are substantially free from inclusions of magnetite, and in which the iron is therefore present in the crystal lattice, the paramagnetic susceptibility is proportional to the iron content. It was therefore surprising that Eitel and Dietzel[3] should report that synthetic mica containing only 0·05 per cent of iron is still paramagnetic, since a small cleavage flake orientated itself parallel to the magnetic field. A rough calculation shows that a mineral corresponding to their synthetic fluorphlogopite ($KMg_3AlSi_3O_{10}F_2$) should have a specific diamagnetic susceptibility of $- 0{\cdot}35 \times 10^{-6}$ C.G.S. units, and using the usual Bohr magneton value for iron of $P_B = 5$ and calculating the paramagnetic susceptibility of iron from the relation $P_B = 2{\cdot}84\sqrt{\psi T}$, where ψ is the susceptibility per gram-ion, one finds that 0·2 per cent of iron corresponds to a paramagnetic susceptibility of just $+ 0{\cdot}35 \times 10^{-6}$ C.G.S. units. A mica with a greater iron content should therefore be paramagnetic, but with less iron should be diamagnetic. Eitel and Dietzel suggested that the anomalous paramagnetism found by them was connected in some way with the highly anisotropic crystal structure of mica.

We have prepared synthetic mica[4] by the method used by Eitel and Dietzel, and a measurement of its susceptibility by the Gouy method gave a value of $1{\cdot}60 \times 10^{-6}$ C.G.S. units at a field of about 9,000 oersteds between the pole pieces for a specimen containing 0·04 per cent of iron. The paramagnetism thus appeared to be very high indeed, and would correspond to a Bohr magneton value for iron of $P_B = 25$.

Closer investigation has, however, shown that this apparent large paramagnetism is spurious, and that the observed effect is really due to the ferromagnetism of inclusions of magnetite in the synthetic mica. This conclusion is based on the following facts: (1) the susceptibility decreases with increasing field strength; (2) a large part of the iron in the synthetic mica prepared by us can be washed out by dilute sulphuric acid, although such a treatment scarcely affects a natural mica which is free from inclusions; thus confirming that magnetite inclusions are present in the mica prepared by us, and hence in that prepared by Eitel and Dietzel also. Although we have not been able to extend our measurements to sufficiently large fields, our results indicate that at very large field strengths this synthetic mica should become diamagnetic, the ferromagnetic inclusions then being saturated and the intrinsic diamagnetism of the mica causing a cleavage flake to set perpendicular to the field.

We carried out similar experiments with a sample of the synthetic fluorphlogopite prepared by Middel[5] and found that in this case magnetite inclusions were substantially absent, although the iron content was about the same (0·05 per cent), since the mineral was diamagnetic at all fields. This is no doubt due to the very much slower cooling rates used by Middel during the crystallization of the mica. (He prepared melts of up to 100 kgm., while Eitel and Dietzel and ourselves prepared melts of only about 200 gm.) The specific susceptibility of Middel's synthetic mica was measured by us, using the Rabi method. Different values for the specific susceptibility parallel to the cleavage plane were obtained for different crystals, ranging from $-0 \cdot 17 \times 10^{-6}$ to $-0 \cdot 29 \times 10^{-6}$ c.g.s. units. This variation would indicate that the small iron content is unevenly distributed throughout the mica crystal lattice.

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Dec. 5.

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[1] Wilson, E., *Proc. Roy. Soc.*, A, **96**, 429 (1920).

[2] Nilakantan, P., *Proc. Ind. Acad. Sci.*, A, **8**, 39 (1938).

[3] Eitel, W., and Dietzel, A., Appendix to B.I.O.S. Report 785 (1946).

[4] Kendall, J. T., and Spraggon, W., paper read at XIth International Chemical Congress, London (1947).

[5] Middel, V., reported by H. A. Curtis, *Chem. and Met. Eng.*, **109** (March 1946).

A Large Field Compensator for Measurement of Birefringence

In the measurement of stresses in glass using polarized light, it is usual to employ some form of compensator in which the amount of birefringence varies uniformly across the field of view and passes through zero value at the centre. This gives a series of parallel fringes when viewed suitably between crossed polarizer and analyser. With white light the central fringe is black, and serves as a useful index.

In the Babinet compensator the uniform variation of birefringence is obtained by superimposing two narrow-angle quartz wedges, cut with their optic axes at right angles, with the thick edge of one adjacent to the thin end of the other. The same effect can be obtained by uniformly bending strips of a photoelastic material in a plane perpendicular to the direction from which it is to be viewed. The central black fringe corresponds to the neutral plane of the bent beam so formed, and fringes due to tension and compression are seen on either side of it. A compensator based on this principle has been described by Holmes[1] and consists of a strip of plate-glass uniformly bent in a suitable bending device, with the plane of bending parallel to the polished faces of the glass.

It has been found possible to produce the same effect by bending a strip of the resin *CR.* 39 in a similar way. The strain pattern can be 'frozen' into this material and the bending device afterwards discarded. A clamp is used which, by means of a screw, can be made to apply equal and opposite couples to the two ends of a strip of the material, so that it is bent uniformly in a plane parallel to the original faces of the sheet from which it was cut. The clamp holding the strip loosely in an unstrained condition is placed in an oven maintained at 105° C. After about ten minutes the sample is removed from the oven and the screw quickly tightened to give the desired strain pattern in the strip. After cooling to room temperature and removal from the clamp, the strip retains the strain pattern, which does not alter appreciably after the first 24 hours. Most of the unwanted end portions where the couples were applied, and where the bending is not uniform, may then be sawn off without affecting the system of parallel fringes extending over the remainder of the strip.

Strips 14 in. × 2 in. of various thicknesses have been used; but the dimensions are limited only by the sizes of clamp and oven available. With this size, parallel fringes cover an area of approximately 8 in. × 2 in., and up to three fringes on either side of the neutral fringe have been obtained in a thickness of ¼ in. A limit is set to this number by the flexural strength of the material when hot. The curvature of the strip with this amount of strain is apparent, but for most applications is not objectionable. By using a number of strips built up into a single unit the number of fringes may be increased; or alternatively the amount of curvature for the same number of fringes may be decreased.

Two strips of 'Polaroid' with their planes of polarization suitably orientated may be used as polarizer and analyser with the compensator. This combination forms a direct vision strain-viewer with a large field of view which may be used with any bright background and needs no projection system. One of the strips of 'Polaroid' may conveniently be mounted on one surface of the compensator and the other in a suitable holder, so that the whole apparatus comprises two compact units. Since no setting up is required, the compensator used in this way is useful for the rapid examination of stresses in glass both under laboratory and also under factory conditions.

The compensator described is superior to the quartz type as regards size of field, and may be of some interest for the evaluation of the degree of birefringence in problems other than the special application in this laboratory.

The work on this compensator was carried out in the Research Laboratory of Messrs. Pilkington Brothers, Ltd., who have kindly agreed to publication.

P. E. Jellyman
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Research Department,
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Dec. 16.

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[1] *J. Sci. Instr.*, **17**, 227 (1940).

New Bands in the Schumann–Runge System of the Oxygen Molecule

Oxygen produced by heating potassium permanganate crystals was excited by a high-frequency (750–850 kc./sec.) discharge (output power less than 10 watts) and the spectra protographed both in the visible and in the ultra-violet regions by a Fuess glass prism spectrograph and a small (baby) quartz prism spectrograph respectively. A good many of the more intense bands of the Schumann – Runge system were found on both our plates. On attempting to extend the system, we discovered that a number of new bands present on our plates, but not reported by previous workers, fitted in the $(v'v'')$ scheme of this system. These new bands (ν_{vac}) along with our proposed quantum assignments are given in the accompanying table.

S.N.	ν_{vac}	Proposed (v',v'')	S.N.	ν_{vac}	Proposed (v',v'')
1	22277	(8,25)	14	28212	(7,19)
2	22616	(0,20)	15	29824	(4,16)
3	22804	(9,25)	16	30361	(1,14)
4	23208	(6,23)	17	30416	(3,15)
5	23270	(8,24)	18	31005	(2,14)
6	24120	(4,21)	19	31056	(4,15)
7	24244	(6,22)	20	31625	(1,13)
8	24285	(8,23)	21	32252	(6,15)
9	24605	(3,20)	22	32291	(2,13)
10	26452	(4,19)	23	35828	(8,13)
11	27065	(5,19)	24	36575	(7,12)
12	27368	(2,17)	25	37327	(6,11)
13	28005	(3,17)	26	40776	(5,8)

These bands are very strongly degraded to the red. The distance between the head and the origin of a band of this system is found to be less than 0·5 A. This gives to most of the bands of this system a confused line-like structure with instruments of small dispersion such as have been used in the present case. However, their existence as bands is definite on our plates.

The quantum assignment of these new bands gives vibrational differences (both in the initial and in the final states) of the expected magnitudes. It is, however, to be noted that appreciable discrepancies in the initial vibrational differences for the level (2–3) and in the final vibrational differences for the levels (12–13) and (13–14) appear on account of too low (λ) values of the bands (3,17) and (0,14) (as obtained by us in the present case).

Since the Schumann – Runge system is in general difficult to observe in emission by other methods of excitation, it appears that the high-frequency discharge is especially suited for obtaining this system in emission. Its appearance here is due to the selective excitation property of the latter.

In conclusion, it may be mentioned that Flory[1] thinks that the $^3\Sigma_v^-$ state predissociates before the bands with $v' > 2$ can be obtained in emission. But he gives no rigorous proof for such a predissociation. The existence on our plates of the new bands with $v' > 2$ (most of which have been marked on the enlargements of the spectrograms and will be published along with the details), however, is quite certain. If theoretical conclusions, based on the present accepted structure of the oxygen molecule, question the existence of these new bands of the Schumann – Runge system in emission, reconsideration is necessary of the structure of the oxygen molecule (a conclusion we have arrived at from many other points of view also).

I wish to thank Prof. R. K. Asundi, of the Benares Hindu University, under whose guidance the work has been done.

LALJI LAL

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Nov. 27.

[1] Flory, Paul J., *J. Chem. Phys.*, 4, Nos. 1-12, 23 (1936).

Meteor Whistles

MANY observers have reported Döppler-effect heterodynes in the background of received high-frequency broadcast signals. The accepted explanation of the whistles is that waves received after reflexion from ionized meteor trails have undergone a frequency-shift, relative to the waves received by a more direct path. Usually, the pitch of the heterodyne descends to zero. Chamanlal and Venkataraman[1] suggested, in 1941, that the descending pitch was the result of the meteor being rapidly retarded in velocity. More recently, Sir Edward Appleton and Mr. R. Naismith[2] proposed an alternative explanation of the change of pitch, which is ascribed to the reduction of the difference between the two path-lengths that occurs as the meteor, travelling tangentially to the observer, approaches the minimum distance.

The latter explanation, involving only the changes in geometry of the reflected ray, is more acceptable because it does not fail to account for the less frequent observations in which the pitch of the heterodyne first descends, passes through zero and then rises again. We have observed these 'doublet' whistles on numerous occasions, although they occur only 1 or 2 per cent as frequently as the single whistles with a falling note. We believe that the dual whistles are caused by meteors that do not approach the earth directly but pass through the atmosphere sufficiently near to earth to ionize a track and to reflect radio signals. The relative velocity of the meteor to earth may, in these cases, be sufficient for the meteor to avoid being deflected and 'captured'.

We used the word 'tadpole' to describe meteor whistles when they were first noted here some years before the War. Unfortunately, the significance of the heterodynes and their connexion with meteoric ionization was only guessed and could not be proved until after short-wave cathode-ray direction-finding apparatus became available to us in 1940, and it was possible to make simultaneous observations of radio direction and of the direction of visible meteor trails in the night sky. By this time, other observers had published conclusions similar to ours.

Since that date, we have made numerous recordings of the phenomena, and it may be of interest to note the results of our observations, as follows:

(1) At the moment when the whistle reaches zero pitch, there is a large increase in the strength of the received signal, as stated by other observers. Amplitude changes of at least 20 to 1 have been recorded here, on carrier frequencies between 15 and 22 Mc./s.

(2) Whistle durations of up to 7 sec. have been followed by 'bursts' of high-amplitude reception sometimes lasting for 10 sec. and, more rarely, for so long as 40 sec.

(3) Of the total of audible whistles, only 1 or 2 per cent have been 'doublets', as noted above. Others have all been falling in pitch.

(4) Whistles have been most commonly heard at the times of year which correspond with the arrival dates of known meteor streams. They are very seldom audible during day-time. The minimum observations occur in the period between about two hours after sunrise and two hours after sunset. Following this, they become audible in increasing numbers, with a maximum about the time of sunrise, falling off rapidly thereafter.

(5) Correlation between visible meteor trains and direction-finder bearings of falling-note radio whistles can often be obtained. We have not yet succeeded in correlating the doublet whistles in this way, perhaps because the visible meteor trails would be too near the horizon of the observer.

(6) It would appear that conditions for reflexion usually fail when the radio whistle reaches a pitch of about 2 kc./s. The whistle heterodyne seldom reaches a higher frequency than this, either when falling or rising.

(7) Amplitude 'bursts'—but without previous heterodyne whistles—have been noted on amateur radio transmissions at frequencies of 60 Mc./s. The bursts on this higher frequency appear to be of shorter duration, possibly with greater amplitude change, than those experienced in the lower frequency bands. Although difficult to record on account of the short duration, the increase in signal-level seems often to reach 35 db. (that is, 56 : 1 ratio).

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S. E. MARTINGELL
R. W. BAYLIFF

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Dec. 12.

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[1] Chamanlal and Venkataraman, *Nature*, **149**, 416 (1942); summary of article in *Electrotechnics* (Bangalore, Nov. 1941).

[2] Appleton, Sir Edward, and Naismith, R., *Proc. Phys. Soc.*, **59**, 461 (1947).

Open-Hearth Furnace Models

LARGE-SCALE trials recently carried out on open-hearth furnaces[1] emphasize the need for more fundamental knowledge of the flow of fuel, air and combustion products through the furnace chamber. To obtain such information by experimental work on a production furnace presents extreme difficulties due to the high working temperature and the necessity of avoiding interference with production. The problem of flow through such complex ducts having also proved too difficult to solve mathematically, it was decided to use a model technique. Models of open-hearth furnaces with differing port designs were therefore made in 'Perspex' on a 1/24 linear scale.

Both fuel gas and air are represented in the model by water. The two flows ('air' and 'gas') to the model are separately metered and can be controlled so that the Reynolds numbers at the incoming ports are equal to the corresponding Reynolds numbers on the actual furnace. The partition of 'waste gases' between outgoing gas and air ports can be similarly controlled by adjusting valves. Flow through the model has been studied in three dimensions using a variety of methods. At present use is made of fine aluminium particles suspended in the water, and illuminated in any desired direction by means of an intense sheet of light. By suitably compounding the two-dimensional patterns thus obtained, a three-dimensional pattern of flow throughout the furnace can be built up. The patterns are recorded photographically, the light source being either (*a*) an over-run 2 kW. line filament lamp; or (*b*) a specially designed Mullard discharge tube, the duration of flash from which is adjustable.

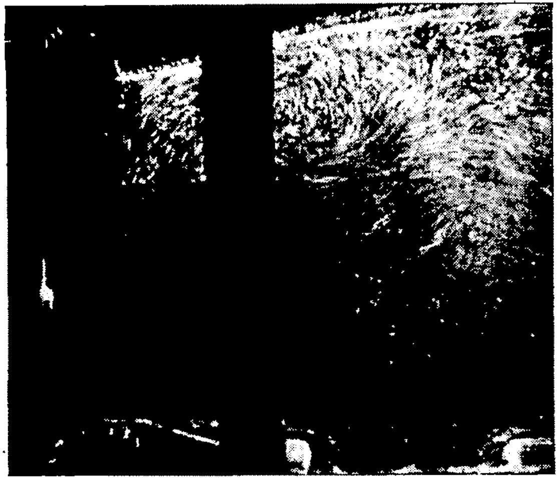
Fig. 1

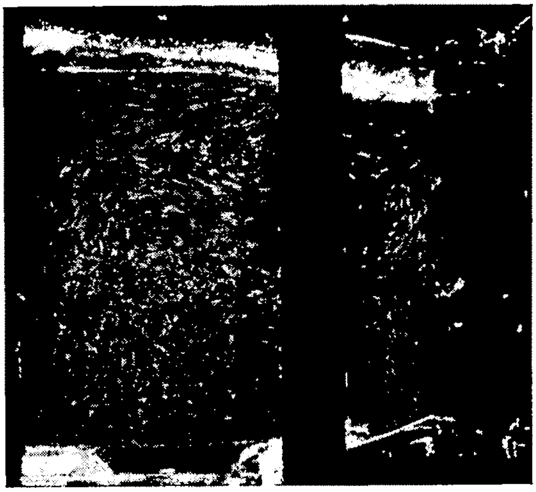
Fig. 2

The work is still at an early stage; but preliminary conclusions with a model of a Maerz open-hearth furnace show:

(1) At the incoming end of the furnace a major vortex is produced on either side of the incoming gas stream over a wide range of flow (Fig. 1). The vortices are asymmetrical and are actually three-dimensional in character.

(2) In the centre of the furnace there is a region of instability in which the particles are moving in all directions.

(3) Near the outgoing end of the furnace, the flow tends to align itself before entering the outgoing ports (Fig. 2) and is particularly rapid along the back-wall.

The general eccentricity of flow is also apparent from a study of the photographs. In particular, Fig. 1 shows that the incoming gas stream is deflected towards the furnace back-wall, although the centre-line of the gas ports is parallel to the centre-line of the furnace. This is of practical interest as it is normal for the line of the gas port on a furnace to be inclined towards the front-wall at an angle of about 3° to the centre-line, in order to counteract the tendency for the flame to be diverted towards the back-wall. The need for this correction has generally been ascribed to air inleakage through the doors, whereas it would appear to be desirable purely because of the asymmetrical furnace design.

It is of interest to note that a somewhat similar flow pattern has been found in the flame tubes of jet engines[2].

A report giving detailed results of the present work will be published elsewhere.

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[1] Iron and Steel Institute Special Report No. 37.

[2] *J. Inst. Fuel*, **21**, No. 116, 1 (1947).

Effect of Ionic Charges on the Energy and Entropy of Activation of Heterolytic Reactions

A PREVIOUS investigation[1] of the influence of the carboxylate-ion substituent on the kinetics of solvolysis of organic bromides, *R*Br, showed that in the two series (*R* =)

$$\mathrm{CH_3} \qquad \mathrm{CH_2(CO_2^-)} \;\vdots\; \mathrm{CH(CO_2^-)_2} \qquad (1)$$

$$\mathrm{CH_2Me} \;\vdots\; \mathrm{CHMe(CO_2^-)} \qquad \mathrm{CMe(CO_2^-)_2} \qquad (2)$$

there is (where indicated) a change of mechanism from S_N2 to S_N1 as the CO_2^--groups accumulate. We have now investigated the kinetics of the solvolysis of the bromides of two more series (*R* =),

$$\mathrm{Me_3C} \qquad \mathrm{Me_2C(CO_2^-)} \qquad \mathrm{MeC(CO_2^-)_2} \qquad (3)$$

$$t\text{-}\mathrm{BuCH_2} \qquad t\text{-}\mathrm{BuCH(CO_2^-)} \qquad t\text{-}\mathrm{BuC(CO_2^-)_2} \qquad (4)$$

and the results permit consideration of the further series (*R* =)

$$\mathrm{HC(CO_2^-)_2} \quad \mathrm{MeC(CO_2^-)_2} \qquad t\text{-}\mathrm{BuC(CO_2^-)_2}. \qquad (5)$$

Throughout series (3), (4) and (5), mechanism S_N1 prevails; and the main interest of the new results relates to the effect of the carboxylate-ion substituent on the unimolecular rate-constants k_1, and on their parameters *E* and *B* in the Arrhenius equation $k_1 = B \exp - E/RT$. The measured reaction is in all cases the heterolysis (ionization) of the CBr-bond. The data are in the accompanying table.

RATE CONSTANTS AND ARRHENIUS PARAMETERS FOR THE UNIMOLECULAR SOLVOLYSIS OF BROMIDES

Series	Solvent	*R* in *R*Br.	k_1 (25°) (sec.$^{-1}$)	*E* (kcal.)	*B* (sec.$^{-1}$)
3	"60%" EtOH—H$_2$O	[2]$\mathrm{Me_3C}$	$3{\cdot}8\times10^{-3}$	21·7	$3{\cdot}4\times10^{13}$
		$\mathrm{Me_2C(CO_2^-)}$	$5{\cdot}6\times10^{-5}$	27·8	$1{\cdot}6\times10^{16}$
		$\mathrm{MeC(CO_2^-)_2}$	$1{\cdot}6\times10^{-5}$	28·0	$6{\cdot}5\times10^{15}$
	H$_2$O	$\mathrm{Me_2C(CO_2^-)}$	$1{\cdot}2\times10^{-4}$	29·2	$3{\cdot}8\times10^{17}$
		[1]$\mathrm{MeC(CO_2^-)_2}$	$8{\cdot}7\times10^{-6}$	30·3	$1{\cdot}6\times10^{17}$
4	"50%" EtOH—H$_2$O	[3]t-$\mathrm{BuCH_2}$	$8{\cdot}0\times10^{-11}$	29·1	$1{\cdot}8\times10^{11}$
		t-$\mathrm{BuCH(CO_2^-)}$	$1{\cdot}1\times10^{-7}$	32·9	$1{\cdot}5\times10^{17}$
		t-$\mathrm{BuC(CO_2^-)_2}$	$2{\cdot}5\times10^{-4}$	26·4	$5{\cdot}4\times10^{15}$
	H$_2$O	t-$\mathrm{BuCH(CO_2^-)}$	$1{\cdot}7\times10^{-7}$	32·3	$6{\cdot}6\times10^{16}$
		t-$\mathrm{BuC(CO_2^-)_2}$	$7{\cdot}3\times10^{-5}$	28·8	$9{\cdot}7\times10^{15}$
3	H$_2$O	[1]$\mathrm{HC(CO_2^-)_2}$	$3{\cdot}4\times10^{-8}$	32·5	$2{\cdot}5\times10^{16}$
		[1]$\mathrm{MeC(CO_2^-)_2}$	$8{\cdot}7\times10^{-6}$	30·3	$1{\cdot}6\times10^{17}$
		t-$\mathrm{BuC(CO_2^-)_2}$	$7{\cdot}3\times10^{-5}$	28·8	$9{\cdot}7\times10^{15}$

We shall require one further set of figures, namely, the following approximate values for a secondary alkyl bromide: k_1 (25°) = 10^{-7} sec.$^{-1}$, $E = 26$ kcal., $B = 10^{12}$ sec.$^{-1}$; they are deduced by interpolation, since no direct determination is yet available[4], though consistent figures for the secondary chloride, *t*-BuCHMeCl, have recently been obtained by Mr. R. J. L. Martin. The following statements can be made: (i) A replacement of H by Alk at the seat of substitution of an alkyl bromide increases k_1 by a factor of approximately 10^4; and a second such substitution repeats the effect. (ii) These effects on rate are mainly (that is, to the extent of about three-quarters of the logarithmic change) due to changes in *E*, each replacement of H by Alk decreasing *E* by about 4 kcal. (iii) The replacement of H by CO_2^- increases k_1 by factors of order approximately 10^3, and therefore the replacement of Alk by CO_2^- reduces k_1 by small factors of average order approximately 10^1. (iv) This small effect on rate, when it arises from a *first* replacement of Alk by CO_2^-, results from the near-cancellation of two large effects; for the replacement increases *E* by 6–8 kcal., and also increases *B* by factors 10^3–10^5. (v) The similarly small effect on rate, arising from a *second* replacement of Alk by CO_2^-, results from small effects on *E* and on *B*.

The groups Alk and CO_2^- both repel electrons. The effects (i, ii) due to Alk have previously been interpreted as being mainly of internal polar origin[4]. Quite similar effects should also originate in the group CO_2^-. However, the important qualitative difference between Alk and CO_2^- is the ionic charge on the latter; and we may now consider briefly how this might produce the special effects (iii, iv, v) which arise when we replace one group by the other.

Such effects are considered to be due to solvation. The principal differences of solvation energy should arise in the initial states of these halide ionizations, because in the initial states such charges as are present are relatively localized, whereas in the transition states the charges are distributed, with partial neutralization of any pre-existing charges. Thus the increase of 6–8 kcal. in *E*, which we observe on introducing a first CO_2^--group in place of the comparably electron-repelling group Alk, is attributable essentially to an additional solvation energy in the initial state, which is only partly compensated in the transition state.

The corresponding increase in *B* by factors 10^3–10^5 is similarly ascribed to pre-fixation of the solvent. Relatively to co-ordinate axes imbedded in a reactant molecule, certain solvent molecules must be restricted by an ionic charge in the initial state to positions which are geometrically close to those which solvating solvent molecules will be required to occupy in the transition state; and thus their displacement from one set of positions to the other will be accompanied by a smaller entropy decrease than would have been involved in the absence of the initial charge.

The large increase in *E* is not repeated on the introduction of a second CO_2^--group, because only one such group can be involved with the forming carbonium ion in the transition state, and hence the second will produce closely compensating amounts of extra solvation energy in the initial and transition states. Again, the large effect on *B* will not be repeated, because, while one CO_2^--group will guide the solvent molecules as described, the other will solvate so similarly in the initial and transition states that it can contribute little to the entropy difference.

The rates of reactions in solution are often considered on the basis that certain frequency factors (of the order of a vibration frequency for unimolecular reactions, and of a collision number for bimolecular reactions) are 'normal', so that it is chiefly the departures from such values which merit discussion. The theories which proceed on these lines, having been evolved by extension from studies of gaseous reactions, do not sufficiently make solvation a prime consideration in the determination of 'normality'. Our point of view is that solvation energy and entropy are the most characteristic determinants of reactions in solution, and that for this class of reactions no norm exists which does not take primary account of solvation. Further illustration and discussion will be offered in papers being submitted to the Chemical Society.

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E. D. Hughes
C. K. Ingold

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Jan. 27.

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[1] Hughes and Taher, *J. Chem. Soc.*, 956 (1940).

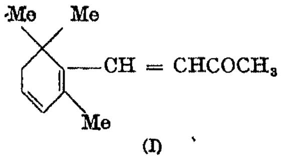
[2] Cooper, Hughes and Ingold, *J. Chem. Soc.*, 925 (1940).

[3] Dostrovsky and Hughes, *J. Chem. Soc.*, 166 (1946).

[4] Dostrovsky, Hughes and Ingold, *J. Chem. Soc.*, 191 (1946).

Synthesis of Dehydro-β-Ionone

The elegant brominating reagent, N-bromosuccinimide, has been employed by Karrer[1] to prepare *bis*dehydrolycopene from the acyclic carotenoid, lycopene. It has now been shown that the cyclic compound β-ionone reacts in a facile manner with this reagent, giving a bromo-derivative which on dehydrobromination with diethylaniline yields dehydro-β-ionone (I), b.p. 75° at 1 mm. mercury pressure, n_D^{22} 1·5497. The absorption spectrum exhibited maxima at 2210 A. and 3380 A. ($\varepsilon = 7,000$ and 9,000 respectively). The product was characterized by the formation of a semicarbazone (m.p. 144–146°) and a 2 : 4-dinitrophenylhydrazone (m.p. 150–151°).



(I)

The synthetic potentialities of dehydro-β-ionone for the preparation of dehydro-compounds of the vitamin A type are now under investigation in these laboratories. The synthesis of dehydrovitamin A_1 by the above approach would be of considerable interest, since this structure is one that has been suggested[2] as representing vitamin A_2.

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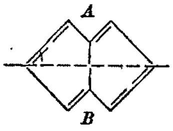
[1] Karrer, P., and Rutschmann, J., *Helv. Chim. Acta*, 28, 793 (1945).

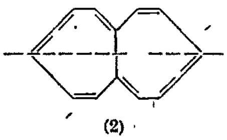
[2] Gray, E. LeB., and Cawley, J. D., *J. Biol. Chem.*, 134, 397 (1940).

The Non-Benzenoid Aromatic Hydrocarbon Pentalene

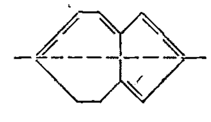
It is an interesting fact that neither pentalene (1), nor heptalene (2), nor any derivatives of them have been definitely reported as being synthesized[1] or found to occur naturally. Azulene (3) is, on the other hand, a substance which can be made by the established procedures of organic chemistry and it is known in Nature.



(1)

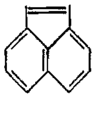


(2)



(3)

When a study is made of these molecules by the valence-bond method first developed by Hückel[2], pentalene and heptalene prove to be different in one respect from azulene, and from other common hydrocarbons: the wave functions describing the most stable state of their π-electrons are antisymmetrical with respect to the axis indicated in the diagrams. In contrast, the π-electron wave functions of azulene, of all hydrocarbons built up from six-membered rings and of other common hydrocarbons, have the full molecular symmetry in their ground-states. An example of a possible exception to this statement is provided by acenaphthylene, which is being investigated. It is not obvious, however, whether this difference between the known hydrocarbons and the unknown pentalene and heptalene is connected with the difficulty of obtaining these latter structures.



In an earlier paper, Coulson and Rushbrooke[3] have examined these molecules by the molecular orbital approximation. In that method, all molecules with an even number of π-electrons are described as having symmetrical ground-states, so that the distinction of symmetry does not emerge. Coulson and Rushbrooke did, however, find that the molecular orbital method encounters a difficulty in dealing with these molecules, but the same difficulty arises with the known molecule azulene as with the other two.

Details of energies, bond orders, etc., are being reported elsewhere, especially for pentalene. According to the calculations, this molecule should possess considerable resonance stabilization (*c.* 40 kcal.), and it has been confirmed in the calculations that the triplet state lies above the lowest singlet, so that the unsymmetric state discussed above is, in fact, the lowest of all the states. A calculation of bond orders by the method of Penney[4] gives the unusual result that the central bond (*A*—*B* in formula 1) has a small negative bond order, expressing the fact that the π-electrons exert a considerable repulsion across that bond; the large resonance energy, however, confirms that the overall effect of π-electron interaction, when all the resonance possibilities are considered, is strongly stabilizing.

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[1] Horn, Nunn and Rapson, *Nature*, 160, 830 (1947).

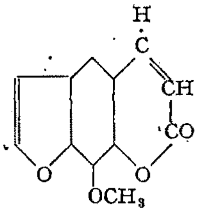
[2] Hückel, *Z. Phys.*, 70, 204 (1931).

[3] Coulson and Rushbrooke, *Proc. Camb. Phil. Soc.*, 36, 193 (1940).

[4] Penney, *Proc. Roy. Soc.*, A, 158, 306 (1937).

Xanthotoxin from the Fruits of *Ammi majus* L.

Fahmy and Abushady[1] have isolated from the fruits of *Ammi majus* L. a crystalline product to which they gave the name 'ammoidin'. We wish to express our gratitude to them for supplying us with this material and for allowing us to determine its constitution. We have found that the substance does not contain active hydrogen or an acetyl group[2], but it contains one methoxyl grouping. Analysis of ammoidin gave the formula $C_{12}H_8O_4$, and after degradation we found that it possesses the constitution:



This constitution is identical with that of xanthotoxin, which had been isolated by Thoms from the fruits of *Fagara xanthoxyloides*[3] and from the berries of *Luvanga scandens* by Bose and Mookerjee[4], and which had been synthesized by Späth and Pailer[5]. We have found that ammoidin possesses the same properties as those described for xanthotoxin; for example, the product, m.p. 233°, was obtained from ammoidin under the same conditions which were followed for the preparation of nitroxanthotoxin[3]. The identity of ammoidin and xanthotoxin was finally proved by the mixed melting point (no depression) with an authentic sample of xanthotoxin; this was kindly done for us by Prof. Ebert of the University of Vienna.

Pharmacological aspect. The powdered fruits of *Ammi majus* are taken by mouth by the public in Egypt to cure leukoderma; the patient exposes the leukodermic patches repeatedly to the sun for half an hour after administration of the crude drug.

Xanthotoxin (ammoidin) has been given internally to leukodermic patients or applied as a paint over the leukodermic patches, resulting in the same curative effect as shown by the crude drug but without the toxic effects of the latter[6].

Note added in proof. Fahmy and Abushady have isolated a second crystalline substance which we have shown to be imperatorin[7].

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[1] *Quart. J. Pharmacy and Pharmacology*, **20**, 281 (1947).
[2] *Nature*, **160**, 468 (1947).
[3] *Ber.*, **44**, 3325 (1911).
[4] *J. Indian Chem. Soc.*, **21**, 181 (1944).
[5] *Ber.*, **69**, 767 (1936).
[6] Private communication from Prof. I. R. Fahmy and H. Abushady.
[7] Späth and Holzen, *Ber.*, **66**, 1137 (1933).

Active Penetration of Fat into Adipose Tissue

WHEN adipose tissue of the rat, depleted of part of its fat by prolonged hunger, is incubated with blood or serum of the same rat, a decrease in the fat content of the medium can be demonstrated. Killing the tissue by heating to 80° C. abolishes this effect. The addition to the medium of sodium fluoride ($M/20$ or $M/40$), or of sodium cyanide ($M/500$) also completely inhibits the disappearance of fatty acids. Sodium azide ($M/1,000$) had no inhibiting effect. The most marked decrease in the fat content of the medium was obtained with adipose tissue and blood of rats starved to 25 per cent loss of weight. With fat-laden adipose tissue of normal rats the effect was negligible or absent. No decrease in the fat content of the blood was found when the incubation was carried out at room temperature. The accompanying table summarizes these results.

No. of expts.	Tissue	Medium	Average decrease in fat content of medium
17	Depleted groin fat	Blood of same rat	40±2·6 per cent
5	,, heated to 80° C.	,, ,, ,,	0
6	Fat-laden groin fat	,, ,, ,,	10±8 ,, ,,
4	Depleted groin fat	,, with $M/20$ NaF	0
4	,, ,, ,,	,, with $M/40$ NaF	5 ,, ,,
5	,, ,, ,,	Serum, with $M/500$ NaCN	0
3	,, ,, ,,	Blood, with $M/1,000$ NaN_3	34 ,, ,,
3	,, ,, ,,	Blood, at room temperature	0

100 mgm. of groin fat are cut with scissors to a fine brei and incubated with 1 ml. of blood or serum, in air, at 38° C. The fatty acid content is estimated in 0·1 ml. of the medium after half an hour (initial value) and after 3½ hours of incubation, according to the method of Marenzi and Cardini[1].

The quantity of fatty acids disappearing from the blood, by incubation with depleted adipose tissue for 3 hours, is between 1 and 2 mgm. The oxidation of fat by the tissue accounts for only 0·025 mgm. (calculated from the value of 0·18 mm.[3] oxygen consumed per mgm. fat-depleted adipose tissue per hour). The main quantity of the disappearing fat must thus have been taken up by the tissue without any profound change.

The results of these experiments show that the penetration of fat into adipose tissue is an active process, depending on the physiological activity of the tissue.

The physiological and pathological conditions influencing this penetration are under investigation.

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[1] Marenzi, A. D., and Cardini, C. E., *Rev. Soc. Argent. Biol.*, **19**, 118 (1943).

Peripheral Action of Botulinum Toxin

AN investigation has been made of the pharmacological properties of *Cl. botulinum* (type *A*) toxin. Rabbits injected intravenously with the toxin developed severe œdema with focal hæmorrhages in the lungs. These lung lesions were also found when 'local' botulism was produced in a number of tissues, but with larger doses of toxin. It was therefore possible to achieve a local concentration of toxin sufficiently high to paralyse certain nerve-endings without killing the animals prematurely by the injury to the lungs.

Intra-ocular injections of the toxin produced a total paralysis of the nerves to the sphincter pupillæ, which failed to react to light or to stimulation of the oculomotor nerve. This action was analysed and was found to be due neither to any injury of the smooth muscle itself nor to a neuro-muscular block of the type produced by atropine (as suggested by Edmunds and Long[1]), since the sphincter reacted normally to acetylcholine.

The injurious effect of the toxin appears, therefore, to be on the cholinergic nerve fibres proper and is restricted to them, since stimulation of the cervical sympathetic nerve still dilates the pupil, and reflexes originating from the cornea are not abolished. This shows that the adrenergic and sensory nerve fibres concerned, although exposed to the same concentration of toxin within the eye, are not affected in the same way as are the cholinergic fibres.

In similar experiments on voluntary (extrinsic ocular) muscles paralysed with toxin, normal responses to acetylcholine were recorded. This differentiates the botulinic effect on skeletal muscle from that of curare poisoning, and again points to a lesion of the motor nerve-endings which are cholinergic.

Lastly, it has been found that despite its high molecular weight (900,000–1,130,000 [2]), this protein is able to pass out of the eye into the general circulation, which suggests that it must be capable either of inducing a change in capillary permeability to allow its passage, or that it is broken down to a smaller diffusible molecule which is still neurotoxic.

It is hoped to publish a full account of this work elsewhere, and further investigations are in progress.

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Jan. 12.

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[1] Edmunds, C. W., and Long, P. H., *J. Amer. Med. Assoc.*, 81, 542 (1923).

[2] Kegeles, G. J., *J. Amer. Chem. Soc.*, 68, 1670 (1946).

Secondary Thickening in Excised Tomato Roots

White[1] has stated that secondary thickening does not occur in excised root cultures. Some of our cultures of tomato ('Best of All') which had been kept without transfer for five to six months were recently submitted to anatomical investigation, and were found to have developed a considerable amount of secondary xylem, though the occurrence of properly differentiated secondary phloem has not yet been demonstrated. The nature and extent of the secondary xylem can be illustrated by reference to two examples.

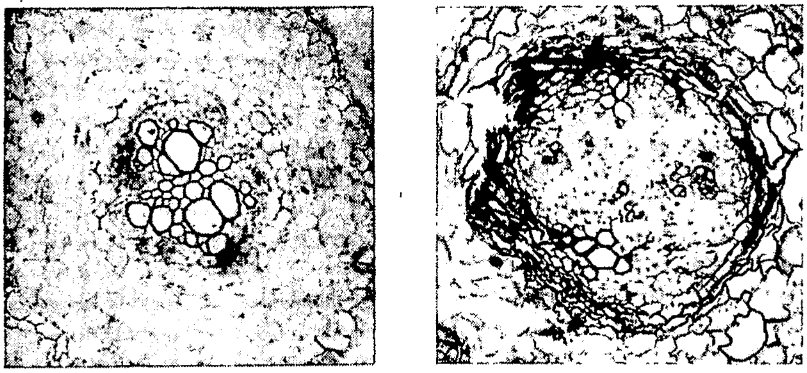
Fig. 1 Fig. 2

Transverse sections of excised tomato roots. × 120

Root culture Passage 5, No. 41, growing on White's synthetic medium, exhibited in its older parts a patchy brown discoloration accompanied by a distinct thickening. Sections of these regions contained considerable quantities of secondary xylem. Most of the sections were characterized by an almost normal distribution of secondary xylem (Fig. 1), though some showed an anomalous condition in which a ring of lignified tissue containing vessels enclosed a central mass of thin-walled cells, the whole clearly formed by the activity of a cambium-like layer.

Culture Passage 1, No. 13, growing on White's yeast medium, also yielded some sections with normally distributed secondary xylem and others showing pronounced abnormality (Fig. 2). Here, on one side of the diarch primary xylem, repeated and disorderly cell divisions have produced a mass of callus-like tissue, only a few cells of which are differentiated into xylem elements. On the other side of the primary xylem, no corresponding development has occurred.

These examples demonstrate the occurrence of secondary xylem, but also show that the cambial activity is frequently seriously disorganised and results in the production of conspicuously abnormal structures. The exact age at which secondary thickening begins and the extent to which the process is influenced by cultural conditions are now under investigation, and will form the subject of a subsequent report.

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Dec. 11.

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[1] White, P. R., "A Handbook of Plant Tissue Culture", 159 (1943).

Second Occurrence and Persistence of the Amphipod *Orchestia bottæ* M. Edwards in Britain

The amphipod *Orchestia bottæ* M. Edwards was first recorded in Britain by Gordon[1], who found it on the banks of the Thames at Richmond in 1942. This species, from the Mediterranean area, appears to be spreading and invading the freshwater systems of Europe. Dr. Gordon quotes records of its being taken in France (Cambrai, Nancy), Holland (80 km. from the sea), Belgium and Germany. The object of this note is to record that in July 1946 we found it in large numbers, adult and very young, in the damp roots of grass just above the water on the right bank of the Thames at Oxford, about half-way between Folly Bridge and Iffley Bridge; this is 92 miles upstream from the first lock (Teddington). In July 1947, one of us (A. J. C.) found it again in the same spot, still quite abundant though perhaps less so than in 1946. The severity of the spring had not apparently affected it.

We are indebted to Dr. G. M. Spooner of Plymouth for identifying our specimens. Dr. Gordon, of the British Museum, who has also seen specimens, confirms that it is the same species as that found by her at Richmond in 1942.

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Dec. 10.

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[1] Gordon, I., *Proc.* inn. *Soc. London*, Pt. 2 (Jan. 21, 1944).

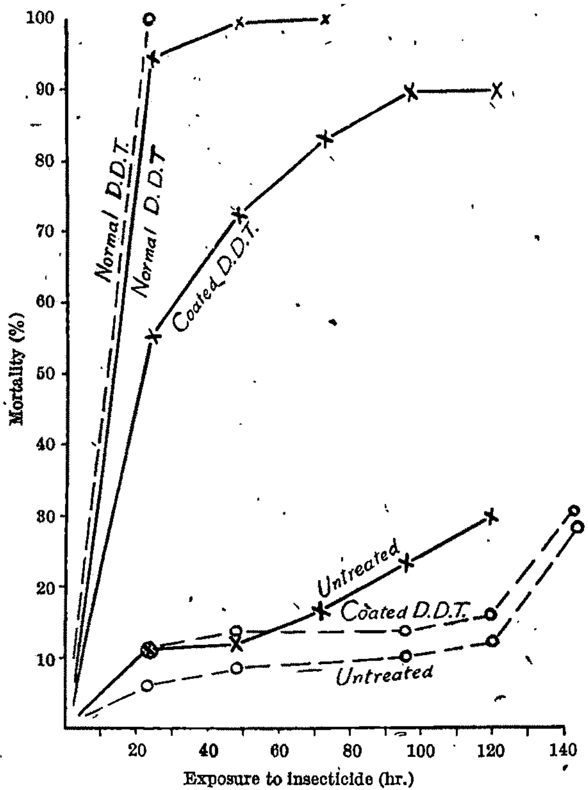
New Formulation of D.D.T. with Selective Properties

In order to produce insecticides which would be toxic only to certain groups of insects and not to others, it seemed a promising line of approach to make use of the known differences in the digestive capability of different insects. If individual particles of toxic compounds could be coated with substances digestible only by certain insects, then obviously only those insects would be killed by such coated insecticides.

Phytophagous insects are able to deal with hemicelluloses found in plant cell walls, and some wood-boring species also with celluloses, while carnivorous insects and insects such as most flies, bees and parasitic Hymenoptera cannot do so. Formulations of D.D.T. were therefore prepared in which the individual particles of D.D.T. were coated with degraded cellulose, by an acid precipitation of the degraded cellulose from alkaline solution to which a D.D.T. suspension had been added. A hardening process, carried out after acidification, greatly improved the characteristics of the coating.

These preparations were then sprayed on leaves or other surfaces and, after drying, test insects were allowed to come into contact with them. These tests showed that a thorough coating had eliminated the contact action of the D.D.T.

Comparing residual films of coated D.D.T. (sample *DC.* 103) and standard D.D.T. suspension both at 0·0157 mgm. D.D.T. per square centimetre, it was found that, in the former, the following D.D.T.-susceptible insects were not killed, or their mortality was significantly reduced: Diptera: *Lucilia sericata* Meig. (adults), *Syrphus* spp. (adults); Hymenoptera: *Apanteles glomeratus* Linn., *Apis mellifera* Linn., *Mormoniella vitripennis* Wlk. The same material sprayed at approximately the same rate on leaves which were then fed to larvæ of *Pieris brassicæ* Linn., *P. rapæ* Linn., and *Tortrix pronubana* Hübn., gave mortalities approaching those obtained with normal (uncoated) D.D.T. suspensions. Examples of the type of result obtained are shown in the accompanying diagram.



EFFECT ON *Pieris brassicæ* LARVÆ (—x—) AND ON *Lucilia sericata* ADULTS (– – o – –) OF 'COATED' AND UNTREATED D.D.T.

These experiments demonstrated that even the notoriously indiscriminate insecticide D.D.T. can be used as a selective insecticide specific to phytophagous insects. This development should prove useful in avoiding certain undesirable repercussions of D.D.T. spraying which are of considerable economic importance, such as outbreaks of other species of insects hitherto controlled by their natural enemies, for example, red spiders and mealy bugs after D.D.T. spraying of deciduous fruit against codling moth, and citrus against scale insect; or the rapid rebuilding of infestations of pests which are controlled by D.D.T. but are able to re-establish themselves because, in accordance with Volterra's Law of the Destruction of Averages, the simultaneous destruction of their natural enemies at the same rate as the destruction of the pests themselves leads to a more rapid building up of the pest population.

W. E. Ripper
R. M. Greenslade
J. Heath
K. Barker

Pest Control, Ltd.,
Harston,
Cambridge.
Dec. 1.

Dependence of Anomaloscope Matching on Viewing-Distance or Field-Size

In a recent communication bearing the above title[1], we pointed out that with a particular anomaloscope the R/G ratio in the mixture required to match a narrow-band yellow depended on the viewing distance. Further work on more than forty normal observers has confirmed this effect, and also established the fact that the effect for each observer is substantially the same whether one eye is used or two eyes, as in the original investigation. Most observers required more green in the mixture the greater the viewing distance. Taking the R/G ratio as unity for an observer viewing an 18-mm. field at 50 cm. (subtending 2°), the ratio drops at a decreasing rate to an average value of about 0·85 at 300 cm. (20 ft.), beyond which there is little further change. The spread of results for different individuals is considerable, some observers dropping below 0·6.

We have now found that the introduction of a 3-mm. artificial pupil in front of the eye tends to reduce the lowering in R/G ratio, especially for those observers showing a particularly large drop. Thus, one of us (R. G. H.) finds that his R/G ratio, which normally drops to 0·6, only drops to 0·85 when using the artificial pupil, although at 50 cm. the ratio is unity in each case. A 3-mm. opaque stop, on the other hand, necessitates an even lower ratio for the match. Moreover, with the artificial pupil it appears that the R/G ratio is dependent simply on the angle subtended by the field both for changes in field-diameter and viewing-distance, whereas with the natural pupil this is not so. This would indicate that part of the effect (in particular for those observers showing a large effect) is due to aberrations of the eye lens.

It may be that the effect would disappear if the chromatic aberrations of the eye were corrected, or possibly the explanation may involve the Stiles–Crawford effect.

Our thanks are due to Mr. D. W. O. Heddle for assistance with the observations.

R. G. Horner
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Physics Research Laboratory,
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Brentwood, Essex.
Dec. 12.

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[1] *Nature*, 160, 23 (1947).

Mr. E. Westlake and the Geology of the Cantal Region, Central France

Information is sought as to the whereabouts of a paper on the geology of the Miocene–Pliocene gravels of the Cantal region of central France which was prepared by the late Mr. E. Westlake of Fordingbridge.

Mr. Westlake stayed for six months at Puy Boudieu in 1905, and accumulated many hundreds of the pieces of flaked chert, which in form and type of flaking closely resemble the specimens from the basement beds of the East Anglian Crag sands, and of the stone beds resting on the chalk beneath the Forest Bed and glacial deposits of the north Norfolk coast. The collection was studied at Oxford by the late Prof. W. J. Sollas, who referred to it in the third edition of his "Ancient Hunters". Owing to his death before the publication of a detailed account and analysis of the collection, the specimens were transferred to the Ipswich Museum, where the late Mr. J. Reid Moir undertook to produce a paper on them. This was written before Mr. Moir's death, and it is hoped now to secure its publication. The collection is available for study at the Ipswich Museum.

As many of the specimens bear the late Mr. Westlake's notes as to site and depth at which they were obtained, and it is clear that they were *in situ* finds, it is most important that the record of the observations made on the beds should be recovered. As it is known Mr. Moir had the MS. in his possession prior to his death, and as it cannot now be found among his papers, it is supposed he may have sent it or lent it to someone to read. Anyone who has any knowledge of its whereabouts, or has access to the papers of the late Prof. Sollas, or to any other likely source where it might possibly be, is asked to communicate at once with one of the undersigned.

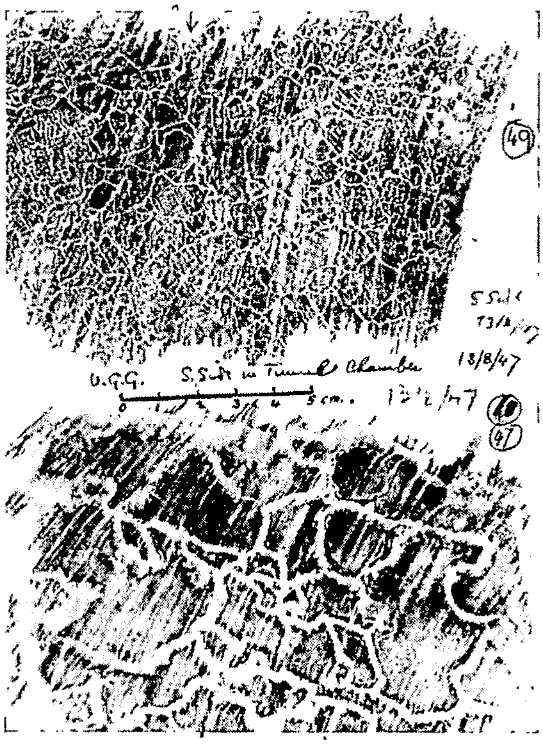
It is also known that drawings were prepared for the illustration of Mr. Moir's paper, and these are likewise missing. Any information about them would be valued.

G. Maynard
Ipswich Corporation Museum.
Aubrey T. Westlake
Godshill,
Fordingbridge.

Growth of Glacier Crystals

The mechanism of the growth of the ice crystal in glaciers is one of the most important of the unsolved problems of glacier physics. Its solution may also prove of value in sciences other than glaciology.

As a preliminary to an investigation into the causes of crystal growth, I spent some months in the Alps last summer making a statistical survey of the crystal sizes at the ends of a number of glaciers. Surprisingly enough, these are the only records which are known to exist. They brought to light several interesting facts, the chief of which are: (*a*) that the crystals in *flowing* ice are not nearly so large as had often been reported; (*b*) that under certain conditions they are surprisingly small; and (*c*) that there seems to be some relationship between crystal size and the inclination of the glacier bed.



Rubbings of crystals in the Upper Grindelwald Glacier

Obviously these tentative deductions need confirmation in other glaciers, and this note is written in the hope that observations may be started in as many widely separated regions as possible. Investigations adequate for preliminary purposes are very simple. The process of recording ice crystal sizes consists of making rubbings with a pencil on paper. Under favourable conditions a single sample can be recorded in ten minutes, and the process need seldom take more than half an hour.

I should be pleased if exploration parties or private investigators who are willing to co-operate, especially those visiting glaciers other than those of the Swiss Alps, would communicate with me, so that I can provide detailed instructions for making rubbings and for the compilation of the data necessary for the analysis of the results.

G. Seligman

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DISINTEGRATION OF HIGHLY EXCITED NUCLEI

By D. H. PERKINS

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IN a previous note[1], it was shown that most of the energy spectrum of protons ejected in nuclear disintegration stars produced in photographic emulsion by cosmic radiation could be explained in a general way by a simple evaporation process. We have now made detailed measurements on the angular distributions of the emitted particles, and compared them with what one would expect from the evaporation model of the nucleus.

Our data were obtained from twenty-four stars, each involving the emission of between fifteen and twenty-two charged particles from nuclei of silver, bromine and iodine present in the emulsion. These stars, which correspond to excitation energies of the same order of magnitude as the nuclear binding energies, represent about 2 per cent of the total observed in our plates, which were exposed for periods of forty days at altitudes of 3,500 m. and 4,400 m. at L'Aiguille du Midi, Chamonix.

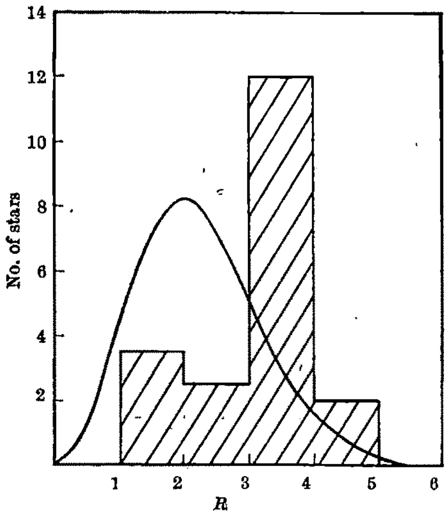

Fig. 1a

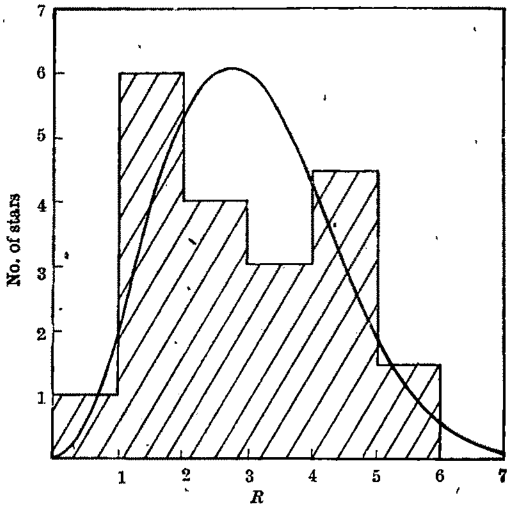

Fig. 1b

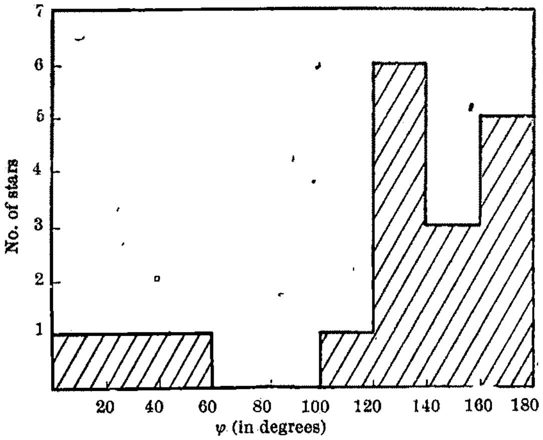

Fig. 2a

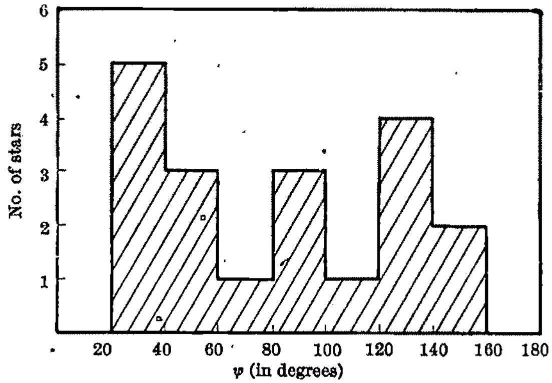

Fig. 2b

If the disintegration of a nucleus can be represented as a simple evaporation process, the angular distribution of the star particles should be, on the average, spherically symmetrical. Thus, if to each track is ascribed a vector of unit length, then the resultant of all the vectors of the star should have a scalar magnitude *R*, the probability distribution of which is determined by the random-walk theory[2]. The complete orientation of all tracks was determined by means of a goniometer eyepiece and by depth measurements in the emulsion, and a value of *R* calculated for each star. In determining the angular distributions we distinguish between the tracks of protons, alpha-particles and heavier nuclei, and the very heavy 'recoil fragments'; the latter are characterized by their short, heavily ionized tracks, which frequently show considerable Coulomb scattering owing to their high charge. In Fig. 1*a* the histogram shows the distribution of *R* for alpha-particles only; in (*b*) that for protons only. A comparison of the histogram with the random-walk curve shows that the alpha-particles have angular distributions with large deviations from spherical symmetry (the probability that the histogram corresponds to spherical symmetry is less than 10^{-4} from the χ^2 test). On the other hand, the protons are seen to be emitted almost isotropically.

Here it must be pointed out that the observed asymmetry cannot be due to the momentum transfer from the incident particle. Even the most energetic stars entail an excitation of only 1,000 MeV. Thus the velocity imparted to the whole silver nucleus by, say, an incident neutron would be $\leqslant 0 \cdot 01$ c., which is very small compared with that of each ejected particle ($\sim 0{\cdot}2$ c.). Furthermore, the sums of the components of R over all the stars, in horizontal and vertical directions respectively, show no essential difference.

In order to determine whether the alpha-particles are collimated in any special direction, we have calculated, for each star, the angle ψ between the short recoil fragment (or fragments) and the resultant direction of the alpha-particles. The distribution of ψ over all stars with observable recoil fragments is indicated in Fig. 2*a*. The alpha-particles show a strong tendency to be ejected in a direction opposite to that of the recoil fragment. On the other hand, as might be expected, the protons do not appear to show any such directional effects (Fig. 2*b*).

A possible explanation of the collimation of the alpha-particles and heavier sub-nuclei is that the first stage in the disintegration process consists of the breaking up of the nucleus into two or more heavy fragments. Each may be supposed to have considerable momentum, and we must further assume the fragments to be of different sizes, and the excitation energy to be asymmetrically divided between them. We then postulate that the lighter fragments, which must necessarily carry most of the kinetic energy, break up spontaneously, preferentially into stable particles with low internal energy, such as alpha-particles, but possibly also a few protons and neutrons. The heavy 'recoil fragment', on the other hand, retains most of the original excitation energy as internal energy, and then 'cools down' by evaporating off neutrons and protons (and, of course, a few alpha-particles). The angular distribution of the protons would then be more or less isotropic, as observed. From the charge carried away by the alpha-particles and protons, it is possible to estimate that on the recoil fragments. We find that their ranges are roughly in agreement with what one would expect, if their momenta were equal and opposite to that of the alpha-particles.

If the above hypothesis is true, one would not expect the energy distribution of the alpha-particles to conform to evaporation theory. In actual fact, measurements on the ranges of the alpha-particles yield an energy spectrum which appears to be much broader than could correspond to an evaporation process. However, it will be necessary to improve the statistical accuracy of our data in order to confirm this.

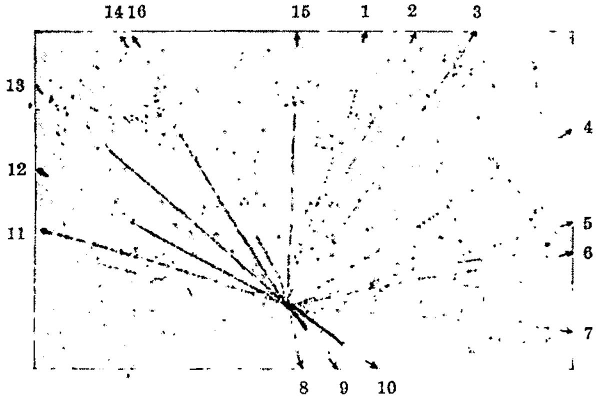

Fig. 3. DISINTEGRATION OF SILVER OR BROMINE NUCLEUS IN ILFORD *B*2 EMULSION, IN WHICH BOTH THE ALPHA-PARTICLES (11–15) AND PROTONS (1–8) ARE STRONGLY COLLIMATED. PARTICLE 16 ENDS IN THE EMULSION AND IS PROBABLY A VERY SLOW MESON. TRACKS 9 AND 10 ARE THOSE OF HEAVY RECOIL FRAGMENTS

It must also be emphasized that not all our disintegrations conform to the above scheme. In a few cases no recoil fragment is visible, and in one extreme example (Fig. 3) the protons as well as the alpha-particles show strong collimation.

The excitation energy required in the processes we have described is estimated at 500–1,000 MeV. Now, the great majority of stars produced by 200 MeV. deuterons and 400 MeV. alpha-particles from the Berkeley cyclotron show forks with only three or four charged particles; no large stars have been reported[3]. As explained by Serber[4], this is because the nuclei become partly transparent to the incident nucleons with these energies. In a similar way, a σ-meson, when captured into a nucleus, would appear to undergo annihilation by interaction with a single nucleon, which is excited to an energy $\sim$ 200 MeV. This nucleon will then leave the nucleus after only one or two collisions, with an energy loss of only some tens of million electron volts. Thus our own observations, and those of Dr. Powell and co-workers[5], show that stars produced by σ-meson capture generally involve only two or three charged particles. Very rarely are more than four secondaries produced. These two experimental facts indicate that it is unlikely that the energetic stars can be explained by nuclear capture of, for example, neutrons with energies of a few hundred million electron volts, or nuclear capture and annihilation of neutral or fast charged mesons with the usual values of mass. Probably, therefore, the stars described above are the results of another process, for example, the inelastic scattering of very fast cosmic-ray particles, with energies in the relativistic region where the cross-section for scattering on nucleons becomes large.

It is hoped to publish a fuller account of this work in the near future.

[1] *Nature*, **160**, 299 (1947).

[2] Chandrasekhar, *Rev. Mod. Phys.*, **15**, 1 (1943).

[3] Gardner, *Bull. Amer. Phys. Soc.* (Jan. 2, 1948).

[4] Serber, *Phys. Rev.*, **72**, 1114 (1947).

[5] Lattes, Occhialini and Powell, *Nature*, **160**, 486 (1947).

RELATIONSHIPS OF VAPOUR PRESSURE, CAPILLARITY AND TEMPERATURE IN CLAYS

By B. VASSILIOU and DR. J. WHITE

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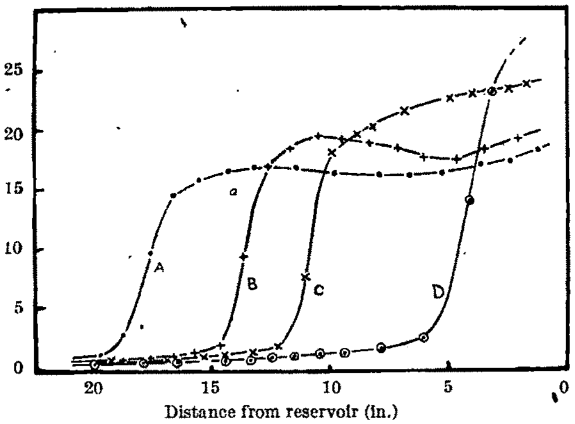
WHEN columns of a commercial kaolin ('Supreme Kaolin') of uniform moisture content are placed in sealed, vertical tubes, along which a constant temperature gradient is maintained, and having a reservoir of water at constant temperature at their lower, cool ends out of contact with the clay, 'stepped' moisture distribution curves of the type shown in the accompanying diagram are obtained, the step moving progressively, but with decreasing velocity, towards the cool end of the tube with increasing time.

It has been found that the observed distributions can be accounted for in terms of the relation

$$\log_{10}P = -\frac{2252}{T} + 7{\cdot}92 - \frac{2{\cdot}146 \times 10^{-5}}{rT} + \frac{2{\cdot}677 \times 10^{-8}}{r} - \frac{1{\cdot}258 \times 10^{-3}}{T}(P_0 - P), \quad (1)$$



MOISTURE DISTRIBUTION IN CLAY COLUMNS UNDER A TEMPERATURE GRADIENT

	Initial water	Time (hr.)
A	16·0	35
B	16·0	125
C	17·8	288
D	17·8	1013

if the vapour pressure is assumed constant from the position of the inflexion near the top of the step to the hot end of the column. This equation was derived from the ordinary vapour-pressure/capillary-radius relation using the approximate substitutions

$$\gamma = 114{\cdot}4 - 0{\cdot}1425\, T$$

$$\text{and } \log_{10} P_0 = -\frac{2252}{T} + 7{\cdot}92,$$

P being the vapour pressure in cm. of mercury in a capillary of radius r cm. at $T°$ abs., P_0 the vapour pressure over a plane water surface at the same temperature and γ the surface tension in dynes/cm. Over the range of vapour pressures involved, the last term on the right-hand side of equation (1) could be neglected. Since earlier work had shown that lowering of the vapour pressure was negligible with this clay at more than 3–4 per cent water, P could be taken as that of a plane water surface at the temperature of the inflexion. Using the appropriate values of P, r was calculated for various positions of known temperature along the column, the curves obtained being of similar form to those reproduced, except that the moisture variation was expressed in terms of r instead of actual moisture contents. By direct comparison of calculated r values with the moisture contents on corresponding curves, the expression

$$r \times 10^7 = 2{\cdot}0\, W^{1{\cdot}57}, \tag{2}$$

where r is the effective capillary radius in cm., and W the weight percentage of water has been derived. Applied to the calculated data, this expression gives an excellent fit with the curves shown and also with curves obtained when the whole of the column had come to equilibrium with the reservoir.

Some light on the underlying rate-mechanism has been obtained from experiments in which water alone or a clay–water mixture was placed in trays evenly spaced along the tubes (equivalent to using a broken column). Movement of water could then take place only by an evaporation–condensation mechanism via the narrow annular spaces round the trays. On plotting the moisture contents of the trays against their position in the tube at various times, curves similar in form to those shown were obtained.

With water alone, the evaporation-rate from each tray was constant until it was dry, the rate varying from tray to tray as a linear function of the vapour pressure. Of the moisture evaporating from any tray, approximately one half condensed in the first tray below, one quarter in the second and one eighth in the third, the remainder passing apparently direct to the reservoir, as no condensation on the tube was found. The movement of the step from the fourth tray onwards is, therefore, given by the equation

$$t_n = cW \times 1{\cdot}20 \times 10^{-8} \left[\frac{5}{12}n + \frac{61}{72} - \frac{2}{9}\left(-\frac{1}{2}\right)^n\right] \exp 5190/T_n, \tag{3}$$

t_n being the time in hours for the nth tray at T_n to become dry, W the initial weight of water in each tray and c a constant equal to 1870. A similar type of equation can be made to fit the movement of the step on the curves shown, and it would appear that movement of the water is an activated process (evaporation–condensation or activated diffusion) involving water which is 'bound' to the clay particles. At higher moisture contents where free flow is possible (necessitating horizontal tubes) no 'stepped' distribution is developed until the moisture content has been reduced by drying.

With a clay–water mixture in the trays, similar relationships hold except that the evaporation-rate for each tray decreases rapidly at less than 3–4 per cent water due to lowering of the vapour pressure by capillarity. During this stage, the vapour pressure of any tray approaches equilibrium with that of the nearest tray still in its constant-rate period of drying at a vapour pressure sensibly that of a plane water surface. From the drying curves it has, therefore, been possible to determine the vapour pressure of the clay at various temperatures and water contents. From this data the expression

$$\Delta H - 10{,}300 = \frac{2350}{W - 0{\cdot}79} \tag{4}$$

has been derived, where ΔH is the total heat of evaporation in cal. per mol. of water when there are W gm. water per 100 gm. clay.

The form of the denominator in equation (4) implies a lower limit to capillarity at $W = 0{\cdot}79$. Equation (2), on the other hand, indicates a continuous rise of r with water content, slow at first, then rapid. Actually at more than 1 per cent water the data can be fitted reasonably by a straight line cutting the axis of zero r at approximately 0·79 per cent water. This value has been taken tentatively as indicating completion of a monomolecular adsorption layer on the clay surface, giving a value of the order of 300,000 sq. cm./gm. for this clay. On the same basis, Pembina bentonite, for which continuous column experiments yielded the relation

$$r \times 10^7 = 0{\cdot}00022\, W^{3{\cdot}3}, \tag{5}$$

requires 16–17 times as much water to complete the adsorption layer, giving a surface area of 4,800,000–5,100,000 sq. cm./gm. This is close to Schofield's estimate of 4,700,000 sq. cm./gm. for Wyoming bentonite[1], but the agreement may be only apparent as Pembina bentonite is non-swelling. The vapour pressure isotherms of the two clays calculated from (2) and (5) for 20° C. agree well with the observation that, stored in the laboratory, the kaolin picks up 0·9–1·0 per cent and the bentonite 16–17 per cent moisture.

A full account of the work will be published in due course. One of the authors (B. V.) acknowledges with gratitude the award of a British Council scholarship.

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[1] Schofield, R. K., *Nature*, 160 408 (1947).

RELATION OF MANGANESE AND SOME OTHER METALS TO THE IRON STATUS OF PLANTS

By ERIC J. HEWITT
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IT has been shown with plants growing in water culture that iron deficiency symptoms may be readily induced by excessive concentrations of manganous salts[1–6]. A reciprocal effect on the incidence of manganese deficiency in the presence of high concentrations of iron compounds has also been shown for soya bean[6] and some fruit crops[4]. These results have been interpreted[6] as suggesting that iron deficiency and manganese toxicity are but relative terms for the same disorder resulting from too wide Fe/Mn ratios, and that manganese deficiency and iron toxicity are similarly relative. It is generally assumed that metabolically active iron exists in plants in the ferrous state, and becomes inactive after oxidation to the ferric state. In one of the experiments referred to[6], this oxidation was assumed to follow reaction with manganese compounds previously oxidized to a higher valency state. A similar ability to induce iron deficiency was forecast for cobalt on account of its still higher oxidation-reduction potential than the manganese system postulated, and some indication was obtained that iron deficiency was induced more readily by cobalt salts.

In other experiments using sand or water culture, it has been shown that compounds of metals such as copper[7,8], zinc[5,7,9,10], and chromium[11,23] can also induce symptoms apparently identical with those of iron deficiency. Observations in the field[10,12,13,14,15] also confirm that similar symptoms may be induced in a variety of crop plants by toxic levels of compounds of copper or zinc in soil, and possibly by other metals in industrial sewage spread over land in which such crops are growing; similar effects may also appear in the vicinity of copper and zinc smelting works, and in areas where zinc-bearing dolomitic limestone occurs[15]. Naturally occurring compounds of cobalt or nickel may also cause this effect in acid soils[16]. It is thus evident that the compounds of several metals, in addition to manganese and cobalt, may induce iron deficiency. Furthermore, recent results obtained with several crop plants grown in sand culture[12,17,18] have shown that symptoms of manganese toxicity can be distinguished from those of manganese-induced iron deficiency and are readily produced even in the absence of the latter. It thus seems necessary to examine more fully the relation of the effects of 'toxic' concentrations of a number of metallic ions to iron metabolism and the appearance of the visual symptoms of this deficiency and of other injurious effects. Results are given below of some experiments made in sand culture with sugar beet, chosen because it shows readily symptoms of iron deficiency in the field in the presence of some of the metals mentioned, and is known to be remarkably tolerant to high concentrations of manganous ions[12].

Experimental. Young sugar beet seedlings were transplanted into purified sand[12] in 10-in. bitumen-painted clay pots[19], and the cultures arranged in two series according to two types of iron supply, as follows: Series 1: Purified sand only, with iron supplied as ferric citrate at 0·1 milli-equiv. per litre in the complete nutrient solution. Series 2: Purified sand mixed with magnetite at the rate of 100 p.p.m., but no iron added in the nutrient solution. In both series the ions Pb^{++}, Zn^{++}, Cu^{++}, Co^{++}, Ni^{++}, Mn^{++}, Cr^{+++} and CrO_4'' (the last to supply the same weight of chromium as the Cr^{+++}) were added separately, at concentrations of 0·5 and 1·0 milli-equiv. per litre in the nutrient solution. There were also three control treatments without any of these additions, and in which iron was supplied as above, either as magnetite, or as ferric citrate, or was omitted altogether.

Plants in the control treatment where iron was omitted developed acute symptoms of chlorosis and also some brown intervenal necrosis typical of iron deficiency. Control plants given iron, either as citrate or as magnetite, grew vigorously and the foliage was normal. Chlorosis of younger leaves, typical of iron deficiency, developed in all plants given the additional ions listed above, and ranged from very severe (total yellow) to a trace. The severity of chlorosis was observed to be in the order of

$$Co^{++} > Cu^{++} > Zn^{++} = CrO_4'' > Ni^{++} > Cr^{+++} > Mn^{++} > Pb^{++};$$

that of the controls where iron was omitted was similar to plants given extra Zn^{++} or CrO_4''. This same order was shown in both the citrate and magnetite series, although certain broad differences were noted between the two series. Thus in the citrate series, the chlorosis caused by the chromic or manganous ions, and the differential effect of using two concentrations, were more marked. The effects of copper, zinc or chromate respectively were comparable in the two series, but cobalt and nickel produced more severe injury in the magnetite series than with citrate. Evidence was obtained, by painting the leaf surface with 0·25 per cent ferrous sulphate solution plus a wetting agent, that the chlorosis was *in all cases* due to failure in the iron metabolism. A response was evident in about forty-eight hours, and complete recovery of the treated areas occurred in five days, while untreated leaves, including the younger ones, remained chlorotic.

In addition to the induced chlorosis, other apparently direct toxic effects were noted in the Co^{++}, Ni^{++}, Zn^{++}, Cu^{++} and CrO_4'' treatments; here the plants were considerably dwarfed, whereas those given Cr^{+++}, Mn^{++} or Pb^{++} grew with normal vigour. Brown intervenal necrosis usually developed in the chlorotic leaves, including those of control plants lacking iron. This necrosis ranged from very severe with cobalt or nickel, to slight or nil with chromium as sulphate, manganese or lead. In the presence of nickel the necrosis appeared rapidly and frequently preceded marked chlorosis, and, when cobalt was given, both necrosis and chlorosis were quick to appear. The necrosis was unusually dark brown or even black in colour in these two latter treatments, and eventually resulted in complete blackening and death of the young leaves and of the plants. Fading, tinting and necrosis also developed in the older leaves of plants given zinc, cobalt or nickel, the last element in particular producing an orange tinting of the faded older leaves. These symptoms were all distinct from those identified as resulting from iron deficiency. A similar distinction has been noted for flax suffering from zinc toxicity[10]. The general order of toxicity, as distinct from induced chlorosis, was as follows:

$$Ni^{++} > Co^{++} \gg Zn^{++} > Cu^{++} > CrO_4'' \gg Cr^{+++} = Mn^{++} \text{ and } Pb^{++}.$$

As previously stated, sugar beet has been found to be relatively tolerant to high concentrations of manganous salts. Symptoms of manganese toxicity distinct from and without those of iron deficiency, however, were produced in another experiment in the *older leaves* of plants given 6 milli-equiv. per litre of manganese in the presence of an adequate iron supply[12]. These observations have confirmed previous conclusions that manganese toxicity and manganese-induced iron deficiency are distinct effects[15,17].

Symptoms which appeared in some of the older leaves of the plants given extra zinc resembled the effects of manganese deficiency and occurred simultaneously with iron-deficiency symptoms in the young leaves of the same plant. Determinations of soluble manganese[20] showed that the affected leaves yielded less than 0·015 and 0·005 p.p.m. of manganese in the tissue extract when given 0·5 and 1·0 milli-equiv. per litre Zn^{++} respectively, as compared with 0·05 p.p.m. in leaves from the control (ferric citrate only) plants. The simultaneous deficiency of iron and manganese in the same plant was observed in another experiment[13] with oat plants grown in sand cultures from which both elements were omitted. In this latter instance, typical iron-deficiency chlorosis and 'grey speck' could be distinguished on the same leaves, and a similar condition was identified in the field in 1946 and 1947, where liming had been used in an attempt to control injury by industrial sewage[12]. Specific morphological effects ascribed to the simultaneous deficiency of these elements have also been described for leaves of *Theobroma cacao*[21].

Discussion. The suggestion that oxidation-reduction reactions may be responsible for the iron-deficiency chlorosis induced by manganese and cobalt may be considered on the basis of this new evidence. It is clear that manganese and cobalt are in no way unique in their capacity to induce such chlorosis and that, of the metals examined, at least one, namely zinc, does not undergo valency changes associated with simple oxidation-reduction reactions; of the others, manganese was one of the least active, while copper and cobalt were the most active in producing chlorosis. These results bear no relation to the E_0 values given by Latimer[22] for changes in valency of the *simple ions*. Thus the E_0 values for $Co^{++} \rightarrow Co^{+++}$, $Cu^{+} \rightarrow Cu^{++}$ and $Mn^{++} \rightarrow Mn^{+++}$ are $-1·84$, $-0·167$ and $-1·51$ V. respectively, whereas for $Fe^{++} \rightarrow Fe^{+++}$, $E_0 = -0·77$ V. Thus copper, even as the cupric ion, should, on that theory at least, be incapable of converting the ferrous to the ferric ion; while it must be assumed that, as the cobalt and manganese were given in the reduced valency form, they must first have been oxidized in the plant to a higher valency by reactions that, in the absence of these metals, do not influence the ferrous-ferric equilibrium. Furthermore, the existence of some of the high-valency metallic ions in living plants is doubtful. Nickel, for example, caused chlorosis, but tetravalent nickel exists only as NiO_2 under strongly alkaline conditions, and the cobaltic ion can attack water.

On the other hand, many of the metals studied would exist as complex ions in the plant. The oxidation-reduction potentials of complex ions, however, may often differ greatly from those of the simple ions. For example, for

$$Co(NH_2)_6^{++} = Co(NH_2)_6^{+++} + e^-, E_0 = -0·1 \text{ V.},$$

while for the $Fe^{++} \rightarrow Fe^{+++}$ change when iron is present as a complex with *o*-phenanthrolene, $E_0 = -1·14$ V. Thus it is clear that explanation of the observed facts must await more accurate information on the form of combination of the metals involved and on their metabolism.

A suggestion that active iron in plant tissues may be closely associated with certain protein fractions[1] requires that the possible influence of various metals on the precipitation, denaturization, or adsorptive properties of such protein fractions should also be borne in mind. Competition between the toxic metal ions and iron in enzyme systems involved in chlorophyll formation, or the activation of enzyme systems influencing the ferrous-ferric iron equilibrium may also be important in reactions inducing symptoms of iron deficiency. It is not, however, justifiable at this stage to infer that the mechanism causing chlorosis is analogous in each case. Thus data showing increased iron accumulation in the presence of toxic concentrations of zinc[10,15] would seem to exclude simple antagonism as a cause of chlorosis in some instances, while the differential response to Cr^{+++} and Mn^{++} in the presence of magnetite or ferric citrate suggests that antagonism may still be significant in others, and work on copper-induced chlorosis[8] suggests that two separate effects may be involved.

Conclusions. The evidence considered here points to the following conclusions: (1) Manganese is not unique in its ability to induce iron-deficiency symptoms, and may, in fact, be less active in this respect than many other metals. (2) The existence of the simultaneous deficiencies of iron and manganese in the same plant has been observed in a number of independent instances, which suggests that these elements have some independent functions in plant metabolism. (3) Toxic effects of excess manganese can be readily distinguished from symptoms of iron deficiency; again suggesting independent effects of these elements. (4) Hypotheses based on oxidation-reduction potentials of *simple ions* appear inadequate to explain the activity of the metals considered herein in inducing iron deficiency, and more than one mechanism may be involved.

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NATIONAL RESEARCH COUNCIL OF CANADA

ANNUAL REPORT

THE thirtieth annual report of the National Research Council of Canada, 1946–47, includes the report of the president, Dr. C. J. Mackenzie, together with the financial statement for the year ended March 31, 1947 (Ottawa: National Research Council). Dr. Mackenzie's report gives a general conspectus of the work of the Council, but for scientific workers and others interested in details of the projects in progress, a more comprehensive booklet, "The National Research Council Review for 1946", is available on order from the Council. At the end of the War, a Defence Research Organisation was formed under the Department of National Defence, and is responsible for determining what research is to be done for military purposes during peace-time. The president of the Research Council is *ex officio* a member of this Board. Associate committees with purely war-time functions which had completed their assigned tasks have now been disbanded, but at the end of 1946 there were thirty-three active committees. Eighty-one research grants were made in 1946–47 directly by the Council, 82 through the Division of Medical Research and 93 through committees, while scholarships were awarded to 185 graduate students to enable them to extend their training in research.

Conversion of the Council's activities from war to peace was completed during the year, but the Council is at present recruiting the personnel required to bring its peace-time establishment to full strength. An Atomic Energy Research Division has been established at Chalk River to investigate the applications of atomic energy and the use of its products in industry and medicine. The Council took over on February 1, 1947, full responsibility for the administration and operation of atomic energy development at Chalk River, and will carry on these activities in accordance with broad general policies fixed from time to time by the Atomic Energy Control Board. A Division of Medical Research has been organised to stimulate and support investigations in this field, and has set up, at the request of the manufacturers, a committee to advise on the distribution of streptomycin and to make recommendations as to clinical conditions for which streptomycin might be used. A Building Research Division is being established, and work is progressing on the construction of a Prairie Regional Laboratory at Sasketoon for the promotion of studies on the better utilization of agricultural surpluses, notably wheat, and farm waste products such as straw. The newly established Division of Information Services has substantially expanded its survey of German and other reports for the solution of specific manufacturing problems.

An Electrical Engineering and Radio Branch has been created to co-ordinate and direct work in this field. The most important contribution in the development of radio aids to air and marine navigation during the year was a radar distance indicator, which enables an aircraft pilot to ascertain his distance from one or more pre-selected ground stations, its distance being read directly in miles on a simple meter. The Council is also co-operating in the development of radar equipment, by means of which it is hoped to determine base lines up to 300 miles long with an accuracy of 20 ft., and to permit spot fixes of photographic aircraft with an accuracy of 100 ft. in 200 miles. The laboratory is also engaged in developing a radio altimeter capable of providing a continuously recorded altitude measurement accurate within 50 ft. In the Division of Physics and Electrical Engineering, work has been undertaken to provide first-class facilities for scientific standardization, and a new project with a magnetic airborne detector is directed to the scientific determination from the air of the earth's magnetic elements and the location of mineral and oil deposits. Two experimental buildings of the radiant-heating project have been constructed, and work has been resumed on the thermostatic control of heated refrigerator cars. An infra-red detector was used successfully to ascertain whether joints were heating on transmission lines, and an apparatus has been completed by means of which the thermal conductivity of metals can be measured up to 800°.

A programme of photographic research is under way to determine the important factors in making positive prints on paper so that the maximum amount of information can be recovered from the negative, and a paper describing the final techniques developed for night photography is being published. Studies have been made of the factors affecting the dimensional stability of film under actual survey conditions, and further work has been done on the measurement of emulsion speed for aerial photography by a resolving power criterion, as well as on photometric standardization. Work in colorimetry has been initiated, and the Canadian Photographic Research Committee has been replaced by an Associate Committee on Photographic Research.

In the Division of Applied Biology one group is primarily concerned with fats and oils, and work on the processing and treatment of domestic oils for edible purposes has continued, particularly attempts to obtain an edible fraction from linseed oil and another fraction with superior properties for use in the paint industry. Work has continued on egg products, pork products and dairy products, particularly butter and dried milk. Preliminary trials of a Fritz butter-making machine from Germany indicated that the difficulties in meeting Canadian standards can be overcome. Efforts are being made to improve the versatility of chemical methods of assaying for riboflavin, thiamin and niacin. In the Ottawa laboratories, pilot plant studies on the production of *l*-2 : 3-butylene glycol from wheat with *Aerobacillus polymyxa* were completed, and fermentation efficiencies of 90–100 per cent were consistently attained. A method has been developed for the manufacture of phthalate resin from 2 : 3-butylene glycol and phthalic anhydride which has outstanding physical properties and is of interest to paint manufacturers. Wheat syrup was investigated on a semi-pilot plant scale, and first-quality corn syrups were prepared from the starch separated.

The reorganisation of the Division of Chemistry into Fundamental Chemistry and Chemical Engineering was completed, and the organic section of the former branch has investigated synthetic rubber and the isolation of new alkaloids. Many studies of photosensitized reactions have been made, including investigations of free radical processes by the mirror technique. Studies in surface chemistry have included the effect of physical adsorption on the electrical conductivity of activated carbon rods; but the work of the inorganic section, like that of the chemical engineering branch, has been concerned with the atomic energy project. The textile section has carried out further work on the rot-proofing of textiles, thermal insulation of protective clothing, the use of synthetic detergents, water-repellants and moth-proofing agents. The corrosion of steel by water is being studied under static and under flow conditions, including the mechanism of corrosion inhibitors. Preliminary data have been obtained on a new type of catalyst for the oxidation of ethylene to ethylene oxide, and an extensive research has been continued on the chemistry of long-chain unsaturated fatty acids. Further work on a new type of propeller de-icing, on the control of frost on standing aircraft, the development of an effective rain repellant for aircraft windows and of a catalyst for the oxidation of carbon monoxide to permit accurate determination of low concentrations in air, promise important peace-time applications. The relation between chemical structure and plasticizer reaction is being studied, while in the aeronautical laboratories the tailless glider was one of the major projects. The hydraulics laboratory completed tests on a model of a Great Lakes' harbour to determine the effect of a proposed pier extension upon sand-bar formation in the harbour entrance. Research on low-temperature lubricants has yielded much valuable information on flow characteristics of greases at low temperatures. Work on artificial limbs has continued in the structures laboratory, making use of processes developed during research on moulded aircraft components. Problems involved in 'panel', or radiant, heating are being investigated, and an important advance in low-cost housing was made in the development of a modular system for the construction of pre-fabricated houses.

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

ANNUAL REPORT

THE work of the British Electrical and Allied Industries Research Association throughout the year ended on September 30, 1947, is recorded in the twenty-seventh annual report recently issued.

The field of activity of the Association is perhaps most readily appreciated from a block diagram given in the report, in which twenty-two main lines of research are represented, several of which divide into as many as ten distinct branches. These include extensive studies of insulating and magnetic materials and of gaseous discharge phenomena, in regard to which researches of both a fundamental and of an applied character are in progress. Surge phenomena, communication interference, earthing safety and circuit problems, overhead lines, power plant and rural electrification are also main subjects of investigation.

In the section on heating, cooking and allied problems, reference is made to work in progress on a heat pump installation and to the early publication of a final report on an experimental investigation of the thermal characteristics of a concrete floor heated by buried cables. In connexion with the work on surge phenomena it is reported that a recurrent surge oscillograph has been developed which employs a sealed-off tube and gives a performance comparable with that obtained with the continuously evacuated type of instrument. Integrating electricity meters provide the subjects of several extensive investigations. A number of these is concerned with the behaviour of instrument jewels, the initiation of a new series of tests on tungsten/diamond and tungsten/sapphire bearings being reported. A detailed examination of the parasitic forces occurring in induction-type watt-hour meters has also been made.

It is interesting to note the wide range of researches supported by the Association in various university departments throughout Britain. These include investigations on the properties of high-pressure, high-temperature steam, work on the fundamental properties of magnetic materials and on the improvement of electrical sheet steels. Studies on the development of spark discharges include an investigation of the build-up of ionization by the Wilson cloud-chamber technique, and work on the high-frequency corona discharge. Experiments on the use of artificial illumination in horticulture are also being conducted in one university department.

In the introduction, the first paragraph deals with the reaction upon the Electrical Research Association of the transfer of the electrical supply industry in Britain to public ownership. The supply industry has provided some 30 per cent of the income of the Association, and the future relation of the British Electricity Authority with the Association is therefore of great importance. It is reported that the chairman of the Authority has confirmed the intention to support the Association and has provided for the safeguarding of the Association's finances during a transitional period in which the new basis will be worked out. The present report testifies to the existence within the electrical industry, both in the supply and the manufacturing spheres, of a spirit of co-operation in research which has built up, by good will and patient effort, a powerful instrument for the scientific and technical advancement of the industry as a whole. Such an achievement is a contribution, by no means inconsiderable, to the vital industrial needs of Great Britain at the present time.

J. G.

Rh NOMENCLATURE

FOLLOWING the hearing of evidence from interested persons, W. B. Castle, M. W. Wintrobe and L. H. Snyder have reported[1] to the Surgeon-General of the U.S. Public Health Service on the nomenclature of the anti-*Rh* typing sera. The report traces the history of *Rh* nomenclature, summarizes the evidence for and against Wiener's and Fisher's nomenclature respectively, and recommends that the Wiener nomenclature shall appear first on the label of serum containers, followed by the Fisher terminology in parentheses, thus: "Anti-Rh_0 (Anti-D)".

The authors have, on the whole, presented a fair and accurate summary of the complex history of the development of *Rh* theory and nomenclature, and of the associated controversies. They have, however, not pointed out that Fisher's notation was put forward[2] a year or more before any discussion of the possible genetic situations. Fisher's essential contribution lies in his postulation of three pairs of antigens, the antigens of each pair separately behaving as though they were the products of a pair of allelomorphic genes. Neither the validity nor the great convenience of Fisher's notation depends on the precise cytological basis of these facts. The most likely explanation consists in the existence of three very closely linked loci, but one cannot at present rule out the possibility of some such mechanism as that of a single gene with three side-chains each capable of variation. Even for this type of mechanism, Fisher's notation would give a more complete and convenient specification than that of Wiener. It should also be pointed out that Wiener's present nomenclature differs greatly from that originally put forward, and a claim of priority for it can scarcely be based on the fact that his original system was published before that of Fisher.

The compromise reached is an advance on previous American practice, and indirectly will do much to enable workers on the *Rh* factor in different parts of the world to understand one another's language. It is, however, to be regretted that Fisher's notation is relegated to parentheses; while its obvious advantages will ensure its use in research work, the first name on the label will tend to be perpetuated among clinical pathologists. A. E. MOURANT

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[1] Castle, W. B., Wintrobe, M. W., and Snyder, L. H., *Science*, 107, 27 (1948).

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PROPOSED INSTITUTE OF RECORDED SOUND

THE Association of Special Libraries and Information Bureaux has taken the initiative, in response to a large number of requests, of calling together representatives and individuals known to be interested in the formation of a permanent means of collecting, and making available to students and others, documentary and artistic material in the form of recorded sound. A meeting was therefore held on March 3 to discuss the matter, and to ascertain what is practicable now and in the near future.

Mr. Frank Howes (president of the Royal Musical Association), as chairman, gave an outline of the proposals already put forward in general terms, and the usefulness of such a potential organisation, started perhaps on the lines of the British Film Institute, was detailed by representatives of such important bodies as the British Museum, the British Council, the British Broadcasting Corporation (which uses sound recording on an immense scale in many forms), the National Register of Archives, the Scientific Film Association, the English Song and Folk Dance Society, the International Folk Music Council, departments of the University of London interested in languages, the commercial and private recording companies, the professional societies, and other individuals.

Mr. A. P. H. Saul described how collections of recorded material have been built up elsewhere, both on the Continent, especially Vienna, over the past fifty years, in Berlin and in the United States; but facilities are totally lacking in Great Britain. As a consequence valuable historical material is being lost, or at the best dispersed in private collections, of which no information is readily available. The interpretations of musicians, the voices of statesmen and poets, the remoter languages, the interesting cases of defective speech, and strange music of other lands are probably all available somewhere, but are denied to serious students of history, anthropology and phonetics.

Since practice is often better than mere precept, the value of such records was demonstrated most effectively by Mr. H. L. Fletcher, who played montage records, with comments, made that morning, from material received from a number of sources. Thus were reproduced the voices of Lloyd George, Asquith, James Joyce, Woodrow Wilson, Vesta Tilly (all pre-1914), Japanese music, an original 1660 pipe organ, a man of eighty recalling the original tune of "Brigg Fair", and modern poets. Also the voices of Gladstone, and, of course, all singers since 1900 are known to be available.

Questions of the copyright in reproductions for practical use, storage, finance, interchange with other countries, research and relations with other interested bodies were generally discussed. The meeting constituted itself a provisional council, having approved the idea that such an institute should go forward, and appointed a committee to study details and make a report.

With Mr. F. Howes as chairman the following were appointed to this exploratory committee: Mr. P. May (A.S.L.I.B.), Mr. A. P. H. Saul, Dr. D. B. Fry (Phonetics Department, University College, London), Mrs. J. Lancaster-Jones (British Council), Mr. D. Shawe-Taylor, Mr. A. C. Cameron (Educational Department, Electric and Musical Industries, Ltd.), Mr. H. L. Fletcher (Association of Professional Recording Studios) and Dr. L. E. C. Hughes (British Sound Recording Association).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, March 30

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. H. E. Faulkner: "The East India Company".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. S. S. Carlisle and Mr. B. O. Smith: "An Experimental Electrical Pressure Meter for Measurement of Furnace Roof Differential Pressures".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Symposium on "Modern Techniques in Stereoscopy and their Applications".

Wednesday, March 31

MANCHESTER LITERARY and PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (in the Portico Library, 57 Mosley Street, Manchester), at 5.30 p.m.—Mr. N. S. Hubbard: "The Place of Philosophy in Christian Civilization".*

BRITISH INSTITUTION OF RADIO ENGINEERS, MERSEYSIDE SECTION (at the Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool), at 6.45 p.m.—Mr. J. B. Birks: "The Physical Applications of Micro-Waves".

Thursday, April 1

MINERALOGICAL SOCIETY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. J. Halsey and Dr. J. H. Swaffield: "Analysis-Synthesis Telephony with Special Reference to the Vocoder".

INSTITUTION OF CIVIL ENGINEERS, NORTH-WESTERN ASSOCIATION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. F. D. C. Henry: "The Development of Motorway Projects".

ROYAL STATISTICAL SOCIETY, SHEFFIELD GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in Room B1, Department of Mechanical Engineering, The University, St. George's Square, Sheffield), at 6.30 p.m.—Mr. G. Komlosy: "The Application of Statistical Quality Control to a Steel Strip Mill".

Thursday, April 1—Saturday, April 3

SCIENCE MASTERS' ASSOCIATION, SCOTTISH BRANCH (at the University, Glasgow).—First Annual General Meeting.

Friday, April 2

Society of Public Analysts and other Analytical Chemists, Physical Methods Group (at Birmingham), at 2.30 p.m.—Visit to the Physics Department of the University, Bristol Road, Edgbaston; at 6.30 p.m. (in the English Theatre, Mason's College).—Papers on "The Determination of Radioactive and Stable Tracer Isotopes".

Physical Society, Optical Group (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7) at 3.30 p.m.—Mr. C. G. Wynne: "Wide-aperture Mirror Lens Systems"; Mr. R. W. G. Hunt: Demonstrations.

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "High-Speed Recording of Optical and Electrical Transients" (to be opened by Mr. H. A. Prime).

Royal Statistical Society, London Group of the Industrial Applications Section (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. H. O. Hartley: "Some Short Cuts in Statistical Calculations".

Society of Dyers and Colourists, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 6 p.m.—Annual General Meeting.

Friday, April 2—Saturday, April 3

Association of Special Libraries and Information Bureaux, Northern Branch (at Leeds).—Conference.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer in Bacteriology at the Essex Institute of Agriculture, Writtle, Chelmsford—The Chief Education Officer, County Offices, Chelmsford (April 3).

Lecturer in Mathematics—The Principal, County Mining and Technical School, Nuneaton (April 3).

Head of the Chemistry Department, and Head of the Mechanical Engineering Department, in the Technical Education Branch of the Department of Public Instruction, New South Wales—The Agent-General for New South Wales, 56–57 Strand, London, W.C.2 (April 5).

Teacher of Botany and Bacteriology in the Chemistry Department—The Principal, College of Technology, Belfast (April 5).

District Metallurgist, Mines Department, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (April 7).

Chief Laboratory Technician for Pathology and Bacteriology Department—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (April 10).

Scientific Assistant in the Department of the Chief Development and Research Officer—The Staff Officer (Ref. ER/E.467), London Transport, 55 Broadway, London, S.W.1 (April 10).

Secretary to the Institute—The Registrar, University College Institute of Education, Hull (April 10).

Senior Industrial Chemist and a Junior Industrial Chemist at the Atomic Energy Research Establishment, Harwell (for control of water supply to the Establishment, effluent disposal arrangements and general chemical service to the Chief Engineer, including control of boiler house, fuel economy, water treatment and large water distillation plants)—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F.215/48A (April 12).

Research and Test Baker to the British Baking Industries' Research Association—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F.179/48 (April 12).

Lecturer (Grade II) in Botany (Morphological)—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (April 15).

Lecturer in Chemistry in the United College, St. Andrews—The Secretary, The University, St. Andrews (April 15).

Senior Lecturer in Physics and a Lecturer in Physics—The Principal, Chelsea Polytechnic, London, S.W.3 (April 15).

Lecturer (Grade III) in the Department of Geography—The Clerk, Birkbeck College, London, E.C.4 (April 17).

Lecturer in Theoretical Physics and an Assistant Lecturer in Theoretical Physics—The Registrar, The University, Manchester 13 (April 17).

Superintendent of the Physics Division of the National Physical Laboratory in the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2140 (April 21).

Principal Scientific Officer in the Armament Research Department of the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2139 (April 22).

Senior Principal Scientific Officer in the Infestation Control Division of the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2138 (April 23).

Entomologist in the Inter-territorial Tsetse Reclamation Department, East Africa—The Under-Secretary of State, Colonial Office (Research Department), Palace Chambers, Bridge Street, London, S.W.1 (April 24).

Lecturer (Grade II) in the Department of Psychology—The Registrar, The University, Liverpool (April 24).

Lecturer in Social Anthropology and a Lecturer in Public Administration, for the Department of Social Studies—The Registrar, University, Leeds 2 (April 24).

Professor of Mathematics—The Secretary and Registrar, University College of North Wales, Bangor (April 24).

Government Chemist in the Public Works Department of the Gold Coast—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1 (April 30).

Research Fellows in Physics and Chemistry, including physical and organic chemistry, biochemistry, chemotherapy, pharmacology and engineering (Fellowships for Scientific Research established by I.C.I., Ltd.)—The Secretary, The University, Edinburgh (April 30).

Lecturer in Mathematics, to teach Pure and Applied Mathematics, more particularly the latter—The Very Reverend the Dean, Christ Church, Oxford (May 1).

Lecturer in Social Anthropology, and a Research Assistant in Social Anthropology—The Secretary, University College, Gower Street, London, W.C.1 (May 1).

Lecturer in Vertebrate Zoology and a Demonstrator, for the Department of Zoology and Applied Entomology—The Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7 (May 15).

Lecturer (Grade II) in Marine Zoology (Fisheries) at Port Erin Station—The Registrar, The University, Liverpool (June 9).

Administrative Officer to the Pneumokoniosis Research Unit of the Medical Research Council at Cardiff—The Director, Pneumokoniosis Research Unit, Llandough Hospital, Cardiff.

Agricultural Chemist in the Department of Agriculture, British Guiana, to undertake analytical and advisory work relating to soil crops and animal nutrition—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

Assistant Experimental Officer (male or female) in the Plant and Animal Products Department of the Imperial Institute, in the Intelligence Section—The Establishment Officer, Imperial Institute, London, S.W.7.

Lecturer in Physics—The Registrar, University College, Exeter.

Micro-Analyst in the Department of Organic Chemistry—Prof. W. Baker, The University, Bristol 8.

Senior Geologist for the Mines Department, Adelaide, to take charge and supervise geological investigations of the coal resources of the State and to advise on geological aspects of exploitation—The Agent-General for South Australia, South Australia House, Marble Arch, London, W.1.

Timber Marketing Officer by the Government of Nigeria Commerce and Industries Department—Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/17860/3E.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

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NATURE

No. 4092 SATURDAY, APRIL 3, 1948 Vol. 161

CONTENTS

Page
Machinery of Government 495
Trees in Prose and Picture. By Sir Edward Salisbury, C.B.E., F.R.S. 497
Brain and Mind. By Dr. O. A. Trowell 498
Medical Diseases in Hot Climates. By Dr. N. Hamilton Fairley . 499
The Thermionic Cathode. By D. A. Wright 500
Ice Cream. By Dr. L. H. Lampitt 500
North American Archæology. By Dr. G. H. S. Bushnell . . 501
Animal Parade. By Dr. Edward Hindle, F.R.S. 501
30-MeV. Electron Synchrotron. By D. W. Fry, J. W. Gallop, F. K. Goward and J. Dain 504
Biology in Colonial Universities 506
Education in Mycology. By Prof. Charles G. C. Chesters . . 507
A Tribute of Industry to Science 508
Obituaries :
  Sir Charles Grant Robertson, C.V.O. By Dr. G. A. Shakespear 510
  Mr. Griffith Brewer. By M. J. B. Davy 510
News and Views 511
Letters to the Editors :
  Electrical Conductivity of the Ionospheric *D*-Layer.—Prof. T. G. Cowling, F.R.S., and R. Borger 515
  Frequency Variation of the Intensity of Cosmic Radio Noise.—Jack W. Herbstreit and Joseph R. Johler 515
  Transmission of the Atmosphere in the 1-5 Micron Region.—Dr. A. Elliott and G. G. MacNeice 516
  Spin-Dependence of Magnetic Dipole Gamma Radiation and the Nuclear Level Scheme of Pb^{206}.—Dr. H. O. W. Richardson . 516
  The Mass of σ-Mesons.—S. Lattimore 518
  A Method of Feeding Micro-wave Power into a Resonator having a Fine Mode Structure.—G. R. Newbery and W. E. Willshaw . 519
  Fission Products of U^{233}.—Dr. W. E. Grummitt and Dr. G. Wilkinson 520
  Fluorescence of Highly Insulating Dielectrics Produced by *X*- and γ-Radiations.—Dr. C. W. Wilson 520
  Transition from Glow to Arc Discharge.—Dr. Chas. E. R. Bruce . 521
  Photography on Selenium.—Dr. P. Selényi 522
  Collision Broadening of the Ammonia Inversion Spectrum at High Pressures.—Dr. B. Bleaney and J. H. N. Loubser . . . 522
  Coefficients of Viscosity and Thermal Conduction in Dense Gases and Liquids.—L. M. Yang 523
  A Bunsen Flame as a Column of Luminous Gas.—Dr. A. S. Leah and Prof. W. T. David 524
  Equations of Piezo-electricity.—Richard K. Cook 524
  The Melanin Problem : a Synthesis of 5 : 6-Dihydroxyindole.—Dr. R. J. S. Beer, K. Clarke, H. G. Khorana and Prof. A. Robertson, F.R.S. 525
  The Carotenoids of the Locust Integument.—T. W. Goodwin and S. Srisukh 525
  Isolation in Chick Embryos of a Filtrable Agent possibly related etiologically to Lumpy Skin Disease of Cattle.—Prof. M. van den Ende, P. Don, A. Kipps and R. Alexander . . . 526
  Effect of Calcium Ions on the Charge of Myosin.—Olle Snellman and Thomas Erdös 526
  Early Effects of Hydroquinone on Mitosis.—R. Parmentier and Dr. P. Justin, Jun. 527
  Antagonism Between Molybdenum and Certain Heavy Metals in Plant Nutrition.—C. R. Millikan 528
  Synonymy of the Nudibranch Genera *Pellibranchus* and *Okadaia*.—Patricia M. Ralph 528
Mass-Defects of the Heavy Isotopes. By A. H. Wapstra . . 529
Constitution of Certain Binuclear Metallic Carbonyls and Nitrosyls. By Dr. R. V. G. Ewens 530
Chromosomal Evolution in the European Mole-Cricket. By Tuviah Kushnir 531
Written Expression in Science 533
Physiology and Biochemistry of Fats and Lipoids 534
Metabolic Aspects of Convalescence. By M. W. Grant . . . 535

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MACHINERY OF GOVERNMENT

SEVERAL distinct trends in public affairs have directed fresh attention in recent months to the adequacy or otherwise of the existing instruments of government in meeting the post-war needs of Britain. The reorganisation of the defence ministries under a co-ordinating Minister of Defence and the tendency to enlarge the responsibilities of the Lord President of the Council for the oversight and co-ordination of scientific effort, making him in effect the Minister for Research and Intelligence suggested by the Haldane Committee of many years ago, have raised the question of the efficiency at the highest level of administrative organisation. The formation of the Defence Research Policy Committee and the Advisory Council on Scientific Policy, with their various sub-committees, is only one special aspect of the problem of relating knowledge to power at the very seat of authority. Sir Stafford Cripps' appointment as Minister for Economic Affairs was another indication of re-organisation in accordance with the recommendations of the Haldane Committee. The Government's programme of nationalization and the creation of the National Coal Board and similar national boards have also brought into question both the capacity of the Civil Service itself and the existing structure of government to deal competently and efficiently with the issues involved, while proposals for the re-organisation of local government and regionalism have likewise stimulated thought on these matters.

It will be recalled that in its fifth report of the 1946–47 session, the Select Committee on Estimates concluded that insufficient thought had been given to adapting the machinery of government to its new tasks, and referred to the danger that in spite of the formation of new ministries and the placing of much of the responsibility for the conduct of nationalized industries and like activities in the hands of quasi-governmental boards, certain Departments of State might have become too large and cumbrous to work as rapidly and efficiently as single administrative units. A reconsideration of the whole pattern of government in the light of modern conditions might well suggest a re-organisation that would increase the rapidity and efficiency with which the ever-growing volume of work is discharged. Even if this survey led to no reduction in staff, it should at least obviate further increases.

It has been objected that such a committee as that suggested by the Select Committee, consisting of a few highly placed and experienced persons from outside the Civil Service, would be less likely to yield practical results than a committee of permanent heads of Departments. Whatever substance there may be in that criticism, there can be no doubt that there are the gravest objections, as has been again pointed out by Dr. W. A. Robson in his able article on the machinery of government in the recent issue of the *Political Quarterly*, to the secret proceedings of the Cabinet committee on the machinery of government. The whole question demands public discussion, and it is well to note that besides Dr. Robson's article, this specific question is discussed by Mr. D. N. Chester in an article "The Efficiency of the Central Government" in the *Journal of Public Administration*, and is the subject of a discerning chapter in Mr. H. R. G. Greaves' recent book, "The Civil Service in the Changing State"*.

Dr. W. A. Robson reviews with approval the arrangements for co-ordinating the Service Ministries and defence policy under the Minister of Defence; but he points out that a ministerial hierarchy is already emerging, and that the effect of the concentration of power in the hands of five or six ministers calls for reflexion. He sees, it is true, in the creation of a Minister of Defence and a Minister for Economic Affairs a trend towards the recommendations of the Haldane Committee; but the growth of functionalism has already made the Home Office anomalous, while the Colonial Office and the Scottish Office are in part, at least, territorial concepts. Dr. W. A. Robson lends his own authority to the suggestion that the whole question demands impartial and objective examination by a committee possessing exceptional ability, great experience of public affairs, disinterestedness and freedom from ministerial preoccupations.

Dr. Chester's article is less concerned with the fundamental structure of the machinery of government than with its operation and the factors responsible for overloading it, and for the decline in the capacity of departments which it is believed has occurred in the last two or three years. None the less, the factors to which he directs attention only strengthen the argument for the early and authoritative review urged by Dr. Robson. It is true that little can be done immediately to counteract the detrimental effects of the demand of the war years on the health of most senior officers; but one certain result of the review of the structure of government at the highest level would be to relieve the tremendous strain which the present plethora of international and like conferences places on senior officials.

Time alone can rectify the defects due to the abnormal turnover among permanent secretaries in the Civil Service which has marked the last few years; but something could be done to redress the weaknesses resulting from the return to civil life of many of the more distinguished temporary members of the Service. On the other hand, there are certain factors which at present favour the central administration, and Mr. Chester does well to point out that they are temporary. The diminishing respect for law which is so marked a characteristic of the post-war years cannot be expected to leave the process and execution of administration untouched. The British people have been accustomed to administer themselves, and a central administration which forgets that fact and does not seek to enlist the support and understanding of the governed is inviting trouble through the breeding of lawlessness.

Mr. Chester, like the Select Committee on Estimates, points clearly enough in general terms to some of the needs and dangers of the present situation. Overloading the administration almost inevitably means that there is no shedding of work which is not essential so as to concentrate on the big national issues. It means, too, that no attention is given to the use of devices to facilitate the execution of policy without employing large numbers of officials, and it is equally unlikely that effective use will be made of outside ability and experience.

These are all urgent needs if the Civil Service is to cope efficiently with the tasks that are now being laid upon it; but they are unlikely to be met unless at the highest level the structure is such that excessive strain is removed and those concerned with the formulation of policy are alive to what is administratively possible rather than politically desirable from the party point of view. The first task must indeed be to take the examination of this whole question right out of the arena of party politics and examine it scientifically and objectively, as it was examined by President Roosevelt's Committee on Administrative Management.

Mr. Greaves' analysis of Treasury control in relation to the machinery of government is no mean contribution to the understanding of the whole subject. In particular, a very fair appreciation of the way in which the Treasury has already adapted itself to the better co-ordination of policy relating to Civil Service matters indicates a series of further administrative needs, arising in part out of the Treasury's financial responsibility and in part out of its general co-ordinating function as the department of the Prime Minister. There are doubts as to whether the Treasury is sufficiently intimate enough with the work of other Departments to fulfil such co-ordinating functions, particularly the periodic review of departmental organisation. There are also doubts whether the Treasury has equipped itself for dealing with the new and different problems in the field of social services, and of the economic and industrial undertakings for which the State has developed varying degrees of responsibility.

Mr. Greaves brings out very clearly that provision is required for co-ordination at two levels. The first is at the ministerial level, where the task normally belongs to the Cabinet and where further delegation of more onerous parts of its work may be necessary on lines indicated by the appointment of a Minister of Defence. The second level is that of secretariat, and here Mr. Greaves stresses the necessity for something in the nature of a super-departmental staff to advise the Prime Minister in particular and the Cabinet as a whole.

An authoritative body to create and maintain the machinery of government—a directive authority for the scientific ordering of public administration in the larger and more complex connotation of that term in the modern social-service State—is considered by Mr. Greaves to be of high importance. He appears to visualize this as a permanent feature of the structure of government. Another need is for an agency of information and public relations, the function of which would be to organise and foster at every level of execution plans for the understanding and co-operation of the public—a need which has been consistently ignored by the present Government and repeatedly stressed by constructive critics, notably in certain P.E.P. broadsheets.

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* The Civil Service in the Changing State. By H. R. G. Greaves. Pp. 240. (London: George G. Harrap and Co., Ltd., 1947.) 10s. 6d. net.

The need for an informed public opinion is increasingly apparent, but it is not so widely appreciated that an informed public implies a conscious effort to inform it—a blend of the arts of publicity and education. Mr. Greaves does not make the mistake of imagining that attention to administrative needs, the provision of means for the periodic overhaul and review of the general lay-out of departments and the distribution of responsibility at the top will suffice. The scientific treatment of establishment matters, including recruitment, promotion, physical conditions of work over the whole field of public service, and research in the whole field of government are also necessary. Information must flow adequately upward as well as downward, and a new temper must be infused into the whole field so as to secure, at the highest level, clear thinking on administrative organisation, firm direction, fundamental reforms and strenuous and sustained endeavour. The segregation of the central official must be overcome, and the whole service brought into closer contact with the spirit and tendencies of the new society. Only when clear understanding of the issues is developed on both sides can we expect either the imaginative and bold reforms and experiments in administration to be initiated, or the public support and co-operation which are indispensable for the enactment of policies thus conceived.

That the danger of bureaucracy does exist as the public service becomes more efficient is made plain by Mr. Greaves; many others have done the same since the Haldane Committee directed attention to the point in emphasizing the necessity of real Parliamentary control being enforced so as to keep pace with any improvement in departmental methods. What must be stressed above all is that we have here a searching test of democracy, which makes high demands on the Government at all levels and also on the private citizen. Whether democracy can meet that test has yet to be seen, but the issues are at least made plain. The Haldane Committee was fully aware in making its suggestions that an efficient departmental system working in satisfactory relation with Parliament could not be established or maintained on lines laid down in advance by any committee of inquiry. The practical efficacy of the principles which the Haldane Committee suggested depends upon the zeal and discretion with which they are applied from day to day by Parliament, by Ministers and by the officers of Departments.

These are the living forces whose spirit is essential to any form of government that is more than a machine; and while we may yet have to evolve, as a result of further experiment, the forms of organisation and the rearrangement of duties which will best serve the needs of the social-service State and preserve the values of democracy, there can be no question that the forces have sometimes been ignored by the Government to an extent dangerous to the existence of a free society. Parliament as ultimate authority must, as Sir John Anderson said in his Romanes Lecture, have adequate opportunity for inquiry, for debate, and for passing judgment. To curtail that opportunity, in order to serve the dictates of a party legislative programme, is as fatal to democracy as the totalitarian treatment of human beings as though they were inanimate objects. There may be no science of statesmanship or politics or persuasion, as Prof. A. D. Ritchie holds. But the study of government and administration holds both promise and profit; and not the least for the growing emphasis on, and understanding of, the human factor both among those who govern and who are governed, which marks these attempts to analyse the problem to-day and to present some approach to a solution.

TREES IN PROSE AND PICTURE

Handbook of the Trees of the Northern States and Canada, East of the Rocky Mountains

By Romeyn Beck Hough. Pp. x+470. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 28*s*. net.

Trees for Town and Country

A Selection of Sixty Trees suitable for General Cultivation in England. Prepared for the Association for Planning and Regional Construction by Brenda Colvin and Jaqueline Tyrwhitt; with drawings by S. R. Badmin. Pp. 132. (London: Percy Lund, Humphries and Co., Ltd., 1947.) 25*s*. net.

INTEREST in trees has increased with the augmented interest in gardening, while the recognition of the merits of roadside planting and the amenity value of trees in the modern vast conurbations has developed the need for more information concerning the exotic species. Moreover, the shortage of timber supplies has involved the economic exploitation of a wider range of species for many purposes and thus stimulated interest in them from other aspects.

Mr. Hough's handbook of the trees of the northern United States and Canada is chiefly notable for the excellent illustrations and the thought devoted to their preparation. This work deals with twenty-three species of coniferous trees and one hundred and eighty-five broad-leaved species. Each of these is illustrated by means of photographic reproductions of the foliage and fruits, the winter condition of the twigs and the appearance of the trunks. For most of the species distribution maps are also provided, and in many instances a photomicrograph of a transverse section of the timber. The use of a background grid for the details and of a rule in all the photographs of trunks enables the reader to assess the scale of reduction. In view of the excellence of the illustrations it seems almost ungracious to cavil at the omission of photographs of the flowers, and the difficulty of recognizing the limits of the foot-rule in front of not a few of the tree trunks.

The book should have a wide appeal, and not least in Great Britain, where American trees have been so long cultivated and prized. To the student the descriptive matter contains much of value and interest; and a perusal of the distribution maps will recall many noteworthy features, as, for example, the large proportion—some 72 per cent—of arboreal species more or less restricted to the eastern half of North America, and the small proportion which are restricted to the western half, while a few afford examples of discontinuity, particularly the swamp species *Leitneria floridana* found as a native tree in Florida and again from Missouri to Texas. The few species confined to the western States comprise two conifers and two poplars.

Keys are provided to the genera and species, although as these depend in large part on reproductive characters their usefulness is limited. The text and illustrations of this work together constitute a valuable and convenient source of information that will be of service alike to the botanist, the arboriculturist and the forester.

"Trees for Town and Country" is a book of a more utilitarian character in which the emphasis is naturally placed upon growth and habit rather than on details of morphology. Each of the sixty species selected is illustrated by a full-page photograph. Many of these are excellent both as typifying the species portrayed and as tree portraits; but a few scarcely do justice to their subjects, as, for example, those of *Catalpa speciosa, Prunus avium* and *Carpinus betulus*, and, particularly with respect to the last-named, fail to convey their potentialities. The hornbeam is a really superb tree when allowed to develop properly, although this is too little realized because its tolerance of trimming and pollarding has so often destroyed its intrinsic merits both in winter and summer.

Each photograph is accompanied by line drawings by S. R. Badmin which are both useful and charming, representing, as they do, the details of structure, the winter appearance and the average heights of the species at various ages, so that the prospective planter can judge the space required and the probable effect on the landscape. The figures are accompanied by short notes on soil, climate, growth and cultural details.

For the tyre especially, this work should prove a very real aid in assessing the merits of the more familiar subjects; though it must be borne in mind that such selections as this suffer from the defects of their merits and may, unless used with caution, lead to stereotyped planting and failure to utilize species such as, for example, *Prunus padus, Tilia parvifolia, Tilia petiolaris,* and *Sorbus torminalis,* which though not included here, may, in certain circumstances, have a prior claim to consideration.

E. J. SALISBURY

BRAIN AND MIND

The Physical Background of Perception

By E. D. Adrian. (Being the Waynflete Lectures delivered in the College of St. Mary Magdalen, Oxford, in Hilary Term 1946.) Pp. viii+95. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 10*s.* net.

PHYSIOLOGY has been defined as the outcome of a curiosity about ourselves. Such curiosity reaches its peak in the attempt to discover what material events in the brain accompany, and might be responsible for, the conscious processes of feeling and thought. The brain–mind relation is the no-man's-land on which the theologian, the psychologist and the physiologist meet face to face. The problem is age-old, and no immediate solution is in sight. The physiological approach has, however, advanced somewhat in recent years. This has been chiefly due to the work of Prof. E. D. Adrian at Cambridge, who summarized the present position in his Waynflete Lectures at Magdalen College, Oxford, in 1946, which are now available.

Prof. Adrian starts from the point that what goes on in the brain is to a large extent determined by what comes into it from the sense organs. It is firmly established that only one type of nervous message, the standard nerve impulse, is transmitted in the nervous system. There is thus only one common form of signalling available, and the message signalled depends for its qualitative interpretation on where it has come from and where it arrives. The sense organs sensitive to one particular type of physical or chemical change are connected by their own private pathway to one particular part of the cerebral cortex, which constitutes the cortical area in which that particular sensation is perceived. Within each cortical area there is a spatial localization of the different parts of the peripheral sensory field. The cortex may thus be regarded as a sensitive screen on which is projected a map or replica of the external world as appreciated by the sense organs.

This cortical projection of sensory data is a concrete reality; it is a pattern of electrical activity which can be mapped out in considerable detail by physiological methods. The map has been fully studied in anæsthetized animals, and the main conclusions have been confirmed in man during surgical operations on the brain. There is no direct proof that the intensity and duration of a sensation are strictly related to the temporal pattern of nerve impulses arriving at the cortex, but the accumulation of much indirect evidence makes this highly probable. One important point, which Adrian's work has clearly brought out, is that the size of the cortical area allocated to a particular sensation coming from a particular part of the body is not determined by the size of the sensory field concerned but rather by the importance which that particular part of sensation has for the conscious behaviour response of the animal. Naturally this varies considerably in different species. In the pig, for example, the tactile area for the snout is quite disproportionately large as compared with that for the rest of the body and with other species. In man, the tactile area for the hand is much bigger than that for the foot.

The arrival of sensory impulses in the cortex can be studied in the anæsthetized animal; but the next stage, the inquiry into what happens in the brain after the impulses arrive, and the relation of this to mental processes, must be pursued in conscious man. Here the technical difficulty that electrical recording can, ordinarily, only be carried out through the thickness of the skull precludes any very exact localization. Nevertheless, one very important and unexpected discovery has been made. When the cortex is inactive, as during anæsthesia, in sleep or simply during inattention, there is a synchronous rhythmical activity of the cortical cells at a frequency of 7–10 impulses per second (α-rhythm). This rhythm originates in the parieto-occipital area, but extends over the greater part of the cortex. When conscious attention is given to what is seen, or when mental calculations are performed, the rhythm disappears or is replaced by a faster local rhythm. The transference of conscious attention to one particular area of the cortex appears to involve the setting free of that area from the basic α-rhythm so that it can be used by the 'mind'. The only prerequisite for the existence of consciousness seems to be that some part of the cortex, and not necessarily a large part, should be freed from the α-rhythm and so made receptive to incoming sensory messages. The mechanism which suppresses the natural α-rhythm and so causes, or allows, consciousness, does not reside in the cortex itself; it appears to originate in the upper part of the brain stem and almost certainly involves the hypothalamus.

So far a mechanistic interpretation suffices; but when we inquire how the brain recognizes and remembers things, very serious difficulties arise. For example, we know that a tune is recognized whatever its key, and a shape is recognized whatever its size and whatever part of the retina its image falls on. So it is obviously not a precise stimulation of certain nerve cells which the cortex recognizes; it must be some abstract pattern or concept which the brain in some way distils from actual sensory data and stores in its memory. Similarly, on the motor side, once a complex skilled movement has been learnt, it can be carried out, though less perfectly, with quite different muscles. Recognition and habit formation cannot, therefore, be due to the facilitation of particular nerve pathways by repeated use. On the sensory side, there must be something which abstracts the significant elements of a pattern; and on the motor side, something which converts an abstract idea of movement into an actual movement.

It is just here that all mechanistic hypotheses seem to break down, and it is in this that the brain differs from all man-made contrivances such as gun predictors, mine detonators and calculating machines. These machines respond when a certain fixed pattern of stimulation reaches a certain threshold. The brain, on the other hand, responds to an abstract pattern and is not tied to a critical threshold of stimulation. Indeed, the property of adaptation, so characteristic of the nervous system, renders it singularly inefficient in the recognition of absolute intensities of stimulation; it can only be relied upon to compare one thing with another.

This is the fundamental problem which confronts those who seek to explain mental processes in physiological terms. Adrian himself can see no immediate prospect of its solution, but he directs attention to certain ideas of Lashley and of Craik which might afford an approach. He concludes that, as contemporary physiology is unable to give a satisfactory account of any kind of mental activity, there is, as yet, no risk of its incursion into the field of metaphysics.

O. A. Trowell

MEDICAL DISEASES IN HOT CLIMATES

Memoranda on Medical Diseases in Tropical and Sub-Tropical Areas. (War Office)

Eighth edition. Pp. 396 (37 plates). (London: H.M. Stationery Office, 1946.) 7*s*. 6*d*. net.

As vast numbers of troops were engaged in campaigns in the Pacific, South-East Asia and the Middle East, it is not surprising that many advances in medical knowledge of tropical diseases were made during the last four vital years of the Second World War. Much of this new knowledge is included in the present publication.

The book comprises thirty-nine memoranda arranged in alphabetical order. New articles are included on nutritional diseases, infective hepatitis, tropical eosinophilia, leprosy and the sulphonamides.

The section on arthropod pests contains pertinent information on the various uses of *D.D.T.* in the control of both the wingless and winged pests. Its special value in the destruction of mosquito larvæ and adult anophelines, house flies and lice is emphasized. *D.D.T.*, however, was ineffective in preventing scrub typhus, and here dibutyl-phthalate applied to clothing proved the repellent of choice, as it afforded most effective protection against the larval mite vector.

An instructive account is given of infective hepatitis based on the 'Alamein Line' outbreak affecting 10,000 troops. This is followed by a consideration of arsenical and homologous serum jaundice—both of which resemble in many respects infective hepatitis. The view is accepted that both these conditions are caused by inoculation with blood or serum containing a virus or some allied icterogenic agent. The comprehensive account on cysticercosis is abridged from the classical work of MacArthur on this subject; it is now gratifying to read that the more recent follow-up of Dixon and Hargreaves shows the prognosis to be brighter than was at first supposed.

The view that secondary invading organisms play an important part in those chronic cases of amœbiasis which prove intractable to amœbicidal drugs is accepted; preliminary treatment with sulphonamides and penicillin is advocated in such circumstances.

As a result of field experience with bacillary dysentery, it is advised that all individuals developing diarrhœa should be immediately treated with sulphaguanidine. This procedure not only reduced hospitalization by preventing the development of clinical dysentery, but also eliminated carriers and cut short epidemics through destruction of dysentery bacilli in the stools.

In the chapter on malaria, some twenty-four out of thirty-six pages are devoted to treatment. Doubt is expressed whether intramuscular 'Mepacrine' can replace intravenous quinine in the urgent treatment of cerebral and algid malaria. The great value of 'Mepacrine' as a suppressive in a dosage of 0·1 gm. daily is emphasized, resulting, as it does, in the radical cure of malignant tertian malaria and the suppression of benign tertian infections. The statement is made that "its use in the 1939–1945 war gave us great tactical advantages against the Japanese—we could operate in malarious areas which they had to avoid". While the first part of this statement is undoubtedly correct, it is doubtful if the Japanese ever considered the military implications of malaria or of any other disease in their forward planning.

A valuable addition to future editions would be the inclusion of graphs based on statistical data showing the dramatic reduction in the incidence of diseases like malaria, bacillary dysentery and scrub typhus following the introduction of preventive measures and chemotherapeutic control during the later phases of the Pacific and Burma campaigns.

As stated in the preface, the aim of this book is to give medical officers something that can be more easily carried about than a text-book and yet offer in a concise form the essentials of the more important diseases of the tropics. This objective has been splendidly achieved in the eighth edition.

N. Hamilton Fairley

THE THERMIONIC CATHODE

Les cathodes chaudes

Théorie et pratique. Par Charles Biguenet. Pp. 183. (Paris: Éditions de la *Revue d'Optique théorique et instrumentale*, 1947.)

AMONG many recent books under the general heading of electronics, there has been until now no comprehensive account of the basis of the subject; the thermionic cathode. While it would not be true to say that the well-known books by Reimann, T. J. Jones or de Boer are out of date, there have been developments in the past ten years with which both the student and the technician should be familiar; none of these books was intended to appeal to the valve designer or to deal with the technique of preparing thermionic cathodes and persuading them to liberate electrons according to the mathematical formulæ. For these reasons any modern account of the theory and practice of such cathodes is to be welcomed.

In the present book there is a detailed account of those properties of tungsten relevant to its use as a thermionic cathode, which will be of considerable value to the technical reader, while the section on thoriated tungsten is almost as comprehensive. There is a discussion of the process of carburizing, which is welcome as there is little literature on this subject, while the theory of the thoriated filament is adequately covered. The section on oxide cathodes is well written, with a modern approach, and summarizes the earlier information in the light of the present ideas of the behaviour of semi-conductors. The practice of the preparation and application of coatings is described, and also their treatment; while the author presents his own theory of oxide coatings and the difference between pulsed and continuous operation. This may justify discussion elsewhere. The remainder of the book gives a short account of other types of cathode, and of associated techniques such as high-vacuum technique, eddy-current heating and the application of the electron microscope.

One statement which is surprising is (p. 70) that hydrogen raises the work function and lowers the emission from tungsten. The original observation to this effect by Langmuir was found erroneous, as discussed, for example, by Reimann ("Thermionic Emission", p. 178). There are statements where it would be helpful if an authority were quoted or if the evidence were indicated; for example (p. 100), "if the degree of carburising of a thoriated filament is less than 6%, the filament remains sensitive to traces of gas", and (p. 129) "the normal operating temperature of an oxide cathode is from 850° to 900° C.". An important omission occurs in discussing the relation between temperature and current in a thoriated filament, where no reference is made to the importance of the geometry of the filament.

These are points of detail. A general comment is that the value of the book would have been increased if further practical information had been included, possibly at the expense of the adaptations from de Boer's book on adsorption. For example, there is little actual information about the pulsed operation of oxide cathodes, and none about the pulsed operation of thoriated filaments, or of their use with high-anode voltages. There is no discussion of gettering techniques and their relation to emission development and maintenance. There is, in fact, no indication that, in practice, difficulties are frequently encountered with cathodes of all types in obtaining or maintaining the theoretical performance. Thus we are not told whether thoriated filaments do in practice give the lives predicted by Langmuir's tables, while it may cause alarm and despondency among those concerned with valve manufacture and development to read that, after a prescribed treatment of an oxide cathode, "le tube est bon à couper et son émission électronique restera stable". The matter is not always so simple, especially with modern short-wave valves requiring high-current density.

D. A. WRIGHT

ICE CREAM

The Ice Cream Industry

By Grover Dean Turnbow, Prof. Paul Hubert Tracy and Lloyd Andrew Raffetto. Second edition. Pp. ix + 654. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 6 dollars.

IT is a commentary on the trend of life that a book of nearly 700 pages should be written on a comparatively small item of diet, an item which, until a few years ago, was either regarded as a luxury or as a special treat for small children. This one item has now become the basis of one of the big food industries, ice cream manufacture, and it must be admitted that ice cream is a useful and palatable method of inducing people to take more milk. Messrs. Turnbow, Tracy and Raffetto have in this revised edition brought their earlier work, of 1927, up to date; have added chapters and rewritten chapters, and the result is a very readable compendium of knowledge (there are a number of minor and several major errors particularly in the scientific parts) dealing with every aspect of ice cream, from manufacture to salesmanship. It would be an interesting study to try to decide which author has been responsible for the various sections, for they are not all of one style, and one gets the feeling of a vision of patchwork quilt.

From the point of view of the chemist, the scientific portions are interesting; but one might question the desirability of including in a book of this nature explanations of some of the underlying scientific principles of physical chemistry. It must be remembered, however, that in the United States there are courses at universities and at technical colleges dealing with the manufacture of ice cream, and the authors state that their review of the physico-chemical properties is for the advanced student. One cannot but feel that the elementary mathematics included in the section dealing with control and standardization is a strange bed-fellow for the physico-chemical theories.

In these days of austerity in Great Britain, it is refreshing to know that on the other side of the Atlantic such a wide range of delectable sweetmeats is still to be had—plain ice creams, fruit ice creams, nut ice creams, confection ice creams, bisque ice creams, ice puddings, parfaits, mousses, and so on, to mention but a selection. To-day, in Britain, there is a welcome interest in food-borne infections, and therefore the statements regarding this danger are of particular import. One could wish that the advice given in the chapter on "Washing and Sanitizing" (!) could be brought to the notice of all manufacturers and purveyors of ice cream in this country.

Having watched children and adults in Britain eating ice cream, the following (p. 385) from the chapter dealing with the food value appears to the reviewer to be of great importance: "Too rapid eating or drinking of large quantities of ice-cold foods may be one of the factors responsible for some of the gastro-intestinal disturbances occurring during the summer months. Any discomfort from consuming ice-cold foods can be avoided by eating slowly, thus allowing the digestive system to function normally."

The survey of refrigerating practice is a concise summary of present practice and well worth study.

Everyone concerned with the production of ice cream may be advised to read this book.

L. H. Lampitt

NORTH AMERICAN ARCHÆOLOGY

Indians before Columbus

Twenty Thousand Years of North American History Revealed by Archæology. By Paul S. Martin, George I. Quimby and Donald Collier. Pp. xxiii + 582. (Chicago: University of Chicago Press; London: Cambridge University Press, 1947.) 33*s.* net.

The authors of this book open their preface by saying that it has been written for the interested layman and for students taking introductory courses in anthropology, but that it is not intended as a general reference book for professional anthropologists. It can be said at once that it is a very useful work, though the greater part of it is likely to appeal more to the specialist, at any rate outside North America, than to the classes for whom it is intended.

The book is divided into eight parts, of which the first two are introductory, the third deals with the earliest American cultures, the next four describe the subsequent North American cultures under the headings of four great natural regions, and the eighth is a concluding summary with correlations. Part 1, entitled "Background", is frankly popular, but it includes a useful summary of how the New World was populated, and a brief, straightforward exposure of a number of hoary fallacies concerning the Indian. Part 2, on arts and industries, summarizes the methods of manufacture of various materials, and ends with a most useful account of what is known about trade and commerce in ancient North America. These chapters are admirably suited to the needs of the people for whom the book was designed; but more advanced students also will read them with pleasure, and very likely with profit, since they contain some new information. Few, for example, can have known that bannerstones and other unexplained objects of slate were really weights for spear-throwers. A valuable feature of Part 3 is the outline it gives of how early cultures, like the Cochise, led up to the better-known cultures of the south-west. There was no hiatus, only a very slow development, until the introduction of agriculture and pottery provided the stimulus to more rapid change.

The next four parts constitute the bulk of the book, and archæologists outside North America, who have had difficulty in following the numerous papers which have appeared within recent years and in forming a general picture from them, will find this the most useful section. The descriptions, competent though they are, will not of themselves be sufficient for this type of reader, but he will find what he needs to supplement them in the excellent lists of sources which accompany each chapter. On the other hand, elementary students and most interested laymen will require far more illustrations to lighten and give meaning to the closely condensed pages of facts. What illustrations there are might be rather more evenly distributed; many cultures have none, but, for example, the striking art of Key Marco in Florida has two whole pages. Each culture is described so far as possible according to a uniform plan, which facilitates reference, and in each case 'conjectures' are, by a wise provision, kept under a separate heading at the end.

The production of the book is excellent, the illustrations are good, and the main culture areas are clearly shown on a map occupying the end papers. The title deserves a word of criticism; North American archæology does not end with Columbus, and fortunately the contents of the book show that the authors do not really imagine that it does. Within the limits outlined above, it is a most valuable work.

G. H. S. Bushnell

ANIMAL PARADE

Parade of the Animal Kingdom

By Prof. Robert Hegner, assisted by Jane Z. Hegner. Pp. vii + 675. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1946.) 20*s.* net.

The fact that this is the ninth reprint of a book first published in 1935 is sufficient evidence that it meets a widespread demand for a general natural history which will give in one volume some information about the modes of life and activities of various common animals. The authors have chosen representatives from each of the main phyla, arranged in order of their complexity from *Amœba* to man; but the basis of selection is somewhat original and one finds not only animals familiar in everyday life, or economically important for food, fur, etc., but also unusual animals, such as those commonly seen in circuses and zoological gardens, animals familiar in literature, prehistoric animals, and even the unicorn, werewolf, and other mythological animals.

As might be expected the greater part of the book, about two-thirds, is devoted to vertebrates, and half of the remainder to insects; but the examples are well chosen and a surprising amount of information about the remaining groups is given in short space. It should be emphasized, however, that the book is intended primarily for American readers and the complete absence of any scientific names sometimes introduces a certain ambiguity. Thus, harvest-men (Phalangids) are referred to as daddy longlegs, a term which in Great Britain is usually applied only to crane flies (Tipulids). The fur of the weasel is stated to turn white in winter, while in Britain the term weasel is reserved for *Mustela nivalis* the coat colour of which does not change in this way. In North America the term weasel seems to be synonymous with stoat or ermine.

There are 743 illustrations, but their reproduction leaves much to be desired; a certain number, including some of the Cœlenterates and Vermes, are obviously photographs of museum models; and a few are photographs of stuffed museum specimens, the gibbon being a particularly unfortunate example.

These are minor drawbacks, however, and the work can be recommended as a useful general natural history. The success of the earlier editions has made it possible for the present one to be sold at the price of twenty shillings.

Edward Hindle

Synthetic Resin Chemistry

For Students. By Dr. S. R. W. Martin. Pp. vii+160. (London: Chapman and Hall, Ltd., 1947.) 15*s.* net.

DR. MARTIN'S book is best considered as an extremely practical guide to laboratory experiments for the student of synthetic resin chemistry, interspersed with an introductory survey of the theoretical side of this complicated field. The fifty-odd experiments are novel and well chosen; and it is difficult to know where else one could find details of such an illuminating series. They are simple, they are specific, and they work. On this score the book is wholly admirable.

Nevertheless, it is perhaps not unfair to doubt whether the accompanying theoretical matter, condensed and simplified though it is, will be smoothly absorbed by the type of reader visualized by the author in his preface—the student whose chemistry is of school certificate standard. This is no carping criticism; for the difficulty is one which must be faced squarely by anyone attempting to instruct the junior student in a technological subject with organic chemistry as its fundamental basis. True, the author devotes some twenty pages to a survey of elementary organic chemistry; but this alone is likely to prove heavy fare for the young chemist fresh from a school certificate course. It would appear essential to stipulate, not merely to hope for, "an elementary knowledge of organic chemistry" as a proper basis for the appreciation of the book. Taken, however, not on its own, but as an accompaniment (or, better, as a sequel) to a systematic elementary course in both aliphatic and aromatic chemistry, the book will be an invaluable guide to the embryo surface-coating technologist.

It may be hoped that in any subsequent edition the author will broaden slightly his title and terms of reference so as to include the cellulosic materials. As it stands, the book is useful only to the student in that section of the surface-coating industry dealing with phenoplastics, aminoplastics and alkyds: expanded slightly, its usefulness would extend to workers in all sections of the field.

P. D. RITCHIE

The Framework of Human Behaviour

By Dr. Julian Blackburn. (International Library of Sociology and Social Reconstruction.) Pp. viii+158. (London: Kegan Paul and Co., Ltd., 1947.) 12*s.* 6*d.* net.

THIS book, presenting in small compass an extraordinary mass of learning and research, the research of others being amply acknowledged, deals, as the title says, with the framework of human behaviour. That framework connotes the equipment with which any person is endowed before he begins his individual development in society. Part of this endowment is due to hereditary factors, and part to the kind of environment in which he has been born. In this book, by no means the author's first production on the subject, he considers the part played by heredity and environment in the physical and mental make-up of individuals, and the part played by sex and racial differences. He then goes on to discuss the behaviour of groups, national and social, and the influences by which they are motivated. The reader will need to know something of the modern psychologist's use of the word 'pattern'—definable as a complex whole, characterized by a definite arrangement or interrelation of parts; as a behaviour pattern or a pattern of brain activity, Many readers will find good use for the eighth chapter. entitled "Conclusion". The abounding references to other books are minutely careful. Dr. Blackburn has, in publishing this volume, made a substantial addition to the International Library of Sociology and Social Reconstruction.

What People Are

A Study of Normal Young Men. By Clark W. Heath, in collaboration with Lucien Brouha, Lewise W. Gregory, Carl C. Seltzer, Frederic L. Wells and William L. Woods. Pp. xvi+141+4 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1946.) 11*s.* 6*d.* net.

THIS book should be welcome if only because it deals with an unusual subject. In both Britain and the United States much time, energy and financial support have been given to investigations of the mentally and physically ill and handicapped; but little attention has been paid to well people, upon whom depend the leadership and work of the world. Yet knowledge of the normal is of great concern in medicine, education, business and government. This report is based chiefly upon the study of selected Harvard undergraduates, but groups of men in the armed forces and in civilian life have been investigated as well. Selection of college students was made on the basis of all-round good adjustment, good health and academic success. The approach is clinical. Characteristics of normal young men are described from the points of view of medicine, physiology, anthropology, mental measurements, socio-economics and psychiatry.

The authors make no pretence that this is a completed work, or that they have the answers to many important problems which they have presented. The field is a large one and much remains to be done.

One word more. We in Britain are bound to ask what about the normal young women, who are by no means content to leave all the leadership to the men, whether in medicine, education, business, or government?

Making Your Own Telescope

By Allyn J. Thompson. Pp. xi+211. (Cambridge, Mass.: Sky Publishing Corporation, 1947.) 3.50 dollars.

TELESCOPE making by amateurs has a great vogue in the United States. In association with the Hayden Planetarium in New York, there has, for almost a dozen years, been an Optical Division of the Amateur Astronomers Association. Facilities and space have been provided in the basement of the Planetarium for classes in telescope making. Mr. Thompson has for some years been the instructor of these classes and has had ample opportunity to develop and test efficient and practicable methods and to become familiar with the various pitfalls and difficulties that beset the beginner. In order to make available to a greater number of amateurs the experience that he has gained, this book has been written. It describes in some detail the methods of grinding, polishing, figuring and testing mirrors, as well as methods of correcting the more common defects, with many useful hints. The other parts of the telescope are not neglected, and descriptions are given of simple pipe mountings, the construction of which does not require much mechanical ability.

A brief account of the history and development of the telescope is given in the first chapter.

The frontispiece of the book is a picture of the author's 6-in. $f/9$ telescope, with equatorial head and tripod mounting; made in accordance with the instructions in this book, it is stated to have cost less than thirty dollars. It may be recalled that William Herschel first embarked upon telescope construction because he could not afford to buy one for himself. With the aid of this book, many a budding astronomer should be able to construct his own telescope at a moderate cost.

Aircraft Strength of Materials

By Dr. H. D. Conway. Pp. viii+256. (London: Chapman and Hall, Ltd., 1947.) 21*s.* net.

DR. CONWAY has produced a book that should be valuable to both students and designers dealing with aircraft structures, but its title is misleading. It is entirely a work on the theory of structures, its secondary connexion with aircraft being that those problems that are of most interest in that field have been chosen, and the illustrative examples are such as occur in the peculiar types of structure occurring in aircraft construction. A critic could quarrel with the author for his sins of omission rather than commission, but incompleteness is inevitable in a book of this size. Also the science of the design of aircraft structures is so fluid at present that a selection of methods is bound to be one based on the author's personal experience. This defect is most noticeable in the part devoted to the behaviour of thin plates, which might have been much fuller. Its application to Wagner beams and stressed skin construction can scarcely be avoided to-day in the aircraft world; even the engine designer is meeting it now in the internal combustion turbine.

The layout of the book is excellent and logical. The chapters follow in an ordered sequence, and are well illustrated with numerical examples, particularly useful to a beginner. The more recent methods of structural analysis, such as the Hardy Cross method, are fully explained. This alone puts the book in a class by itself so far as an aeronautical reader is concerned.

The author has the courage to say that he has not tried to avoid the use of mathematics, claiming that no serious aircraft designer could be without such knowledge, a statement with which the reviewer heartily agrees.

Electronic Theory and Chemical Reactions

An Elementary Treatment. By R. W. Stott. Second edition, revised. Pp. viii+112. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 6*s.* net.

THE development of electronic theories of the mechanism of reactions has reached a stage at which it is possible to give useful general accounts of the main features, and there are indications of a rapidly growing interest in the subject. This interest has now deeply penetrated not only the ranks of teachers of chemistry who have a regard for major theoretical developments, but also the harder core of chemists in industrial and other fields who attach greater importance to tangible applications and concrete results.

The publication of a second edition of Mr. Stott's elementary treatment will be greeted with pleasure by those who were unable to obtain a copy of the first issue. This edition is almost identical with the first (see *Nature*, **153**, 510; 1944); at a time when the prices of many commodities are rising steeply and continuously it is a pleasure to note that the old price is retained. E. D. HUGHES

Mechanical Vibrations

By Prof. J. P. Den Hartog. Third edition. Pp. xi+478. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 30*s.*

DEN HARTOG'S book combines mathematical simplicity with a rare insight into the physical nature of vibrations, and its author has a happy knack of explaining things in a way that the less gifted can understand. For these reasons, and for the wealth of information it contains, the book has long been a standard work in Great Britain as well as in the United States.

The present edition includes observations on helicopter rotors, the 'singing propeller' and oscillations of submarine periscopes. Electronic methods of vibration measurement and analysis, the damping of torsional oscillations in engine crank-shafts, oscillations excited by oil-film lubrication and 'flutter' are among important subjects which are discussed more fully in the light of recent work. This is a book of which no mechanical engineer should be unaware, and which those faced with vibration problems find of constant help. A. L. P.

Modern Assembly Processes

Their Development and Control. By J. L. Miller. Second edition revised. Pp. xii+199. (London: Chapman and Hall, Ltd., 1946.) 18*s.* net.

IN this new edition of his book, Mr. Miller has taken advantage of war-time experience to bring certain sections up to date; modern aircraft riveting practice in flush riveting and the invaluable pop riveting technique are described, for example. The descriptions of fluxes for soft soldering are considerably expanded and include recommendations for the lead/silver solders and the low-tin solders of B.S.219. Brief details are given of the newer welding processes such as Heliarc, the Elin-Hafergut process and automatic stud-welding machines. Apart from these additions, the book remains substantially the same as in the first edition and is still the only one available covering its specialized field. Mr. Miller has resisted all temptation to extend its scope, wisely preferring to restrict his words to the subjects on which his authority is undoubted. H. W. G. H.

Foundations of Chemical Theory

By Charles Simpson. Pp. viii+220. (London: University Tutorial Press, Ltd., 1947.) 6*s.* 6*d.*

THIS book aims at giving a concise account of the main principles of theoretical chemistry required for higher school certificate, intermediate science, pre-medical and first M.B. examinations, and providing a foundation for distinction and scholarship students. It actually contains rather less on many topics than is usually found in general text-books of this stage. More space is given to phase rule than is usual. A good feature of the book is the large number of questions and problems, which will provide useful exercises for students. Unfortunately, the book is marred by a number of minor errors, and in places insufficient detail is given to enable students to understand the principles of some experimental methods described. In a new edition the book should be carefully revised.

30-MeV. ELECTRON SYNCHROTRON

By D. W. FRY, J. W. GALLOP, F. K. GOWARD
AND
J. DAIN

Atomic Energy Research Establishment, Harwell

FOLLOWING earlier work on the conversion of a betatron to a synchrotron[1], a 30-MeV. electron synchrotron has been constructed and was first operated in October 1947. The machine is shown in Fig. 1, and employs a rectangular-yoke magnet, designed to give maximum space for experimental work. A more compact magnet, with eight C-shaped yokes, has also been designed by the English Electric Co., Ltd., for medical and industrial use, and is shown in Fig. 2; this magnet uses the same poles as that of Fig. 1, and should, therefore, give the same performance.

The machine has been operated so far only at 24 MeV. and at low gamma-ray intensity, because of temporary difficulties in protecting personnel. It is expected that the full output will be of the order of 10 röntgen/min. at 1 metre: the voltage will probably be a little less than the nominal 30 MeV. (see below).

Some of the techniques used in the construction of the machine are novel and will be emphasized in the brief description which follows. Details of the engineering practices used will, however, be omitted.

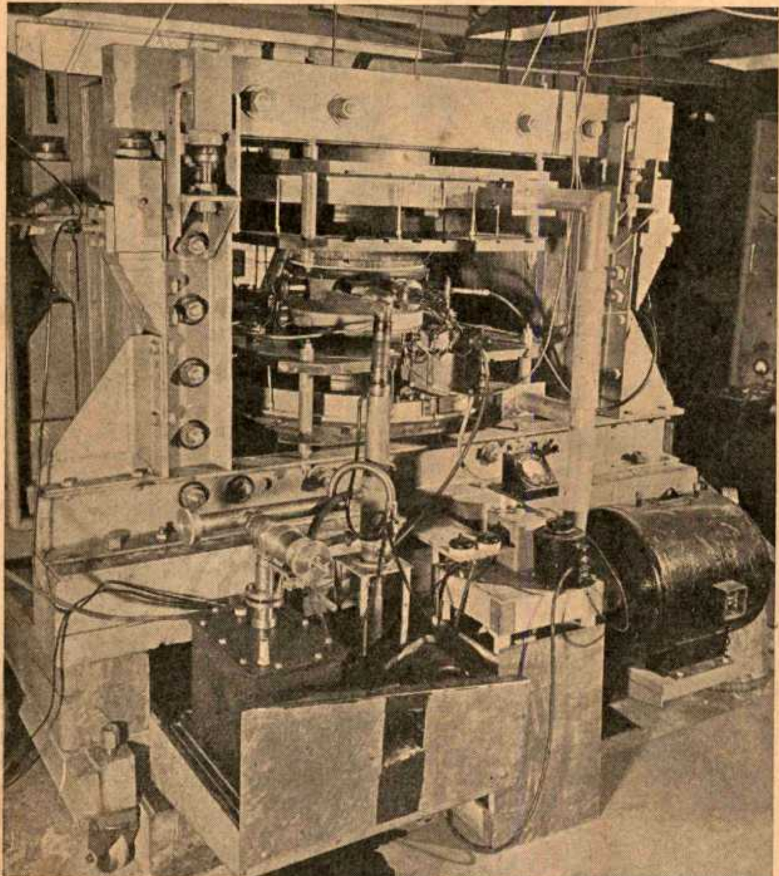

Fig. 1

The magnet of the synchrotron weighs about three tons and provides a peak field of 10,000 gauss in an annular gap of 10 cm. mean radius; the field in the annulus varies as (radius)$^{-0.7}$. The magnet is excited continuously, from the 50-cycle mains, by a resonant circuit carrying a reactive r.m.s. power of 1,500 kVa.; the losses in the circuit are about 25 kW. A betatron core is provided which accelerates the electrons to 2 MeV. (their velocity is then 0·98*c*), when the core becomes saturated. The laminations of the rectangular-yoke magnet are bent to follow the natural flow of flux, so far as is possible. This feature does not, however, achieve the desired result of reducing the normal field inhomogeneity of a betatron-type magnet. In particular the field disturbances due to eddy currents require correction, and this is achieved by inserting single-turn water-cooled coils between the pole shoes and the main pole cylinder. The coils are arranged to make the eddy-currents substantially equal at all points. The field homogeneity thus obtained, at injection, gives rise to a forced oscillation of the electron which occupies about one fifth of the space available for the electron orbits.

Difficulty has been experienced in starting-up the excitation circuit of the synchrotron, due to the change in the resonant frequency caused by the betatron core becoming saturated as the excitation increases[2]. This difficulty has been overcome by switching a portion of the condenser in and out. A variable choke has also been developed as an alternative method; this choke will be placed in parallel with the main coils of the magnet, and its inductance will be changed by a variable air-gap in its core. These methods allow for mains frequency changes as well as giving easy starting.

Two different types of 'donut' (evacuated annular chamber) have been developed and operated. For experimental purposes a 'donut' is formed from flat plates and cylinders waxed together[3]. For general use, blown 'donuts' in *F.C.N.* glass have been constructed by the Research Laboratories of the General Electric Co., Ltd.; one of these 'donuts' is shown in Fig. 3. The synchrotron just operates at a pressure of 5×10^{-5} mm., and the output does not improve as the pressure is reduced below 5×10^{-6} mm. With both types of 'donut' a pressure of 2×10^{-6} mm. is obtained consistently, with the electron gun and resonator operating; considerably lower pressures are obtained with the gun and resonator not operating. Sealed-off blown glass 'donuts' of similar design have also been used successfully.

The electrons are injected for 2 microsec., at a voltage of 10 kV. The electron gun is the standard type of Kerst betatron gun[3], which is placed on a variable mounting and is nominally at a radius of 11·5 cm.; the gun assembly is shown on the left-hand side of the 'donut' in Fig. 3.

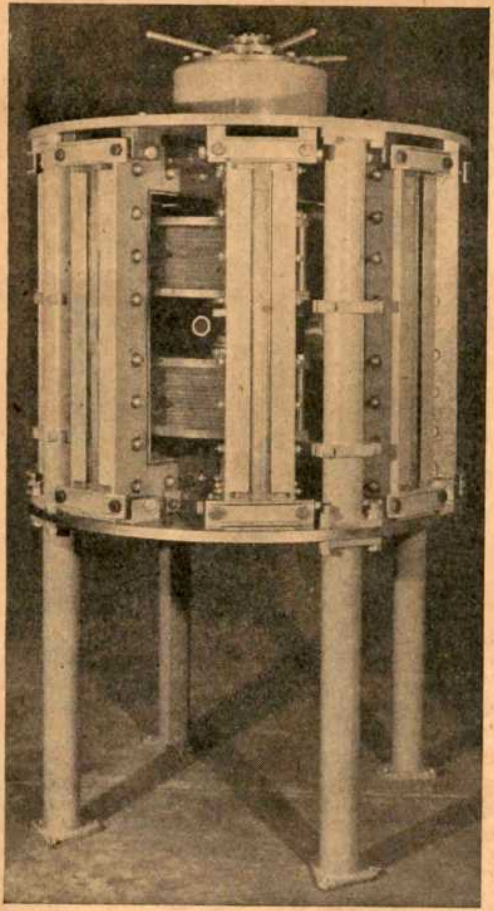

Fig. 2

The synchrotron acceleration is produced by a quarter-wave long radio-frequency resonator which is excited at 477 Mc./s. The resonator actually supplies about 10 V. per revolution to the electrons, but the voltage across its gap must be substantially greater than this, namely, about 100 V., to obtain stable synchronous operation and acceleration of a large fraction of the electrons. Some 8 watts peak power must be fed into the resonator losses to produce this voltage. In addition, power must be supplied to the electron beam to accelerate it. If the beam current in the synchrotron is assumed to be 1/100 microamp. at full output, the mean power required to accelerate this current to 30 MeV. is 0·3 watt, which means that the peak power required to be fed into the electron beam is about 2 watts. The total power required is, therefore, about 10 watts peak, and to give a safety margin 20 watts peak power is supplied to the resonator by a continuous wave oscillator and modulated amplifier. The relatively high efficiency of the resonator in this low-energy machine contrasts with the efficiency obtained in higher-energy machines, say 300 MeV., where the losses in the resonator are larger compared with the power used in accelerating the beam.

Two types of resonator have been developed, both made from high permittivity ceramic with a conducting silver coating fired on to it. The silver forms the inside and outside conductors of a coaxial line, and also forms the shorted back. A narrow accelerating gap in the inner conductor is burned by an arc. The resonators are made of Steatite and Porcelain Products Co.'s materials 'Tempradex', dielectric constant 15, and 'Faradex', dielectric constant 80. The resonators are so short that they need not be moulded to a circular shape as would be necessary with an air dielectric. The 'Faradex' resonator in particular is so small that no appreciable eddy currents are produced in it by the main field. It is therefore unnecessary to laminate it, and, further, it can be inserted into the 'donut' through a side-arm. The resonator is supported on a coaxial line which feeds it; it also has a second coaxial line attached, to monitor the voltage across the gap. The walls of the resonator are $\frac{1}{8}$ in. thick, and the internal conductor forms a rectangle 4·1 cm. wide × 2·8 cm. high; this dictates the area which is available for the electron orbits. Fig. 3 shows the resonator assembly, withdrawn from the 'donut' side arm.

The tungsten target is mounted internally and acts as a thin target. The electron orbits are allowed to shrink on to it, by switching off the radio-frequency accelerating voltage before the peak field is reached. This means that the acceleration ceases when the field at the equilibrium orbit is just over 9,000 gauss, which corresponds to an energy less than the nominal 30 MeV., namely, 28 MeV.

The switching operations required during each magnetic field cycle are the triggering of the electron gun modulator, the switching on and off of the radio-frequency, and the starting of the trace of the cathode ray tube display. This sequence was originally controlled electronically by pulses formed from multivibrators, which gave variable time delays relative to the pulse from a peaking transformer. This transformer was made from a strip of permalloy wound with a small coil and placed in the magnet gap. This system required frequent adjustment during operation, since the fields at which the switching occurred were dependent on the somewhat variable mains frequency. A system is now being used consisting of a series of peaking transformers, placed in series with the magnet excitation coils, and biased by D.C. windings to vary the field at which the pulses are produced.

A photograph of the main cathode ray tube display when the synchrotron is operating is reproduced in Fig. 4. The upper trace shows the rise of the magnetic field; its horizontal displacement is proportional to the field. The lower trace shows the falling magnetic

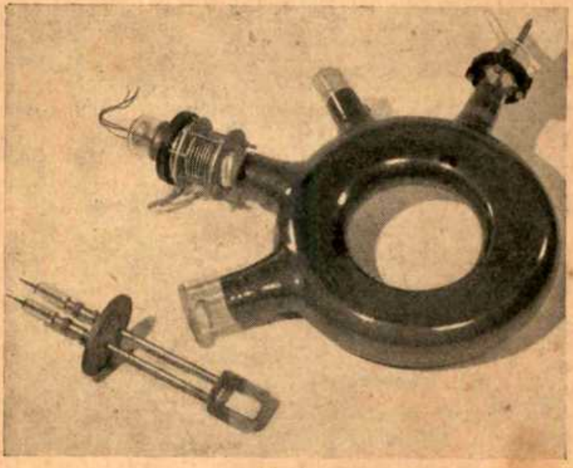

Fig. 3

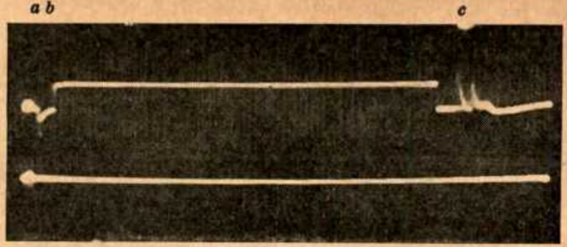

Fig. 4

field; this trace is needed when the gun is used as a target by switching off the radio-frequency at the peak field and allowing the electron orbits to expand. On the trace shown may be seen the zero field pulse, *a*, the envelope of the rectified radio-frequency accelerating voltage, *b*, and the response, *c*, from a Geiger–Müller counter placed in the γ-ray beam. The response appears as a double pulse, a phenomenon which has been already investigated on the American 70-MeV. synchrotron, which has sufficient intensity to actuate a photomultiplier tube[2].

The experimental results so far obtained with the synchrotron are qualitatively in agreement with previous results reported[1,2]. This first 30-MeV. machine will continue to be used to develop synchrotron techniques and to guide the design of the 140-MeV. and 300-MeV. synchrotrons which are being constructed. One of the later 30-MeV. machines, now in the stage of final commissioning, will be used as a nuclear physics tool by the Physics Department of the University of Glasgow. Two further machines are being built for the Medical Research Council for medical investigations. In addition, a machine has been modified to test whether a frequency-modulated synchrotron is practicable.

Acknowledgment is made of the assistance given to this project by our colleagues at the Telecommunications Research Establishment and by industrial firms and potential users of the machines. It is hoped to make full acknowledgment of these contributions in later descriptions of more specialized features of the apparatus. The work described here was carried out by the Electronics Group of the Atomic Energy Research Establishment, at the Telecommunications Research Establishment, Malvern, and acknowledgment is made to Sir John Cockcroft for permission to publish the results.

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[1] Goward and Barnes, *Nature*, **158**, 413 (1946).

[2] Elder, Gurewitsch, Langmuir and Pollock, "A 70 MeV. Synchrotron", *J. Appl. Phys.*, **18**, 810 (1947).

[3] Kerst, *Rev. Sci. Instr.*, **13**, 387 (1942).

BIOLOGY IN COLONIAL UNIVERSITIES

PLANS which are in train or which have already been carried out for the setting up of university colleges in the West Indies, at Singapore, at Ibadan, Nigeria, and in the Gold Coast, as well as for the extension of Makerere College, Uganda, give point to the parallel discussions which have been going on with regard to the content and outlook of the curriculum which should be offered in these centres of higher education for Colonial people. It has been generally agreed that subjects contributing directly to human welfare should receive greater attention than has been the case in the more ancient seats of learning in Britain; it has also been generally agreed that the subjects offered should form part of some concerted scheme. With such ends in view Dr. E. B. Edney makes out a case for the setting up in Colonial universities of single departments of biology instead of separate ones for botany and zoology[1].

Dr. Edney has had experience of Colonial education as tutor in biology at Makerere College. In his article he directs attention to the fact that many problems coming under botany and zoology are really biological; the biological approach to them is more vital and organic. For students working to 'pass' standards—and these for some time to come will be the great majority at Colonial universities—botany and zoology as taught at present, he maintains, are too morphological. One reason for this is that all human physiology is taken over by the medical schools.

So far as Colonial universities are concerned, the question may be debated in relation to three main functions: the training of teachers, applied scientists, and research workers. As regards the first it is suggested that at the school stage the aim should be to develop a biological approach built around the concept of the organism in relation to its environment. As for applied scientists, whether agriculturists, entomologists or medical practitioners, problems in the field are always biological. Training, therefore, should include instruction in biological relationships. Under present conditions such training is given only as part of vocational work.

In relation to research, Dr. Edney maintains that, in any event, a biological approach could not have a stifling effect, and that the association of workers interested in both plant and animal biology should prove a fruitful one. Fields of research like genetics, cytology and ecology are not either purely botanical or zoological, yet they are as important and attractive as any others. It might be objected that the biological approach is too general and superficial, and that concentration on the morphological and systematic aspects of the subject is necessary for developing accuracy and an appreciation of scientific discipline. The author admits that the subject of biology is far too wide to be covered adequately in a course of two or three years, but he sees no reason why accurate and painstaking work should not be done in fields which are essentially biological, while at the same time giving due weight to considerations which are chiefly morphological.

If it is agreed that the biological approach is of value, the question remains whether the subject should be presented by two separate departments or one. For a number of reasons Dr. Edney holds that the latter would be preferable. Existing departments of zoology and botany have their own distinctive flavours; while as regards examinations, if for the new Colonial universities they are to continue to be directed from London, a single department of biology would find it easier to devise and gain acceptance for its own syllabus. Where new universities are being founded, the setting up of a department of biology would be comparatively easy; where separate departments for botany and zoology already are in being, it might be advisable to allow them to continue, while working progressively towards closer union.

A point not touched on by Dr. Edney is the question of staffing. The supply of men of science with a genuine biological point of view is small and it is not likely rapidly to increase. To present at university standard a syllabus of the type envisaged would require the close co-operation of several men of science. While that would be highly desirable in itself it would not be easy to achieve. At the same time, a demand for biologists, as distinct from botanists and zoologists, would have repercussions on the universities in Britain which in the long run would be likely to be salutary.

As an appendix to his article, Dr. Edney has drawn up a three-year curriculum in biology to pass-degree standard, which may be obtained on application.

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[1] *Biology and Human Affairs*, 13, 111 (1948). (British Social Hygiene Council (Inc.), Tavistock House North, London, W.C.1.)

EDUCATION IN MYCOLOGY

THE first duty of Prof. A. E. Muskett as president of the British Mycological Society for the ensuing year was to preside at the discussions of the Society on "Mycological Education" at its meeting on January 31. In the first paper of the session, "The Society and Mycological Education", Dr. G. C. Ainsworth reminded us that mycological education is implicit in many of the activities of the Society, not the least of these being the annual foray where amateur and professional mycologists forgather for a week of intensive study of fungi collected on daily excursions. This club meeting has done much to keep alive the "tradition of species". By its report on "The Need for Encouraging the Study of Systematic Mycology in England and Wales" printed, but not published, in 1944, and by its subsequent report on "The Teaching of Mycology" printed in 1946, but again not published, the Society focused attention on the dearth of trained mycologists and of systematists in particular, and on the need for detailed consideration of, and early action to secure, the adequate training of mycologists in the diverse fields in which present-day conditions require their services. The discussion afforded the exchange of views on the question of mycological education between mycologists of widely different interests.

Admitting that the topic of education for a specific career is always a difficult subject to review, Dr. W. G. Keyworth, in presenting the case of "Mycology for the Plant Pathologist", outlined the present course of training of a plant pathologist during the study for his initial degree. Here mycology is treated in the same way as other aspects of botany, emphasis being placed on those families showing features of taxonomic interest. Research on a specific and often rather limited field of investigation usually followed before the plant pathologist embarked on his career as an adviser or as a research worker. Valuable as the present system is, Dr. Keyworth considers that continued study of general mycology after taking a first degree is of paramount importance. This study should not only include pathogenic but also saprophytic fungi, should involve a consideration of the Fungi Imperfecti, should deal with the study of the fungi *in vivo* and *in vitro*, and should include an adequate treatment of the taxonomy of fungi. Thereafter, and before commencing professional duties, the plant pathologist destined to become an adviser might gain experience in field recognition of diseases at an advisory centre, and the plant pathologist following research work as a career might gain experience in research methods and technique as applied to pathogenic fungi. Dr. Keyworth concluded by suggesting that postgraduate courses should be instituted, and that these might well lead to a diploma or to a higher degree which could be the accepted hallmark of a sound preliminary training.

The absence of courses which completely cover the requirements of industrial microbiologists was emphasized by Dr. F. D. Armitage during his paper on "Mycology and the Industrial Microbiologist". Certain microfungi are studied as examples of moulds in courses of bacteriology, but to obtain a working knowledge of systematic mycology the microbiologist must depend on private reading of current literature —a task almost impossible without some expert guidance. He suggested that the Society might use its influence to create a school of mycology which would develop a course suitable for mycologists in industry, paying particular attention to mycological technique, to the maintenance of culture collections, to the sampling methods applied to mycological analysis, to the study of inhibitors and to the principles of taxonomy. Failing this, the Society might organise, and later publish, a series of lectures designed for those commencing the study of microfungi. He was certain sound mycological education is a vital problem at the present time.

During his paper on "Mycology for the Medical Practitioner", Dr. I. Martin Scott suggested that the practitioner's lack of intimate knowledge of this branch of science was due to the overloaded curriculum of the present degree and to the lack of facilities for graduate studies. Normally only a single lecture is devoted to pathogenic fungi during undergraduate courses, and in public health studies only a short course on medical mycology is available. The remedies are obvious: future undergraduates should receive systematic instruction in mycology, as they do now in bacteriology, and graduate schools for further study and for research should be established. Close collaboration between medical practitioners and mycologists is essential in this field.

The case for "Mycology for the Amateur" was ably presented by Mr. J. M. B. King, who stated that the Society offers the best place for the amateur, who takes his mycology seriously, to obtain that advice and guidance which the personal experience of its members, obtained by the study of fungi in the field, can give. The Society could further aid the amateur by sponsoring books written in as non-technical a language as possible containing adequate keys, colour charts and fully documented glossaries of necessary technical terms. He believed that periodic publication in its *Transactions* of articles dealing with the fundamental features of fungal structure, with the principles of classification and with taxonomic problems would be appreciated. Efforts might be made to increase the number of forays and of meetings of general interest, some of which might be demonstrations of named specimens similar to that recently held.

Dealing with "Mycology and the Universities", Prof. C. G. C. Chesters stated that the orthodox training in mycology was obtained within the scope of an honours degree in botany, the fungi being treated as a section of the Thallophyta. He believed that the fungi should be removed from this phylum and might be treated as a separate discipline within the confines of botany. Since mycology must be based on a knowledge of the living fungus, collection of material in the field must play a large part in any well-balanced course, which must also include the study of the physiology, the genetics and the technique of cultivation of fungi *in vitro*. Graduate studies of a more detailed character should precede research investigations. Suggesting that there might well be a place for a more heterodox training in mycology, he outlined a course for an honours degree in which, during the years subsequent to intermediate studies, chemistry, botany (excluding the fungi) and mycology should be studied as parallel courses for two years and should be followed by a final year devoted entirely to mycology. The principles of bacteriology should be introduced during initial studies in mycology.

Mr. L. M. J. Kramer, speaking on "Mycology in Relation to Schools", said that it was mainly during study for the higher school certificate or the university entrance examinations that the implications of mycology and the future openings for those able to undertake the necessary training could be presented to the scholars. Teachers would appreciate articles on simple laboratory exercises, on current trends in mycological studies and on openings for mycologists, as well as details of the necessary training, in such journals as the *School Science Review*.

In the discussion which followed the papers, Dr. Wilkins supported the separation of mycology from botany and hoped that the Society might influence university opinion to recognize mycology as a special subject for study. Dr. J. Ramsbottom considered that Mr. Kramer's suggestion that there was a lack of trained science teachers raised an important topic and stated that, while he would not enter the argument for or against mycology being taught as a discipline separate from botany, it was essential to realize the great development of mycology during the past few years. Progress in teaching industrial mycology is slow at present but nothing can stop the development of this line of study. The hope for medical mycology lies in the fullest co-operation of the mycologist and practitioner. He believed the possibility of a bulletin for amateurs sponsored by the Society might be considered. Mr. Large pointed out that plant pathologists had to be more than professional mycologists and that there was a decided lack of good drawings and simple descriptions of fungi. Dr. Wood was against any separation of botany and mycology and emphasized that plant pathologists had to be botanists. Dr. Cook believed that botany was outgrowing itself, that the difference between green plants and fungi was fundamental and that there was a place for a specialized mycology course following a general degree with botany as one of its subjects. Dr. Prentice deplored early specialization and considered that specialized graduate studies should follow a liberal first degree course. Dr. Keyworth thought a degree in botany was of fundamental value and that the necessity of a lengthened period of training by the introduction of postgraduate courses must be considered.

Reviewing the papers and the subsequent discussion, Prof. C. T. Ingold reminded members that the Society had developed from a field club to assume the lead in mycological thought in Great Britain without losing the essential characters of a field club. Its reports demonstrate its vital interest in adequate provision for mycological education and its encouragement of taxonomic studies. Believing that the greatest weight should be placed on special postgraduate courses, Prof. Ingold referred to the present contribution of individual departments and suggested that industrial mycology might be established at technical colleges and, when medical education is reorganised, a place should be found for medical mycology. He considered that fungi should be treated outside the Thallophyta and that a reunion of bacteriology and mycology would be advantageous. Additional literature on the systematic side is urgently required. Prof. Ingold concluded by suggesting that the Committee of the Society which dealt with the teaching of mycology might continue its deliberations in the light of these discussions and might consider the institution of special series of lectures on mycological topics.

CHARLES G. C. CHESTERS

A TRIBUTE OF INDUSTRY TO SCIENCE

A SPECIAL meeting of the Industrial Research Committee of the Federation of British Industries was held at the Royal Institution on March 19 in honour of Sir Robert Robinson and Sir Edward Appleton, who received the Nobel Prizes in 1947 for Chemistry and for Physics, respectively. Sir Frederick Bain, who presided, pointed out that not since 1904 had the prizes for chemistry and physics both come to Great Britain undivided and undisputed, although since 1901 Britain has had no less than thirty-six Nobel Prize awards in the five different categories. He described the meeting as a whole-hearted demonstration by British industry of pleasure at this authoritative recognition of the work of Robinson and Appleton, who now shared the distinction of Sir William Ramsay and Lord Rayleigh in 1904, and also a sincere recognition of what industry owes to science as represented by them. Sir Frederick said that he had been privileged to work intimately both with Sir Robert and Sir Edward, and that during the War we had learned how the scientist and industrialist could work together for a common objective. Great scientists could be effective men of affairs, and through the example and devotion of men like Robinson and Appleton, Britain had become, in war as in peace, not only a country of the questing mind and free experimental approach but also, above all, a place for sharing ideas, improvisation in emergency and effectiveness in application of scientific work.

Sir Robert Robinson, in a brief address on the "Scope of Organic Chemistry", referred to the way in which contact with industry has enriched our knowledge of organic chemistry, to the great stimulus which the study of complex molecules has given to organic chemistry and conversely to the contribution of organic chemistry to the development of the biological sciences. After referring to the opportunities for co-operation between different scientific workers afforded by such fields as catalysis and polymerization, and to the evolution in the last twenty years of the industry of aliphatic chemicals, Sir Robert stressed the national importance of organic chemical industry. In this connexion he urged the extension of facilities for research in organic chemistry and stressed the function of the universities in training research workers. For that function to be discharged effectively, parallel with the growth of industrial research laboratories and the expansion of technical colleges, there should be higher salaries for science teachers and the enlarging and modernization of university departments.

Sir Edward Appleton's address, "The Scientist in Industry", discussed in greater detail some aspects of the balance of the scientific effort of Britain now that it has recovered from the distortion due to our war effort. That effort, and particularly the development of the atom bomb, illustrated the rapidly increasing momentum of scientific and technical progress and the way in which the lag between scientific discovery and its practical application can be decreased. Sir Edward, emphasizing the importance of avoiding any segregation of our research effort whether in the universities, in Government departments, or in industry, said that while in the university, where fundamental scientific research is mainly conducted, the only discipline is that of science itself, in Government and industrial research there is the further discipline of specified objectives, wide though these may be. The more liberally the restrictions imposed by the nature of the organisations which such scientific workers serve are interpreted, the better the scientific health of the men who work in them. Sir Edward then spoke of the broad lines of policy pursued by the Department of Scientific and Industrial Research, and of the necessity of a wise use of men of science in industry. He attributed our success in the War very largely to the mutual understanding which developed between the General Staff, the scientific workers and those responsible for production; and we need in peace the same sense of partnership between management, scientific men and other workers in industry. Commenting further on the importance of the human aspects of the scientist's work, he urged that the discipline of science should result in complete impartiality in interpretation, and that the scientific worker should make his own contribution to the simplification of managerial decision, and particularly by clarity in expounding the results of his work. He described 'operational research' as meaning the application of scientific methods to the quantitative estimation of the effect of the changes in all kinds of factors which might influence industrial efficiency; and he said that, while industry before the War had often sought in this way to obtain reliable data as a basis for executive decisions, such methods could be of particular value at the present time in enabling science to contribute effectively to the increase of national productivity. The research associations are admirably fitted for such work.

The scientific worker in industry, Sir Edward said, has three principal functions: first, to provide a scientific service for his firm or industry; secondly, to carry out research aimed at devising new or improved processes, goods and materials; and thirdly, to contribute to the world's stock of scientific knowledge. He believed that what scientific workers value most is the good opinion of their scientific colleagues, and it is impossible for them to feel they can acquire and retain this if their work is so circumscribed and limited in outlook as to cut them off entirely from the main stream of scientific progress. What matters most is not money and equipment, but men and leadership—above all, leadership which understands men.

Sir William Akers, in a tribute to Sir Robert Robinson, spoke of the extreme elegance of his methods as the distinguishing characteristic of his work on complex organic molecules ranging from the anthocyanins and alkaloids to the sterols, in which he had made organic chemistry a branch of physical chemistry. His approach and methods in dealing with a problem were of intrinsic beauty, and this elegance was matched by his personal modesty. Sir William Larke, in a tribute to Sir Edward Appleton, referred not only to his work on the exploration of the ionosphere and his contribution to the development of radar, but also to his fine and human leadership of the Department of Industrial and Scientific Research. Sir William particularly welcomed Sir Edward's reference to the importance of exposition and interpretation, and to the view of operational research as a normal function of management. It was most fitting that the meeting should be held in the Royal Institution, where Faraday and others had carried out so much work upon which industrial development was based.

A complimentary dinner was given by the Federation to the two Nobel prize-winners that evening, and there were present the Prime Minister, the Lord President of the Council, the Minister of Food, the Minister of Fuel and Power, Lord Samuel, Lord Hankey, Lord Addison, Lord Cherwell and Sir John Anderson, the High Commissioners of New Zealand, India, Canada, Australia and Eire, and many other public men. The Prime Minister proposed a toast to the two guests of honour, saying that the recognition by the Federation of British Industries of the work of these two great men of science showed that the Federation appreciates the vital necessity for Britain to use to the full the resources of science if we are to hold our own in the modern world—and, he added, we are going to hold our own. He believed that industry is more alive than ever to the value of fundamental research, and he paid a tribute to the work of the Department of Scientific and Industrial Research. He hoped that the National Development Corporation would help to fill any gaps in the development of scientific discovery to full-scale production, and while the award of the Nobel Prizes to Sir Robert Robinson and Sir Edward Appleton showed that we are recognized as in the front rank in the field of science, he believed that Britain still has an immense contribution to make to the progress of the world.

Sir John Anderson, who seconded the toast, dealt more particularly with the scientific achievements of the two prize-winners, and stressed the importance of Sir Edward Appleton's work for radar during the War, and of Sir Robert Robinson's work for the supply of drugs and medicinals in the First World War. Sir Robert's rise to fame, in fact, coincided with the rise of the organic chemical industry in Britain, and Sir John remarked that while Britain has often led the world in fundamental science, we have not been quite so good in following up fundamental discovery.

Sir Robert Robinson, in responding to the toast, paid a warm tribute to the work of the many colleagues associated with him in his researches over the last forty years, among whom Lady Robinson had already been mentioned by the Prime Minister in a charming little tribute. Sir Edward Appleton, who also replied, said that in looking back over twenty-five years of research, he could not recall any sudden flashes of insight, although there had been many exciting moments. He reminded his audience that really great achievements are sometimes accidental and unintentional, and we should not be concerned exclusively with the material consequences of science. Science enlarges men's minds and could bring home to everyone the wonder and significance of the world in which we live. Science-teaching in our schools and universities should be far more than merely vocational training. In the international sphere, science means knowledge, and knowledge means power. Like other men, the scientific worker is deeply perturbed and morally concerned about the use or misuse of scientific knowledge. Atomic energy, for example, in itself threatens no one; but the possible use of atomic energy by nations prompted by hatred, envy or fear brings a new apprehension in our lives. The problems raised by this challenge are not for the scientific worker alone, though he has a right to his own views as a man of science; and Sir Edward stoutly supported a scheme of adequate international control at the present stage of the world's moral development, even while looking forward to a world in which such control would be unnecessary.

OBITUARIES

Sir Charles Grant Robertson, C.V.O.

Sir Charles Grant Robertson, who had been principal and, after the amendment of the University Charter in 1927, vice-chancellor of the University of Birmingham from 1920 until 1938, died at his home at Ringwood in Hampshire on February 29. Born in 1869, he passed from Highgate School to Hertford College, Oxford. There he had a brilliant career, being elected a fellow of All Souls in 1893. At Oxford he earned a reputation as a distinguished historian. In 1920 he was appointed principal of the University of Birmingham, to succeed Sir Oliver Lodge, the first principal, who had retired in 1919.

On the outbreak of war in 1914, the main buildings of the University of Birmingham at Edgbaston were immediately taken over by the War Office and converted into the First Southern General Hospital, and what was left of staff and students was scattered to various crowded and inadequate quarters in the city. At the end of the War in 1918, the problem of reconstruction was immense. The buildings had to be cleared and restored to their proper functions and a battle had to be waged with the War Office for the cost of reconversion. Many temporary huts had to be erected to accommodate the flood of undergraduates surging in after demobilization, staffs had to be increased and money had to be raised. The University was heavily in debt and new and costly buildings were essential. An appeal for half a million pounds was therefore launched. The new principal used his remarkable powers of eloquent persuasion, both in public and in private, to great effect, and soon large sums came in from generous Birmingham benefactors, and some of the much-desired ideals became realities. The new Biological Block was built; to the department of chemistry was added the Hills Chemistry Block; and through the munificence of Sir Charles Hyde the Hall of Residence (Chancellor's Hall) and the Students' Union came into being. Sir Charles Grant Robertson used his organising abilities to get a better balance between the faculties by the development of the Arts side and extending the Library. A faculty of law was established, with a chair endowed by Mr. Henry Barber.

Another project dear to the heart of the principal was the building and endowment by Lady Barber, in memory of her husband, of the Barber Institute of Fine Arts. This Institute, which has a beautiful music room in addition to its picture galleries, provides the students with rare opportunities for cultural education outside the routine courses. Behind all this development was always the energetic personality of Sir Charles.

But perhaps the greatest and most far-reaching of Sir Charles' activities was his advocacy of the Hospitals Centre, with an associated medical school. For thirteen years he laboured unceasingly as chairman of the Hospitals Centre Committee with a generous, energetic and resourceful band of fellow citizens, and finally had the satisfaction of seeing the completion (or, perhaps more exactly, 'the end of the beginning') of their work in the form of the great Queen Elizabeth Hospital, in front of which extends the magnificent building of the Medical School, a visible monument to the solidarity of the University and the City. The persistent energy with which Sir Charles Grant Robertson worked for the advancement of the University of Birmingham in all its branches has left an abiding mark on the great city of whose long line of great 'peaceful invaders' he was not the least.

G. A. Shakespear

Mr. Griffith Brewer

By the death of Mr. Griffith Brewer on March 1, the fraternity of aeronautical pioneers has lost a well-beloved and much respected friend. Brewer was born in London in 1867 and was by profession a patent agent. For nearly sixty years his chief interest lay in aeronautics, and he was not only an authority on aircraft patents but also a notable balloonist and, later, an aviator who bore the distinction of being the first Englishman to fly in an aeroplane—as a passenger with Wilbur Wright in 1908. Abroad, he was perhaps best known for his work and friendship with Wilbur and Orville Wright and, in particular, for the part he played in the so-called 'Wright–Langley controversy'.

Griffith Brewer was a man of marked integrity and courage; he displayed these virtues to the full when investigating and exposing the claims made in respect of Prof. Langley's 'aerodrome' after its reconstruction and flight in 1914—claims which he regarded as damaging to the credit of the Wright brothers. He was instrumental in 1928 in obtaining the original Wright aeroplane of 1903 for exhibition in the Science Museum, London, as a further step towards securing unqualified recognition of the Wrights' achievement. This recognition is now happily established and shortly to be confirmed by the return of the machine to the United States for preservation in the National Museum at Washington. His vindication of historical truth in that issue is likely itself to pass into history. In 1913, Brewer was entrusted with the formation of the British Wright Company to administer the Wright brothers' patents in England.

Brewer obtained his pilot's licence at Dayton, Ohio; in 1933 he gained a licence for flying autogiros. He served for many years on the Council of the Royal Aeronautical Society, of which he was a past-president; and in 1912 founded the Society's Wilbur Wright Memorial Lecture. His gentle presence and kindly nature will be missed there. M. J. B. Davy

We regret to announce the following deaths:

Prof. A. S. Eve, C.B.E., F.R.S., emeritus Macdonald professor of physics in McGill University, on March 24, aged eighty-five.

Prof. M. C. Potter, emeritus professor of botany in the University of Durham since 1925, on March 9, aged eighty-nine.

NEWS and VIEWS

Sexcentenary of the University of Prague

THE decree of Charles IV, king of Bohemia, founding the Universitas Carolina, now the University of Prague, was dated April 7, 1348. Its sexcentenary was to have been celebrated by an international gathering; but events in Czechoslovakia have led to the withdrawal of acceptances of invitations by universities of Britain, on the ground that the University no longer enjoys its academic freedom. Charles' decree appointed the archbishop, Arnošt of Pardubice, as chancellor and stipulated that it should "serve the cultural needs of the Bohemian people, that they should no longer beg at foreign tables but have a worthy feast brought to their own table". At first, instruction was in Latin, and being one of the few educational centres it attracted many German and other students. During the rectorship of John Hus at the beginning of the fifteenth century, the Czechs were outvoted in administrative appointments. This led to the famous Kutná Hora decree of King Wenceslas, in 1409, giving the Czech 'nation' three votes and the others (German, Polish and Silesian) one each, an action that led to the departure of the Germans and hastened the founding of the University of Leipzig in 1411.

Religious matters often dominated university life, and many *magisters* found themselves against ecclesiastical and royal authority, especially after the advent of the Habsburg rulers in 1526. The botanist, Zaluzianský, was rector about 1600 and tried in vain to secularize the University; when the Czechs lost their independence in 1620, Ferdinand II installed Jesuit teachers and it became the Charles-Ferdinand University. A long period of stagnation followed, but eventually it regained some of its earlier significance, and during the nineteenth century several professors achieved world-wide reputations. Czech was again used by some, and in 1882 the University was divided into Czech and German institutions. These endured through the period of the first republic until Czech higher educational establishments were closed by the Nazis in 1939. The Charles University reopened in 1945 and had to cope with six years accumulation of students and with teaching staff depleted through age and executions. In the present academic year there are altogether 23,977 students (including 5,423 medical, 4,977 philosophy, 2,181 science) and provision has been made for research work in practically every subject.

Duddell Medal of the Physical Society: Dr. R. J. Van de Graaff

THE Duddell Medal for 1947 of the Physical Society has been awarded to Dr. R. J. Van de Graaff, of the Massachusetts Institute of Technology, in recognition of the invention and development of the high-voltage electrostatic generator already known by his name. To Van de Graaff belongs the credit of making a type of particle accelerator based on the simplest possible conception. Electric charge, sprayed on to a moving belt, is carried into a sphere, acting as a Faraday cage, until the potential rises to the desired value. The full potential to be applied to the particles thus exists between the sphere and the earth, and the great practical difficulty is to avoid discharges at undesired positions and corona losses. Van de Graaff overcame all these difficulties and so long ago as 1937 he exhibited at the Paris Exhibition an apparatus producing 4,000,000 volts. Sets for 10,000,000 volts have more recently been built and operated successfully. Dr. Van de Graaff will receive the Medal at a meeting of the American Physical Society in Washington, D.C., on April 29; the presentation will be made by the British Ambassador, Lord Inverchapel.

Chemistry at University College, London: Prof. E. D. Hughes

RECENTLY the Chemistry Department of University College was reinforced on the side of inorganic and physical chemistry by the addition to the staff of Dr. Kathleen Lonsdale; now organic chemistry in the Department is to be strengthened by the appointment of Prof. E. D. Hughes to the additional chair of chemistry which the Senate of the University has just created. The other professors in the Department are Prof. S. Sugden and Prof. C. K. Ingold. Prof. Hughes was originally trained in the University of Wales. His first researches were carried out during 1927–30 at Bangor under the leadership of the late Prof. Kennedy Orton and Dr. H. B. Watson. In 1930 he went to London to work with Prof. Ingold at University College, and in 1934 joined the staff of that College. There he formed an active research group, closely integrated with that of Prof. Ingold. In 1936 he received the Meldola Medal, which is awarded for the most distinguished chemical work carried out under the age of thirty. In 1943 he was appointed professor of chemistry at University College, Bangor, thus succeeding to a chair which his former master, Prof. Orton, was the first to make famous.

Prof. Hughes is distinguished for his researches on the mechanism and kinetics of organic reactions, particularly in relation to substitution and elimination. He discovered and firmly established the unimolecular forms of these reactions, and made many extensions of these basic observations, for example, to the elucidation of the multiform mechanisms of carboxyl esterification and hydrolysis, and to the clarification of the conditions for the Walden inversion. In these studies he has made considerable use of both radioactive and non-radioactive tracers: the stills at Bangor for the production of heavy oxygen are probably the most powerful in existence. His most recent work refines the concept of steric hindrance, provides direct evidence concerning the formation and stability of the nitronium ion and its role in nitration, and defines the mechanisms operative in anionotropic change. He has published more than ninety original papers.

Geography at Bedford College, London: Mr. Gordon Manley

MR. GORDON MANLEY will go to the newly created chair of geography at Bedford College, University of London, with wide experience of university life in Britain and as an acknowledged authority on climatology. Mr. Manley graduated at both the Universities of Manchester and Cambridge, where he was an exhibitioner of Gonville and Caius College, and he has held university posts successively at Birmingham, Durham—as first head of the Geography Department—and Cambridge. His interests in the meteorological aspects of snow-cover may have derived from his enthusiasm for the Pennines and the Lake District as a keen mountaineer and rock climber as well as geographer. A visit to East Greenland as a member of Mr. J. M. Wordie's expedition of 1926 confirmed these interests. More recently he has analysed long-period temperature records in the north of England and revealed the gradual warming of our winters since 1820. The close resemblance between these changes and those for Stockholm suggests that this matter is of far more than local significance. In these early records Mr. Manley sees a valuable source of information that may throw light on the greater climatic changes of the Pleistocene Ice Age. Mr. Manley is, too, a keen but balanced advocate of the geographer's contribution to meteorology. This was the theme of his second presidential address to the Royal Meteorological Society. The Buchan Prize in 1943, the Symons Lecture in 1944, and the Murchison Grant of the Royal Geographical Society in 1947, all marked Mr. Manley's contributions to climatology; but his papers also include other branches of geography, particularly the history of cartography. Mr. Manley remained at Cambridge long enough to see the University give somewhat belated recognition to meteorological studies by setting up a Meteorological Committee, of which he was the first secretary.

Iron and Steel Institute Awards

The Council of the Iron and Steel Institute has made the following awards: Bessemer Gold Medal for 1948, to Mr. W. J. Dawson, formerly of Hadfield's, Ltd., in recognition of his contributions to the development of steel castings and to the production of alloy and heat-resisting steels; Sir Robert Hadfield Medal for 1948, to Mr. A. Preece, reader in metallurgy in the University of Leeds, in recognition of his researches on the scaling and on the overheating and burning of steel; Williams Prize for 1947, to Mr. R. Fowler, of Richard Thomas and Baldwins, Ltd., for his paper on "Blowing out a Blast-Furnace", printed in the *Journal of the Iron and Steel Institute*, **155**, 513 (1947). The presentations will be made on May 5 during the annual general meeting of the Institute.

American Institute of Biological Sciences

An American Institute of Biological Sciences has recently been established. The rapid advance of the biological sciences and their impact on human welfare have created new problems relating to the development and application of those sciences. During recent years many biologists have recognized that the biological sciences suffer from the lack of a service organisation, which would help "the various biological societies to discharge more effectively those functions which are of common concern to them all, but which they cannot adequately exercise as individual societies." The new organisation is designed to fill this need as well as to serve the biological sciences in other ways. A governing board has now elected the officers and an executive committee. Recognizing the potential importance of this new undertaking for the advancement of the biological sciences, and through them for all biologists, the U.S. National Research Council has not only endorsed the programme, but has also agreed to make available the general services of the Council. As a part of the National Research Council, the Institute will also provide biologists with an agency through which they can maintain close relations with governmental activities and with other fields of science represented within the Council.

The Fall Webworm of North America in Europe

Dr. Paul Surányi, University of Agricultural Sciences, Budapest, states in a letter that the first specimen of the moth of fall webworm (*Hyphantria cunea* Drury) to be caught in Europe was found in the vicinity of the Danubian Free Port of Budapest in 1940. Hitherto it has not been observed outside the United States and Canada. The way it has increased shows that its caterpillar has found very favourable conditions of life in Europe. Nests of the caterpillars were first observed in 1943; since then it has increased rapidly, and during 1945–46 it did considerable damage in orchards and on various trees. It was distributed over a semicircular area with a diameter of 80 km. in 1946, which has now increased to 200 km. Indeed, this destructive insect has overrun two-thirds of Hungary, has reached the borders of Czechoslovakia and Yugoslavia, and is approaching those of Austria and Rumania. North of Budapest it is seldom observed, due probably to the prevailing north to north-west wind. Its favourite feeding-plants—the same as in North America—are *Acer negundo* L. and *Morus alba* L., from the latter of which it strips the leaves in groves and along the highways. But it feeds on all fruit-bearing and garden trees, and—what is much more dangerous—it has established itself also in the woods. Fifty-eight species belonging to different genera are known to be food plants; they include oak (*Quercus* spp.), alder (*Alnus glutinosa L.*), black locust, (*Robinia pseudacacia* L.), common stinging nettle (*Urtica dioica* L.), cabbage (*Brassica oleracea* L.), and also horseradish (*Armoracia lapathifolia* Gilibi). Two generations of the fall webworm normally hatch in a year. Its swift spread seems to be due not only to suitable conditions, but also to the fact that, so far as Dr. Surányi's experience goes, the caterpillars are seldom attacked by European parasites.

Mechanics of Packings of Granular Material

In view of the many technological fields where an understanding of the properties of granular materials is fundamental, it is surprising that there has been little systematic investigation, the present inchoate body of knowledge being derived from *ad hoc* studies. In reviewing the more recent literature, D. R. Hudson (*Machinery*, **70**, 617, 681; 1947) discusses work on packings of material in bulk carried out by investigators in the fields of geology, fuel technology, the ceramic industry, civil and chemical engineering, and powder metallurgy. This widespread interest may account partly for the diffuse study in industrial research. On the academic side the present preoccupation with the fine-structure of matter has led to the neglect of Osborne Reynolds' pioneer work on packings, undertaken in the 1890's in an attempt to provide a mechanical explanation of the universe.

Hudson's review is more concerned with the structure and characteristics of a compacted granular bed—the voidage and number of interparticle contacts and their dependence on particle size and size distribution, the relative size and the shape of the container—than with the effect on the structure of deformation of the packing, which is of especial importance in earth pressure theory, in the study of handling and conveying mechanisms and in the design of hoppers, bunkers and silos, where Reynolds' principle of dilatancy provides a key to the construction of force diagrams. Nevertheless, Hudson emphasizes the complex character of packings as opposed to the ordered structures of crystallography and the random assemblies of statistical mechanics, and implies the impossibility of deriving a satisfactory theory of packings as an extension of the geometry of ideal ordered or disordered arrangements of equal spheres.

Foraminifera

To British marine zoologists, more particularly those dealing with the North Sea area, Hans Högland's work on the foraminifera in the Gullmar Fjord and the Skagerak (*Zool. Bidrag f. Uppsala*, **26**; 1947) should prove very useful. While it includes only thirteen families of the Foraminifera it has reached formidable size, for in it are discussed in detail 133 species and varieties, and the remaining families are likely to contain nearly as many forms. It is fortunate that the author has had access to Goës' material, for it formed the basis of our knowledge of the Foraminifera in this area. Since the publication of Goës' work more than fifty years ago, a great deal has been done on this group with much alteration of classification and taxonomy. In classification, Högland has adopted a somewhat conservative attitude and has based his upon that of Cushman (1933), but he has been more drastic in the matter of nomenclature. Where the data appeared adequate the work has been carried out quantitatively, and here striking differences resulting from various collecting techniques are manifest. As an example, we have one form, *Bulimina fusiformis*, where the core sampler gave a total of 5,500 specimens and the corresponding sledge-net sample gave only thirty. It is interesting to note that the author was attracted to the study of this group from the ecological point of view, but soon realized that ecology must be based upon sound identification and taxonomy: hence the 32 splendid plates and the 303 figures which illustrate the range of variation within what the author regards as valid species.

Scientific Research in India

A REPORT has been issued, in the *Proceedings of the National Institute of Sciences of India* (**11**, Pt. 4, 161–370), of a symposium on the centralization of scientific research in India, held on July 23, 1945, which was opened by the president of the Institute, Mr. D. N. Wadia. Mr. Wadia, after referring to the necessity of taking into account the effect of a central policy on the work of various scientific institutions in India, emphasized the benefits likely to accrue from a central organisation for scientific research. Central direction should not involve too much interference or loss of independence in the pursuit of science. Dr. J. A. Dunn supported the liaison and co-ordination of research by a single member and department of a central government as the only course which could be wisely pursued, but he was not in favour of the whole of the country's research being brought under one department. He outlined a scheme for a central council for scientific and industrial research, with provincial and State councils, a committee of central scientific departments and other boards and committees as required. Dr. A. C. Ukil advocated the co-ordination of researches but without power of interference with the findings of the National Research Council, which should be the supreme central body to organise research throughout the country; no Government department, he said, should be allowed to maintain its separate research section, independent of the guidance of that Council.

Prof. J. N. Mukherjee also emphasized that the different units dealing with various aspects of research need not all be under one authority; centralization of scientific research should not mean centralized control under one government department. The autonomy of universities and other non-official institutions should not be circumscribed. Prof. M. N. Saha strongly supported Prof. Hill's scheme, as did Prof. P. C. Mahalanobis, with some warning on the danger of bureaucracy and departmentalism creeping in. He urged that the National Institute should press for the fullest possible association with the work of the proposed department of the learned societies, universities and scientific institutions. Prof. S. P. Agharkar thought that the real difficulties in India were encountered at the policy-making level. Dr. G. J. Fowler set forth points for and against centralization and urged the need for care lest organisation crippled individual initiative. Dr. Nazir Ahmad indicated some practical difficulties, but supported the co-ordination of research so as to avoid overlapping, to accelerate the pace of research and to use and to train talent to the best advantage. Dr. J. N. Roy considered that the National Institute of Sciences should concern itself solely with the availability of adequate funds for scientific research, and that the question of organisation was outside its sphere. A report of the symposium is being sent to all Departments of the Government of India with an expression of opinion from the fellows of the Institute as to the necessity of there being one Department of the Government of India concerned with the formulation of policy, determination of priority and administration of all funds earmarked for scientific research.

Radio and Electrical Research in Canada

THE National Research Council of Canada has announced the formation of a Radio and Electrical Engineering Division under Mr. B. G. Ballard. This new Division is a consolidation of work formerly carried on in the Division of Physics and Electrical Engineering, and has become necessary on account of the great expansion of research activities in the fields of electronics and electrical engineering consequent upon the advances in radio and related techniques during recent years. There are at present some 230 members of staff in the Division, including about fifty scientific personnel, and their work includes various aspects of radar, radio-physics, high-voltage electrical engineering, and the general application of electronics for military as well as for civil purposes.

Mr. Ballard, the new director of the Division, after graduating from Queen's University, Canada, obtained five years industrial experience with the Westinghouse Electric and Manufacturing Co. at East Pittsburgh. He joined the staff of the National Research Council in 1930, and has been engaged continuously in radio and electrical engineering research. His activities during the War were largely devoted to the development of mine-sweepers for enemy magnetic mines and the protection of ships against these mines; in recognition of his contributions in this field, Mr. Ballard was made an O.B.E. in 1946.

Lens-cleaning Tissues

Users of optical instruments will be interested in details just issued by Messrs. J. Barcham Green, Ltd., the well-known makers of specialty hand-made papers, of their "105 Lens Tissue". It is claimed that this tissue has a particularly high strength, and yet is thin, light and almost fluff-free. It absorbs moisture and oil films readily, and special precautions are taken to exclude grit and similar impurities. Its bulking properties are evident from the fact that 500 sheets make a pack 1 in. thick and weigh less than 10 per cent of the weight of the same area of an ordinary writing paper. A 'near miss' from perfection is claimed; however, since (according to the leaflet) it has been possible to achieve the long-sought ideal of a *p*H value of 7·0, this claim must be regarded as modest, in one respect at least.

University College, Leicester: Appointments

The Council of University College, Leicester, has announced the following appointments: Dr. A. G. Pool, senior lecturer in economics in the University of Sheffield, to the new chair of economics at the College; Dr. Z. P. Dienes, assistant lecturer in mathematics in the University of Manchester, to a lectureship in mathematics.

Physical Society's Exhibition

The thirty-second Exhibition of Scientific Instruments and Apparatus, organised by the Physical Society, will be held during April 6–9 at the Imperial College of Science and Technology, London. Discourses will be delivered on three evenings at 6.45 p.m. as follows: Tuesday (April 6), "Studio Acoustics", by H. L. Kirke (British Broadcasting Corporation); Wednesday (April 7), "Low Temperature Physics", by Dr. K. Mendelssohn (Clarendon Laboratory, Oxford); Thursday (April 8), "The Reflecting Microscope", by Dr. C. R. Burch, W. J. Bates and Mr. K. W. Keohane (University of Bristol). Films will be shown on each of the four days: "Atomic Physics" (including Friday, April 9, at 6.45 p.m.); "Physics and the Film" by the British Kinematographic Society. The Exhibition will be open at the following times: April 6, 2 p.m.–9 p.m.; April 7–9, 10 a.m.–1 p.m., 2 p.m.–8 p.m. Admission is by ticket only. Catalogues are now available.

Announcements

M. Charles Dufraisse has been elected a member of the Paris Academy of Sciences in the Section of Chemistry, in succession to the late M. Robert Lespieau.

Prof. W. T. Astbury, professor of biomolecular structure in the University of Leeds, will give the Silvanus Thompson Memorial Lecture of the British Institute of Radiology on April 16 at 8 p.m. in the Reid-Knox Hall at 32 Welbeck Street, London, W.1. The title of his address will be "The Structure of Biological Tissues as Revealed by X-Ray Diffraction Analysis and Electron Microscopy".

Lord Portal of Hungerford, controller of production (atomic energy) in the Ministry of Supply, has completed his work for the production organisation and its relation with research, both at the Atomic Energy Research Establishment, Harwell, and elsewhere. He has agreed, however, to continue to act on a part-time basis, without salary, for another year.

A conference on "The Human Factor in Industry" has been arranged by the British Association and will be held at Leamington Spa in the afternoon and evening of Saturday, May 8. Sir Henry Tizard, president of the Association and chairman of the Advisory Council on Scientific Policy, will preside at the first session, and Sir George Schuster, chairman of the Industrial Productivity Committee's Panel on Human Factors, will occupy the chair at the second. The conference will be open, without charge, to all who are interested. Further particulars will be available in due course by application to the Secretary, British Association, Burlington House, Piccadilly, W.1.

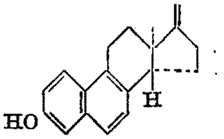
The Botanical Society of the British Isles is holding a conference on "The Study of Critical British Groups" in the Royal Horticultural Society's New Hall, Westminster, S.W.1, during April 9–10. The meeting will be held under the presidency of Mr. J. S. L. Gilmour. Further particulars can be obtained from Miss M. S. Campbell, c/o Department of Botany, British Museum (Natural History), Cromwell Road, London, S.W.7.

The Council of the Chemical Society will award grants from its research fund in June next. Applications, to be made on forms obtainable from the General Secretary, must be received on or before May 10. Applications from fellows of the Society will receive prior consideration. Attention is directed to the fact that the income arising from the donation of the Worshipful Company of Goldsmiths is principally devoted to the encouragement of research in inorganic and metallurgical chemistry, and that the income from the Perkin Memorial Fund is to be applied to investigations relating to problems connected with the coal tar and allied industries.

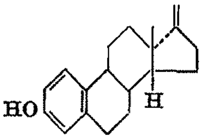
In the article in *Nature* (**160**, 250; 1947) giving an account of the International Conference on the "Emission Spectra of the Night Sky and Auroras" that was held in the rooms of the Royal Society, Burlington House, last July, it was mentioned that the papers read would probably be published in the "Reports on Progress in Physics". Pressure on space, however, prevents this, and the Physical Society has arranged for separate publication.

Prof. W. von Buddenbrock, (16) Fronhausen/L., Talstrasse 10, U.S. Zone, Germany, is asking for reprints of papers, to enable him to proceed with the preparation of vols. 3 and 4 of his "Grundriss der vergleichenden Physiologie". It is intended to translate the work into English.

Errata. Referring to the communication "The *C*/*D* Ring Union in Œstrone and Equilenin" in *Nature* of March 20, p. 434, Dr. W. Klyne states that formulæ V and VII should have been as follow and not as shown:



V. 13-*iso*, 14-*iso*



VII.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Electrical Conductivity of the Ionospheric D-Layer

RECENTLY, D. F. Martyn[1] has suggested that electric currents in the *D*-layer of the ionosphere must make a contribution to the solar and lunar geomagnetic variations roughly equal to that of the *E*- and *F*-layers. Since theoretical work on atmospheric tides suggests that the tidal motions tend to increase with height, the electric forces causing the currents can scarcely be greater in the *D*-layer than in the *E*- and *F*-layers. Hence Martyn's suggestion implies that the integral conductivity of the *D*-layer must be at least as big as that of the *E*- and *F*-layers combined. This appears to us to be improbable.

The integral conductivity of the *E*- and *F*-layers combined[2] is of order $2 \times 10^{-8} - 10^{-7}$ E.M.U. If electrons in the *D*-layer (taken to be at about 65 km.) were to produce an integral conductivity of this order, they would have to number several million per cm.^{3}. This is, of course, an impossibly high figure: to produce only a reasonable degree of attenuation in waves passing through the layer, only a few hundred electrons can be present per cm.^{3}.

If ions in the *D*-layer produced a similar conductivity, there would have to be at least 3×10^9 of them per cm.^{3}. This estimate, though large, is easily seen to be correct in order of magnitude; the ion conductivity, for a given number of ions, varies inversely as the gas-density between the *D*- and *E*-layers (that is, about in the ratio 1 : 1,000); the *D*-layer is narrower than *E*; and the *F*-layer possesses a larger conductivity than *E* unless negative ions are numerous in the latter. A density of 3×10^9 ions per cm.^{3} is difficult to reconcile with only a few hundred electrons per cm.^{3}; Massey and Bates' work on the *E*-layer[3] suggests that there can scarcely be as many as 1,000 negative ions per electron in the *D*-layer. Moreover, 3×10^9 ions per cm.^{3} are enough to reflect waves of wave-length 150 m., and to attenuate waves of wave-length greater than 35 m. to less than a tenth of their strength each time they pass through the *D*-layer. This, then, rules out the possibility of a layer of the required conductivity existing at the assumed height of the *D*-layer, that is, at about 65 km.

There remains the possibility that the conducting layer exists at a greater height, though still definitely below the *E*-layer. To get reasonable values for the attenuation of 200-m. waves the conducting layer must be at a height of more than 80 km.; if in addition the ratio of the numbers of negative ions and electrons is not to exceed 1,000 : 1, the layer must be at least at a height of 95–100 km. Such a height is not far from that of the *E*-layer, and since there are likely to be far fewer than 1,000 negative ions per electron at this level, even this height is likely to be an under-estimate. It appears, therefore, that a layer of the required conductivity can scarcely exist below the *E*-layer.

T. G. COWLING
R. BORGER

University College, Bangor.
Dec. 23.

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[1] Martyn, *Nature*, 160, 535 (1947).

[2] Cowling, *Proc. Roy. Soc.*, A, 183, 453 (1945).

[3] Massey and Bates, Rep. Prog. Phys., 8, 62 (1942).

Frequency Variation of the Intensity of Cosmic Radio Noise

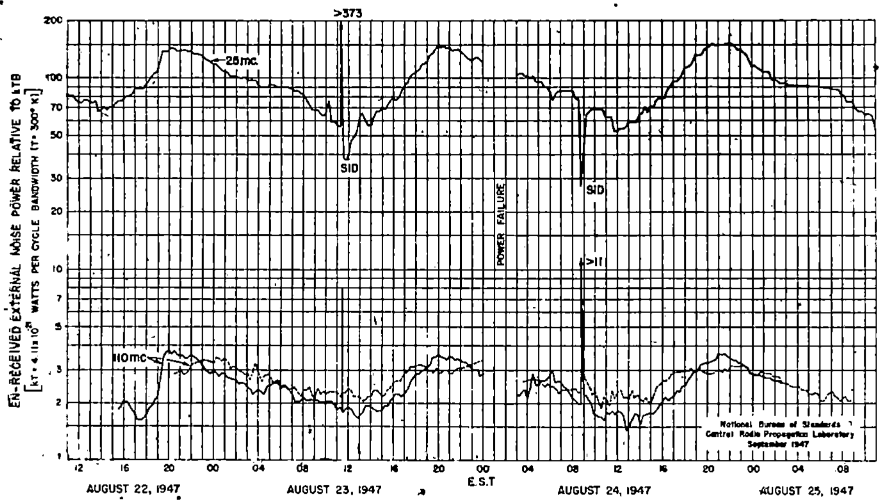
THE intensity of cosmic radio noise (as received on horizontal half-wave dipole antennæ one quarter wave-length above ground) has been measured at 25 Mc. and 110 Mc. by H. V. Cottony, W. Q. Crichlow, J. W. Herbstreit and J. R. Johler at the Central Radio Propagation Laboratory, National Bureau of Standards, using identical noise diode calibration methods. The use of similar antennæ on the two frequencies ensured that comparable weights would be given the cosmic radio noise arriving from various directions in space. Results of these measurements are shown in the accompanying graph in terms of an external noise factor $\overline{EN}^1$. Results are given on 110 Mc. for antennæ oriented both normal to and parallel to the geographic meridian. These have somewhat different diurnal patterns which compare favourably with the calculated patterns obtained when the cosmic radio noise intensity contours obtained by Reber[2], using highly directional antennæ, are appropriately integrated over the two broad directivity patterns of the dipole antennæ.

After allowing for the portion of the external noise energy radiated from the ground at an assumed temperature of 300° K., and on the assumption that the effective temperature of outer space (weighted in various directions by the dipole directivity) varies in accordance with some power of the frequency, the following expressions have been derived from these measurements for the maximum and minimum external cosmic radio noise factors corresponding to reception at this latitude on half-wave antennæ, one quarter wave-length above a perfectly reflecting ground:

$$\overline{EN}' = 4 \cdot 40 \times 10^5 \, f_{\text{Mc.}}^{-2 \cdot 41} \text{ maximum;}$$
$$\overline{EN}' = 1 \cdot 58 \times 10^5 \, f_{\text{Mc.}}^{-2 \cdot 41} \text{ minimum.}$$

Since the effect of absorption in the earth's ionosphere would be expected to be negligible on both 25 and 110 Mc. at night and on 110 Mc. both day and night, the exponent in the above two expressions was derived from the averages of the maximum values for the three nights, while the ratio of maximum to minimum noise was determined from the 110-Mc. measurements. The above expressions having been obtained in such a way as to minimize the effects of both ground and ionospheric absorption, they provide a direct measure of the variation of the mean cosmic radio noise arriving from outer space as a function of frequency. Thus this incident noise is seen to be proportional to $f_{\text{Mc.}}^{-0 \cdot 41}$, after allowance is made for the frequency-squared factor arising from the relative absorbing areas of the two antennæ. The absolute accuracy of the measurements on both frequencies is such that the first significant figure in the above exponent is considered to be accurate while the second is doubtful.

Also shown in these measurements is the occurrence of several short-time bursts of very strong noise radiation which occurred at times when sudden ionosphere disturbances were reported[3]. During the first of these, a burst of radio noise presumably of solar origin occurred on both 25 and 110 Mc. at the onset, followed, on 25 Mc. only, by a period of extraordinarily reduced external noise. In the second, the sudden ionospheric disturbance and reduced external noise on 25 Mc. commenced approximately 7½ min.



EXTERNAL NOISE RECEIVED ON HORIZONTAL HALF-WAVE DIPOLES A QUARTER WAVE-LENGTH ABOVE GROUND, AT STERLING, VA., LAT. 38° 59′ N., LONG. 77° 28′ W.

Approximate characteristics, $\sigma = 2 \times 10^{-14}$, $\varepsilon = 4$. Full line, dipole in east–west plane; broken line, dipole in north–south plane. *SID*, sudden ionospheric disturbances

before the radio noise burst, similar to the phenomena described by Hey, Parsons and Phillips[4].

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JOSEPH R. JOHLER
Experimental Ionospheric Research Section,
Central Radio Propagation Laboratory,
National Bureau of Standards,
Washington.
Nov. 10.

[1] Norton, K. A., and Omberg, A. C., *Proc. Inst. Rad. Eng.*, **35**, 4 (1947).

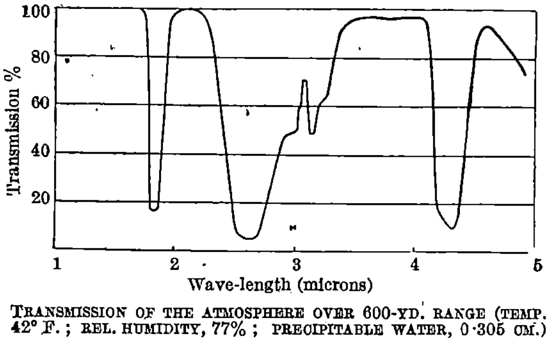
[2] Reber, G., *Astrophys. J.*, **100**, 279 (1944).

[3] Central Radio Propagation Laboratory, National Bureau of Standards, Ionospheric Data, CRPL-F37 (September 1947).

[4] Hey, J. S., Parsons, S. J., and Phillips, J. W. *Nature*, **160**, 371 (1947).

Transmission of the Atmosphere in the 1–5 Micron Region

THE most comprehensive published data available for the transmission of the atmosphere in the infra-red region is that of Fowle[1], whose results were obtained over comparatively short paths (maximum 127 yards) in the laboratory. In spite of the short path, no region clear of considerable absorption was reported between 2·1 and 8·5 microns. It may be of interest to record preliminary field results obtained during work at this Laboratory in the 1–5 micron region using the greatly improved apparatus now available.



TRANSMISSION OF THE ATMOSPHERE OVER 600-YD. RANGE (TEMP. 42° F.; REL. HUMIDITY, 77%; PRECIPITABLE WATER, 0·305 CM.)

The measurements were made using a source and spectrometer separated by a 600-yard range. The source consisted of a Nernst filament at the focus of a 2-ft. focal-length parabolic mirror of 2-ft. diameter. A mirror system of 10-ft. focal-length served as collector unit for the spectrometer. The latter was a Littrow arrangement with a 30° rocksalt prism. A Hilger – Schwarz thermopile was used as detector in conjunction with a General Motors D.C. amplifier[2]. Amplifier output was displayed on an Evershed and Vignoles 5-mA. double-pen recorder, one pen of which was used for wave-length calibration marks. To obtain the transmission curve, comparison was made between emission curves of the Nernst filament obtained over a short range (5 ft.) and over the 600-yd. range. In calculating percentage transmission, it was assumed that the value at 2·2 microns was 100 per cent[1].

A typical curve is reproduced herewith. It will be seen that, in particular, a region of high transmission exists between 3 and 4 microns. Fowle's figure for 3·5 microns is about 65 per cent transmission (127 yards). Our results were obtained in what was intended to be only a preliminary investigation; but they are considered quite adequate to show that transmission in the 3·5-micron region is comparable with that at 2·2 microns.

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* Now at Courtaulds, Ltd., Maidenhead, Berkshire.

[1] Fowle, F. E., Smithsonian Misc. Coll., **68**, No. 8 (1917).

[2] Liston, M. D., Quinn, C. E., Sargeant, W. E., and Scott, G. G., *Rev. Sci. Instr.*, **17**, 194 (1946).

Spin-Dependence of Magnetic Dipole Gamma Radiation and the Nuclear Level Scheme of Pb^{208}

Hulme, Mott, Oppenheimer and Taylor[1] remarked that a γ-ray due to a transition between levels of the same parity may be a mixture of magnetic dipole and electric quadripole radiations. This is possible when the change ΔI in the quantum number I for the total nuclear spin is ± 1 or 0. The relative proportions in the mixture will depend on the structure of the nucleus. For $\Delta I = \pm 2$, no parity change, magnetic dipole radiation is forbidden and nearly pure electric quadripole radiation will be emitted. An exception occurs if the spin change is $1 \longleftrightarrow 0$, when the radiation must be pure magnetic dipole.

The presence of a high proportion of magnetic dipole radiation will give an abnormally large coefficient α_K of internal conversion in the K-shell.

α_K may approach the value for pure magnetic dipole radiation, which is roughly three times that for pure electric quadripole radiation of the same quantum energy $h\nu$, if less than 0·5 MeV.

The classification of γ-rays by the proportion of magnetic dipole radiation may prove useful in assigning quantum numbers I to the upper levels of nuclei when estimates of α_K are available.

In the case of Pb^{208}, it is clear from the photoelectron spectrum of Thibaud[2] that the M γ-ray of $ThC'' \rightarrow Pb$ of 582 ekV. has an intensity about three times that of the L γ-ray of 510 ekV., and yet their internal conversion lines have similar strengths. Measurements made with D. G. E. Martin[3] have shown that for both the L and the G rays (277 ekV.) α_K is near the theoretical value for pure magnetic dipole radiation, whereas for the M γ-ray it is much lower and in rough agreement with the pure electric quadripole value.

The contrast is striking and can scarcely be due to the highly converted G and L rays arising from $1 \leftrightarrow 0$ transitions.

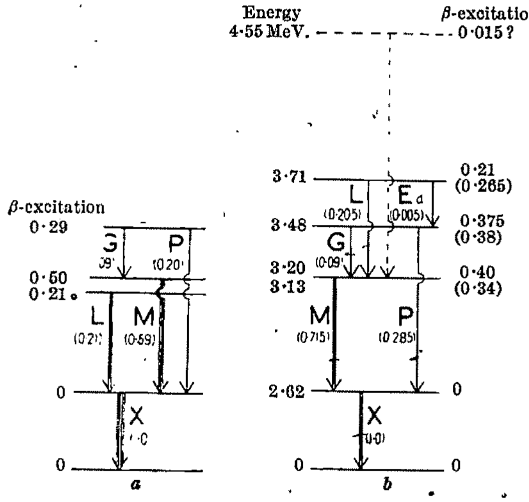

Fig. 1. LEVEL SCHEMES FOR Pb^{208} SHOWING THE NUMBER OF TRANSITIONS PER DISINTEGRATION OF THE MAIN γ-RAYS

In Fig. 1 are two level schemes for Pb^{208} (thorium D) compatible with the uncertain evidence on the γ-ray intensities which, for the P ray (859 ekV.), are taken from the data of Johansson[4]. A decision between the two schemes may be based on further evidence provided by the shape and end-point of the nuclear β-spectrum of $ThC'' \rightarrow D$.

We can calculate the end-points of the partial β-spectra which should excite the levels in Fig. 1 if we take the energy difference between the ground-states of ThC″ and Pb^{208} to be 4·995 MeV., from the known α-ray energies and the value 2·2505 MeV. for the β-ray energy of $ThC \rightarrow C'$. For the 3·204 MeV. level, for example, the β end-point is at 1·791 MeV.

Using these end-points, we get the theoretical composite β-spectra in Fig. 2. Curve (1) is for scheme (*a*), and curves (2) and (3) are for (*b*), omitting the β-spectrum to the 4·55 MeV.-level. In curve (3) the G and L γ-rays are given higher intensities of 0·10 and 0·26, with the β-excitations shown in brackets. The ordinates N/N_1 give the ratio of the number of β-rays between ε and $\varepsilon + d\varepsilon$ to the number for a single allowed transition with end-point at 1·791 MeV. The small circles are the experimental points of Martin, Richardson and Hsü[5], and the large ones those of Siegbahn and Johansson[6], obtained with an α-ray recoil source.

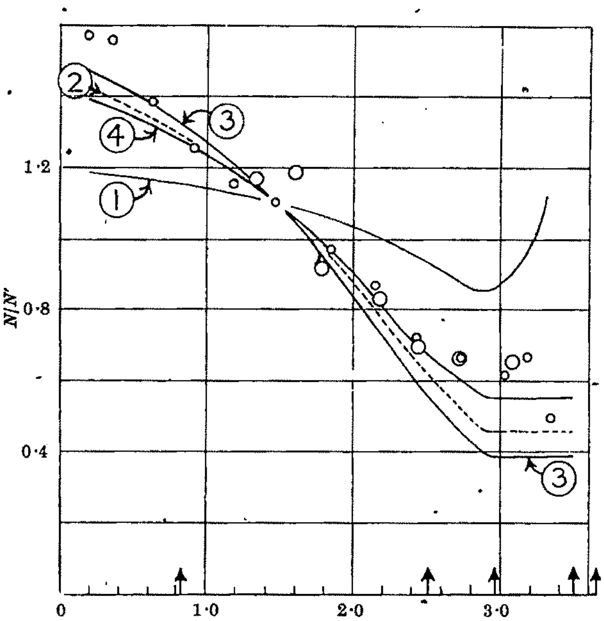

Fig. 2. β-SPECTRUM OF THORIUM $C'' \rightarrow D$. THE ARROWS INDICATE β-END-POINTS ON THE LEVELS IN FIG. 1. CURVE 4 DIFFERS FROM CURVE 2 IN USING INTENSITIES 0·80 AND 0·20 FOR THE M AND P γ-RAYS

Curve (1), with end-point at 1·864 MeV., predicts too many high-energy β-rays. The experiments agree fairly well with curves (2) and (3), except below 0·4 MeV., where a surplus of low-energy β-rays is found. This may be due to a partial β-spectrum exciting one or more levels of Pb^{208} at about 4·55 MeV., as shown by the broken line in Fig. 1. The resulting weak γ-rays of intensity about 0·03 per disintegration have not been identified with certainty, but all the other rays allowed by the selection rules in scheme (*b*) have been found.

The levels should all have the same parity because the observed values of α_K are too large for electric dipole γ-rays. The parity should presumably be even because Pb^{208} is an even-even nucleus with $I = 0$ in the ground-state. It follows that if the β-transition to any one of these levels is allowed, the β-transitions to the others must be either allowed or second or fourth forbidden to avoid a change of parity.

For scheme (*b*) the values of I for the upper levels can then be deduced under the following conditions. (*a*) the G and L γ-rays have $\Delta I = 0$ or ± 1, and the M ray has $\Delta I = \pm 2$; (*b*) the β-transitions to the higher levels are allowed with $\Delta I = 0$ or ± 1 and no parity change; (*c*) the β-transition from ThC″ to the ground-state of Pb^{208} is fourth forbidden and that to the 2·62 MeV. level is second forbidden. These conditions restrict I for the ground-state of ThC″ to be either 5 or 4.

Nucleus	ThC″	Pb^{208}					
Energy of level (MeV.)	0	0	2·62	3·20	3·48	3·71	4·55
Possible set of values of I	5 4 4	0 0 0	2 1 2	4 3 4	4 3 3 or 4	5 4 5	4, 5 or 6 3, 4 or 5 3, 4 or 5

The value 5 leads to a unique set of spin quantum numbers for the five lower levels of Pb^{208}. The value 4 gives the alternative sets shown in the table.

The upper of the two rows with $I = 4$ for ThC″ gives $\Delta I = -1$ for the 2·62 MeV. ray, thus making it pure magnetic dipole radiation. The other choices with $\Delta I = -2$ make it pure electric quadripole radiation.

The term scheme is incomplete because it does not include the weak *Ec* and *Fb* γ-rays.

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The Mass of σ-Mesons

The existence of mesons of different masses has been demonstrated by the recent exhaustive papers of Dr. C. F. Powell and his colleagues. We have recently carried out an investigation of the mass of the σ-mesons, that is, those mesons which produce disintegrations in nuclei.

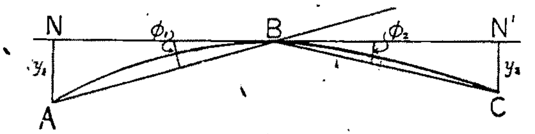

Fig. 1

The method used was that of measuring the Coulomb scattering of the meson in its passage through the emulsion. Hitherto, this method has been utilized only by measuring the angle between the directions of the track at two points along it. It is, however, very difficult to draw tangents to the tracks. Accordingly, we measured the angles ψ between consecutive chords along the track. Let *ABC* in Fig. 1 be the projection of a section of the track in the plane of the emulsion, and the lengths *AB* and *BC*, measured along the track, be each equal to x, say. Draw the tangent *NBN′* at *B*, and join *AB* and *BC*; then the angle between the chords is equal to $(\varphi_1 \pm \varphi_2)$;

$$\therefore (\psi^2)_{av} = (\varphi_1{}^2)_{av} + (\varphi_2{}^2)_{av}.$$

Draw perpendiculars *AN*, *CN′*, of lengths y_1 and y_2 respectively, to *NBN′*; then

$$\varphi_1 = y_1/x \text{ and } \varphi_2 = y_2/x.$$

$$\text{Hence } (\varphi_1{}^2)_{av} = (y_1{}^2)_{av}/x^2 \text{ and } (\varphi_2{}^2)_{av} = (y_2{}^2)_{av}/x^2.$$

If the angle between the tangents at A and B is θ_1, and that between the tangents at B and C is θ_2, it can be shown that

$$\begin{aligned}(y_1{}^2)_{av} &= \tfrac{1}{4}x^2\,(\theta_1{}^2)_{av} \text{ and}\\ (y_2{}^2)_{av} &= \tfrac{1}{4}x^2\,(\theta_2{}^2)_{av}\\ \therefore (\psi^2)_{av} &= \tfrac{1}{4}\,\left((\theta_1{}^2)_{av} + (\theta_2{}^2)_{av}\right),\end{aligned}$$

and $(\theta^2)_{av}$ can be calculated from the formula

$$(\theta^2)_{av} = \frac{4\pi e^4 Z^2 N x}{p^2 v^2} \log\left(\frac{\theta_{max}}{\theta_{min}}\right),$$

where

$$\theta_{min} = \left(\frac{mc}{p}\right)\left(\frac{Z^{1/3}}{181}\right),$$

and θ_{max} is the smallest angle that is recognizable as a single deflexion, Z, N, p and v have their usual meanings.

The advantages of this method are that the chords are easy to draw, and the observations repeatable. The only other method of measuring mass at present is by grain counts along the track, and owing to latent image fading this is not reliable. Also, multiple scattering gives a higher mass resolution for low masses than does grain counting.

We have observed, at the time of writing, some thirty σ-meson tracks, of which fifteen were long enough to investigate. These were traced on the screen of a projection microscope, using a magnification of about 1,500 ×, and divided into twenty μ sections, and the angles between the chords measured. The theoretical values of $(\psi^2)_{av}$ at various distances along the tracks of mesons of mass 200, 360 and 900 electron masses, as well as those for protons, were calculated. It was found that if $(\psi^2)_{av}$ was plotted against range from end of track, the forms of the curves were very similar.

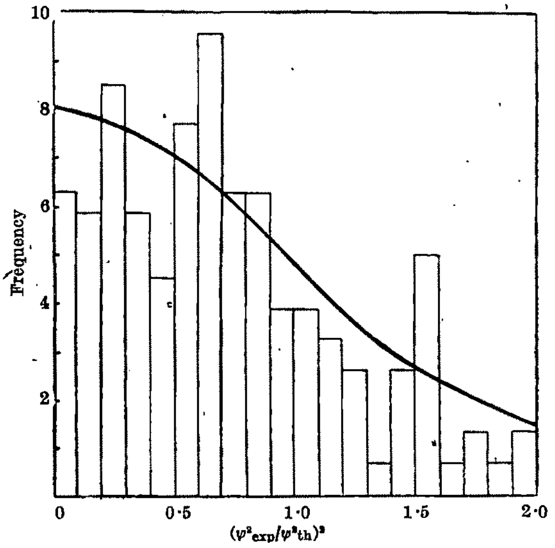

Fig. 2

Therefore, to interpret the results, the values of ψ^2 obtained experimentally at any point were divided by the theoretical value of $(\psi^2)_{av}$ at the same distance from the end of the track, for a meson of mass 300. A histogram (Fig. 2) was plotted of the square root of these quotients against frequency, for all quotients from all tracks. It can be shown that the distribution of multiple scattering angle is Gaussian, and it follows that the distribution of this quotient is also Gaussian, assuming that the mass is always the same. From this it was found that the mass was in the neighbourhood of 300 electron masses. The curve for this mass is shown in Fig. 2. It was also found, however, that the distribution obtained could equally well be explained by assuming mesons of different masses; but the results show that the mesons are not all of mass 200 electron masses. The value of 290 for the mass was also obtained by taking the mean of the values of ψ^2 obtained from the different tracks, at the same distance from the end, and finding the corresponding mass. This was done for all distances, and the mean of the mass values thus obtained taken.

This method would seem to be capable of giving a good estimate of the mean mass of a number of particles; but would be unable to resolve the masses into distinct groups, if such groups occurred. We can, however, say that if any appreciable number of the σ-mesons have mass 200, there must be a corresponding number with mass greater than about 400, and the mean mass is 290 ± 80 electron masses.

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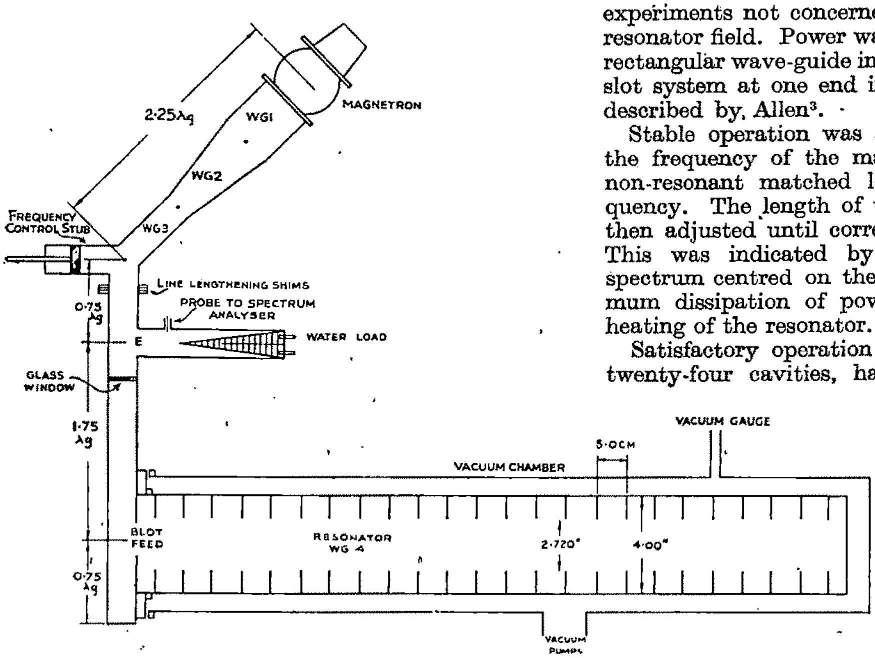
A Method of Feeding Micro-wave Power into a Resonator having a Fine Mode Structure

IN the course of investigations into the design of a micro-wave linear accelerator of the resonant type, to operate at 3,000 mc./s. (cf. Fry[1]), we have succeeded in feeding power into a 24-cavity evacuated resonator 120 cm. long, having a separation in frequency of only 0·2 per cent (that is, 6 Mc./s.) between the required mode of operation and the adjacent mode. The required mode had a phase difference of π between currents in adjacent cavities.

The micro-wave power was generated by an experimental pulsed magnetron, type E 1944, driven at 500 p.p.s. with 2 μsec. pulses by a standard Admiralty type 277 modulator, loaned by the Admiralty Signal Establishment. This modulator had a peak power output of 1·25 MW., and an estimated peak power of 390 kW. was fed into the resonator.



WG	Size	Mode
1	3¼ in. int. diam.	H_{11}
2	Taper	$H_{11} \rightarrow H_{01}$
3	3 in. × 1 in.	H_{01}
4	4 in. int. diam. iris loaded	$E_{0,1,3,4}$

The circuit arrangement is shown in the diagram. The resonator was coupled to the feeding wave-guide in such a way that it was equivalent to a series resonant circuit in parallel with the wave-guide at its point of connexion. The resonant resistance of this was 1/1·2 times the guide characteristic resistance (Z_0). In order to achieve frequency stability in the steady-state condition of oscillation, the effective length of wave-guide between the valve and the resonator was 4·75 guide wave-lengths. The combination of wave-guide and resonator measured at the valve was thus equivalent to a parallel resonant circuit the resistance of which at resonance was 1·2 Z_0. In order to achieve stability during the resonator build-up time, a resistance of the water-load type was placed in series with the wave-guide[2] at such a point that in the steady-state condition it was effectively in series with the resonator, when measured at the valve, and had a resistance of 0·6 Z_0. Consequently, 65 per cent of the generated power was absorbed by the resonator. The magnetron used had a frequency pulling figure of 15 Mc./s., so that in the steady state, with an effective load impedance of 1·8 Z_0 due to the resonator and the stabilizing resistance, its electronic efficiency was reduced from 50 per cent to 45 per cent[3]. The power absorbed by the resonator was thus 60 per cent of the power output of the valve when feeding a matched load. The peak power output when feeding into a non-resonant matched load was 650 kW.; hence the estimated peak power fed into the resonator was 390 kW.

The resonator consisted of a circular wave-guide of 4 in. internal diameter having twenty-four circular irises of diameter 2·720 in. spaced 5 cm. between centres (that is, half the operating wave-length) and closed at both ends by walls spaced 2·5 cm. from the centre of the end irises. The measured Q factor was 8,000, the internal finish being poor; but this factor was considered relatively unimportant for initial experiments not concerned with the strength of the resonator field. Power was fed from the 3 in. × 1 in. rectangular wave-guide into the resonator by a double slot system at one end in a similar manner to that described by Allen[3].

Stable operation was achieved by first adjusting the frequency of the magnetron, operating with a non-resonant matched load, to the resonator frequency. The length of the feeding wave-guide was then adjusted until correct operation was obtained. This was indicated by a very stable frequency spectrum centred on the resonator frequency, minimum dissipation of power in the water load and heating of the resonator.

Satisfactory operation was readily achieved with twenty-four cavities, having an overall length of 120 cm., with a frequency difference between adjacent modes of 0·2 per cent. This frequency difference is theoretically proportional to the inverse square of the number of cavities. From the range of magnetron tuning over which stable operation occurred it is anticipated that a considerably longer resonator, with a correspondingly finer mode structure, can be satisfactorily fed in the required mode by this method.

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Fission Products of U^{233}

EXPERIMENTS have been described[1,2] which give data for the fission products of U^{235} produced in thermal neutron irradiation of natural uranium. Recently, a new radioactive series, not present in Nature, has been reported[3,4]. Seaborg has shown that U^{233}, a member of this series, is fissile with neutrons. The following is a summary of the results of a survey of the longer-lived fission products of U^{233}. The data were obtained in conjunction with those previously reported[1], but could not be released for publication at that time.

The relative yields of the fission products are given directly by the equilibrium activities for an infinitely long bombardment at a constant rate. The yield of Ba^{140} from the fission of U^{235} in natural uranium is taken as a reference. Three samples were irradiated simultaneously, one U^{233} and two natural uranium samples. In order to facilitate direct comparison of the fission-product activities in the natural uranium and U^{233} samples, the weights of the respective samples used were such that the number of fissions produced in each were equal.

After irradiation, a chemical separation of each element lying between arsenic and praseodymium was made. Thirty-one active isotopes were found and identified by their half-lives and their β-, γ-ray absorption characteristics. In all cases, identical activities were observed in the natural and U^{233} samples.

The fission yields for U^{233} are presented in the accompanying table together with those for U^{235}. As with U^{235}, a plot of fission yield against mass number shows a double-humped curve indicating a light group and a heavy group.

FISSION YIELDS FOR U^{233} AND U^{235}

Mass number	U^{235}	U^{233}	Active isotope determined	
89	$3 \cdot 2 \times 10^{-2}$	$4 \cdot 1 \times 10^{-2}$	55 d	Sr
90	$4 \cdot 0 \times 10^{-2}$	$3 \cdot 7 \times 10^{-2}$	~30 y	Sr
91	$4 \cdot 0 \times 10^{-2}$	$4 \cdot 1 \times 10^{-2}$	61 d	Y
95	$3 \cdot 2 \times 10^{-2}$	$3 \cdot 9 \times 10^{-2}$	65 d	Zr
103	$8 \cdot 4 \times 10^{-3}$	$2 \cdot 1 \times 10^{-3}$	37 d	Ru
106	$1 \cdot 5 \times 10^{-3}$	$6 \cdot 4 \times 10^{-4}$	290 d	Ru
111	$1 \cdot 6 \times 10^{-4}$	$1 \cdot 5 \times 10^{-4}$	7·5 d	Ag
(123)	$6 \cdot 4 \times 10^{-6}$	$1 \cdot 9 \times 10^{-5}$	~18 d	Sn
(123)	$8 \cdot 5 \times 10^{-6}$	$2 \cdot 5 \times 10^{-5}$	136 d	Sn
127	$1 \cdot 5 \times 10^{-4}$	$6 \cdot 7 \times 10^{-4}$	90 d	Te
125	$8 \cdot 9 \times 10^{-5}$	$6 \cdot 0 \times 10^{-4}$	~10 y	Sb
129	$9 \cdot 0 \times 10^{-4}$	$2 \cdot 2 \times 10^{-3}$	32 d	Te
131	$1 \cdot 5 \times 10^{-2}$	$2 \cdot 4 \times 10^{-2}$	8·1 d	I
132	$4 \cdot 9 \times 10^{-2}$	$4 \cdot 9 \times 10^{-2}$	2·3 h	I
137	$1 \cdot 8 \times 10^{-2}$	$1 \cdot 8 \times 10^{-2}$	33 y	Cs
(136)	$\sim 10^{-4}$	$\sim 10^{-4}$	~20 d	Cs
140	$5 \cdot 6 \times 10^{-2}$	$6 \cdot 7 \times 10^{-2}$	40 h	La
144	$2 \cdot 9 \times 10^{-2}$	$2 \cdot 2 \times 10^{-2}$	290 d	Ce
147	$\sim 6 \times 10^{-3}$	$\sim 6 \times 10^{-3}$	~4 y	61

In U^{233} fission the groups have a similar shape to those for U^{235} but are one unit lower on the mass scale. The maxima of the fission-yield curves are approximately the same in all cases, being approximately 6×10^{-2}.

A detailed account of the investigation is to be published.

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Fluorescence of Highly Insulating Dielectrics Produced by X- and γ-Radiations

IN the course of experiments designed to study photographically the secondary electron emission from various light-atom materials when they are irradiated with high-voltage X-rays, we have found that under certain radiation conditions some highly insulating dielectrics fluoresce when so irradiated, visible and possibly ultra-violet light being emitted. Polystyrene in the commercial form known as 'Distrene' shows the phenomenon quite markedly.

In our first experiments, using X-rays generated at 200 kVp. (half-value layer, 2 mm. copper), the photographic blackening due to secondary electronic emission[1,2,3] was being examined for a range of light-atom materials which included amber, 'Perspex', paraffin wax, 'Alkathene' and 'Distrene', and for such elements as carbon, sulphur, aluminium, copper, silver, tin, gold and lead. The density of blackening obtained for the light-atom materials was much as one would theoretically expect with the exception of 'Distrene'; for this material the density was almost as great as that for copper. Various samples were used with always the same result. It was suggested by Dr. F. W. Spiers that the extra unexpected density might be due to fluorescent radiation, and this is so. A single layer of black paper was found to absorb the radiation and reduce the density of blackening to expected values; the transmission through various thicknesses of glass suggested that some of the radiation might be ultra-violet as well as visible.

The same light-atom materials were examined visually in the dark while they were irradiated with X-rays. No definite fluorescence could be seen from amber, only a faint suggestion was seen from paraffin wax, 'Perspex', and 'Alkathene'; but quite a strong diffuse whitish fluorescence was observed from 'Distrene'. Similar observations were made using X-rays generated at 110 kVp. and 60 kVp. No apparent afterglow was seen; as the X-ray beam was switched off so the fluorescence disappeared.

Similar experiments were made in the dark using the gamma-ray beam from a 2-gm. radium mass unit[4]. In this case a feeble fluorescence of a similar colour was seen from amber and 'Perspex' and quite a strong fluorescence from paraffin wax, 'Alkathene' and 'Distrene'. This fluorescence was also detectable photographically for paraffin wax as well as 'Distrene', but nothing could be detected from 'Perspex' by this means. Again no apparent afterglow could be seen even when the materials were left in the gamma-ray beam for a whole week-end.

Mallet[5] referred to the fluorescence under γ-irradiation of some fluids, including water, grease, oil, albumin and blood serum, and Newcomer[6], in a paper dealing with the fluorescence under X-irradiation of some five hundred compounds, mostly organic, refers to the fluorescence of his paraffined paper cups as being barely within the limits of visibility.

The fluorescence observed in 'Distrene' may be related to the observation by Farmer[7] that, after receiving a considerable dose of X-rays, the insulating properties of 'Distrene' are impaired. Slight traces of impurities are known to be sometimes responsible for fluorescence in many substances, and it is likely that something of this nature may be the responsible agent in this case. If this is so, their removal might conceivably eliminate the phenomenon and improve the insulating properties of 'Distrene' under X-irradiation.

A use of this property of 'Distrene' which suggests itself is as an intensifying screen for certain purposes. If photographic response to X-rays could be made independent of wave-length, such response could be used for measuring X-ray dose and dose distribution. Independence of wave-length might be more nearly realized by the use of suitable intensifying screens; but a difficulty, particularly for phantom measurements, is absorption in the screens. Sheet 'Distrene' would act as a light-atom intensifying screen which would possibly eliminate absorption difficulties and might lead to the required wave-length independence.

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Transition from Glow to Arc Discharge

I have suggested[1] a mechanism to account for the occurrence of long electrical discharges in electric fields which are only of the order of one per cent of those generally believed[2,3] necessary to cause sparkover. In the case of the leader stroke of the lightning discharge, the integrated lateral corona currents from the channel ultimately reach values of the order of thousands of amperes[4], so that the characteristics of the channel must be those of the electric arc, though the discharge must start as a brush or glow discharge. This consideration led me to suggest that the steps in the initial leader stroke represent the transition of successive lengths of the channel from glow to arc conditions, and that a self-propagating discharge is initiated by this transition.

It has been contended[5], in criticism of this view, that the phenomenon of glow to arc transition is entirely governed by the conditions at the cathode, and not at all by those in the discharge column. Experiments in these laboratories have, however, shown that a clearly discernible transition, of the nature usually described as that of glow to arc, occurs in a discharge, which is certainly independent of conditions at the cathode.

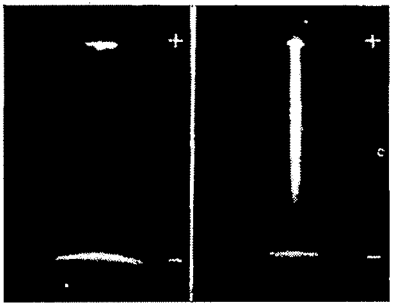

Fig. 1. Stroboscopic photographs of 1 cm. a.c. discharge in hydrogen. (*a*) 0·9 amp.; (*b*) 1·6 amp. Actual exposure times, 2 sec. and 1 sec. respectively

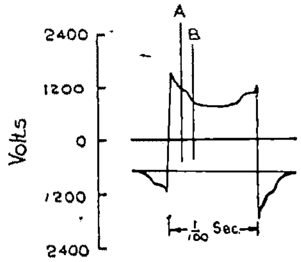

Fig. 2. Oscillogram of voltage across discharge. Photographs of Fig. 1 taken at *A* and *B*

Fig. 1 shows two stroboscopic photographs taken before and after this transition has occurred in an alternating current discharge between water-cooled copper electrodes 1 cm. apart in hydrogen at atmospheric pressure, the peak current being 2 amp. At about 35 electrical degrees after current zero, that is, at a current of about 1·2 amp., the discharge column begins in the region of the anode to change from a diffuse glow to the narrow, bright, crimson column of the hydrogen arc. By the time the current reaches 1·5 amp. this condition has spread along the column to the vicinity of the cathode, which last, however, remains covered by the characteristic wide-spread glow of the glow discharge throughout. The cathode fall of potential likewise remains constant throughout at about 350 volts, whereas the potential gradient along the column falls from about 650 V./cm. in the glow phase to 350 V./cm. in the arc phase. Thus two interesting discharge conditions would appear to have been obtained, namely, a discharge with the column in the arc state while glow conditions persist at the cathode, and one in which the transition occurs in the discharge column itself.

The transition from glow to arc is dependent on the gas pressure as well as on the current in the discharge. In particular it has been observed by several investigators[6] that it does not occur at all below a gas pressure of the order of one hundredth of an atmosphere. This is just about the pressure at the surface of the solar photosphere, and, on a theory I have advanced[7], the latter surface is the result of the occurrence of this transition. Conversely, this agreement supports the view that the transition is a phenomenon primarily of the column and not of the electrode surface.

A fuller account of this work and its application to the spark discharge will appear in due course. I am indebted to my colleague, L. A. King, for much of the experimental work.

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Photography on Selenium

IT was observed many years ago that the crystallization of amorphous selenium is promoted and accelerated by illumination[1,2]. I rediscovered this in the summer of 1941 and succeeded in producing true photographic images by means of this effect, using the initial product of selenium manufacture, namely, aluminium or steel disks covered with a film of selenium, as photosensitive plates. To do this, the mirror-like surface of the selenium must be polished with a soft material, such as tissue paper. The disk is then placed on a metal plate, preheated at 90–95° C., and an image, preferably a diapositive, projected on the surface of the selenium. During exposure, 'self-development' takes place and in 1–2 minutes a somewhat faint but in other respects perfect image will appear. The photographic process is then complete and the disk can be removed from the hot plate.

The image is produced by progressive crystallization of the amorphous selenium. It causes the selenium surface to lose its lustre, to become velvet-like in texture, diffusing the light and changing its colour from black to grey, gradually and in proportion to the intensity of the incident light, that is, with the brightness of the different parts of the projected image. In consequence of this the copy of a positive image will be also a positive. Over-exposure rapidly deteriorates the image and turns it finally into a roughly crystalline uniform surface of grey colour.

The 'trick' of polishing (that is, covering the surface with very fine scratches) is of decisive importance: it facilitates the crystallization and makes this capricious process uniform and regular. Pure selenium crystallizes slowly: the selenium we used was mixed with 0·07 per cent iodine; increasing the iodine content would probably be advantageous.

Another method of 'selenography'—also in connexion with rectifier manufacture—is based upon my observation that the imperfectly reflecting black surface (at 100–120° C.) of hot-pressed, crystalline selenium changes to a light grey-coloured one; this takes place in the usual second heat treatment at about 210° C., and is also promoted by illumination.

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[1] Bidwell, S., *Proc. Phys. Soc.*, 7, 130 (1885); original not seen.

[2] Saunders, A. P., *J. Phys. Chem.*, 4, 423 (1914); original not seen.

Collision Broadening of the Ammonia Inversion Spectrum at High Pressures

THE collision broadening of the inversion spectrum of ammonia has been studied by Bleaney and Penrose[1] at pressures up to 600 mm. mercury. The line-widths, measured at a pressure of 0·5 mm. mercury, give values for the collision diameters (for self-broadening) varying between 8·7 A. and 14·2 A., with a mean value (weighted according to the line strengths) of 13·2 A. Between 0·5 mm. and 100 mm. pressure, the shape of the absorption curve agrees closely with that calculated from the intensity and position of the individual lines, assuming that their widths vary linearly with the pressure. At 600 mm. pressure, however, the absorption maximum has shifted to less than 0·6 cm.$^{-1}$, and the curve shape is no longer consistent with that calculated from the structure factor of Van Vleck and Weisskopf[2], and Fröhlich[3], using the extrapolated line-widths.

These measurements have been extended to delineate the absorption curve in ammonia gas over the frequency-range 0·1–1·2 cm.$^{-1}$ at pressures up to six atmospheres. The absorption was determined from the damping of a resonator caused by the admission of the gas, by a technique similar to that of Bleaney and Penrose[4]. A cavity resonant in the H_1 mode was used, however, in order to avoid errors due to the tails of other resonances, which can occur in an H_0 cavity when filling it with a fluid of appreciable dielectric constant (see Bleaney, Loubser and Penrose[5]).

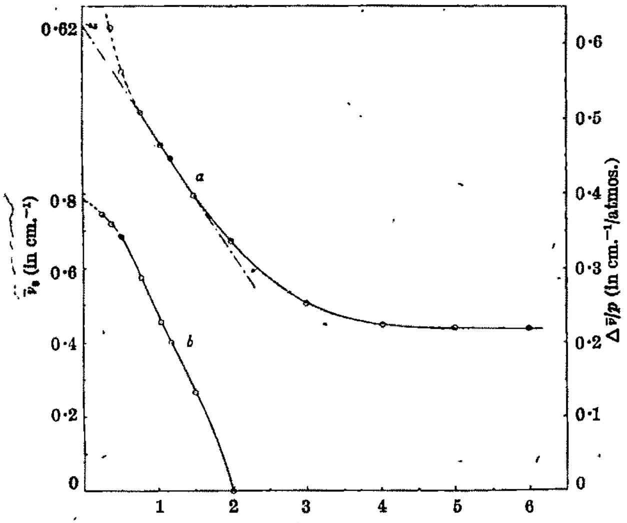
At high pressures the widths of the individual lines of the ammonia spectrum become large compared with their separation, and it should be possible to represent the observed line by the formula

$$\frac{\alpha}{\bar{\nu}^2} = \frac{4\pi^2}{3kT} \sum_{J,K} N_{J,K} \, | \mu_{J,K} |^2 \left\{ \frac{\Delta\bar{\nu}}{\Delta\bar{\nu}^2 + (\bar{\nu}_0 - \bar{\nu})^2} + \frac{\Delta\nu}{\Delta\bar{\nu}^2 + (\bar{\nu}_0 + \bar{\nu})^2} \right\}. \quad (1)$$

The whole resonance curve is thus treated as if due to a single line of resonant frequency $\bar{\nu}_0$, with a line-breadth constant $\Delta\bar{\nu}$, and an intensity corresponding to the sum of the intensities of the individual lines. It is found that above 10 cm. pressure, the experimental absorption curves can be adequately represented by this formula using empirical values of $\bar{\nu}_0$ and $\Delta\bar{\nu}$ to give the best fit at each pressure. The variation of these values is shown in the accompanying graph, where $\bar{\nu}_0$ and $(\Delta\bar{\nu}/p)$ are shown as functions of the pressure (p in atmospheres). At zero pressure $\bar{\nu}_0 = 0{\cdot}78$ cm.$^{-1}$ corresponds to the centre of gravity of the absorption band, and $\Delta\bar{\nu}/p = 0{\cdot}62$ cm.$^{-1}$ per atmosphere corresponds to the average collision diameter of 13·2 A. As the pressure increases, the resonant frequency $\bar{\nu}_0$ shifts steadily downwards, becoming substantially zero at 2 atmospheres and above. At the same time, the value of $(\Delta\bar{\nu}/p)$ decreases, showing that the collision frequency no longer increases linearly with the pressure. (Here the dotted curve at low pressures has no meaning, since the rotational fine structure of the inversion band gives an artificial width not due to collision broadening.)

The initial portion of the $(\Delta\bar{\nu}/p)-p$ curve (up to about 2 atmos.) can be represented by the formula

$$\Delta\bar{\nu} = 0{\cdot}62\, p\, (1 - bp) \text{ cm.}^{-1} \ (p \text{ in atmospheres}), \quad (2)$$



CURVE *a*, $\Delta\bar{\nu}/p$ AGAINST *p*. CURVE *b*, $\bar{\nu}_0$ AGAINST *p*

where the coefficient *b* has the value of 0·25 atmos.$^{-1}$. The fall in $(\Delta\bar{\nu}/p)$ may be ascribed to the effect of double collisions. Since the collision diameter is considerably greater than the kinetic theory diameter, an absorbing molecule *A* will have a colliding molecule *B* within its sphere of influence for a fraction $\frac{4\pi}{3}\sigma^3 N$ (where *N* is number of molecules per c.c.) of the total time. If another molecule collides with it during this time, the collision is not effective in contributing to the line-width, since the absorption of radiation was already interrupted. The line-width therefore rises less rapidly than the pressure by the factor $(1 - \frac{4\pi}{3}\sigma^3 N) = (1 - 0{\cdot}23p)$, in close agreement with the experimental formula (2). As the pressure rises still further, the probability of multiple encounters increases, until at about 4 atmospheres the molecule would be spending practically all its life in 'collision'.

The fall in the resonant frequency to zero at about 2 atmospheres represents the destruction of the inversion of the ammonia molecule, either due to the fact that the mean time between collisions $(1/2\pi c\Delta\bar{\nu})$ is then only a fraction of the natural period of the inversion, or to the enormous fluctuating electric fields of the surrounding dipoles. Van Vleck and Weisskopf point out that the formula (1) for the shape of the line should still be valid when $\Delta\bar{\nu} \approx \bar{\nu}_0$. The destruction of the inversion must therefore be ascribed to the electrical interaction, which for two ammonia dipoles with a separation of 27 A. (the mean distance between the molecules at 2 atmos. pressure) corresponds to an energy of 0·5 cm.$^{-1}$. Since each molecule has a number of nearest neighbours, the mean energy will be considerably greater than this, and it seems reasonable that the random electric field can destroy the inversion doublet in the energy levels, and so substitute a non-resonant inversion similar to that observed in heavier molecules. The facts that the line-breadth constant becomes again proportional to the pressure (but with a smaller collision diameter of 7·6 A.) and the total intensity is the same as for the resonant inversion are in agreement with this hypothesis. If, on the other hand, a true Debye absorption, similar to that observed in polar liquids, had set in, the intensity would be greater by a factor of about 2·5, and one might expect the line-breadth constant to be independent of the pressure, like the viscosity of a gas.

To determine whether the destruction of the resonant inversion is indeed due to the electrical interaction and not simply to the high collision frequency, measurements are being undertaken on mixtures of ammonia with non-polar gases at high pressures. In this way it should be possible to increase the value of the line-breadth constant without a corresponding increase in the fluctuating electric field in which the ammonia molecule moves.

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[1] Bleaney and Penrose, *Proc. Phys. Soc.*, **59**, 418 (1947).

[2] Van Vleck and Weisskopf, *Rev. Mod. Phys.*, **17**, 227 (1945).

[3] Fröhlich, *Nature*, **157**, 478 (1946).

[4] Bleaney and Penrose, *Proc. Roy. Soc.*, A, **189**, 358 (1947).

[5] Bleaney, Loubser and Penrose, *Proc. Phys. Soc.*, **59**, 185 (1947).

Coefficients of Viscosity and Thermal Conduction in Dense Gases and Liquids

THE coefficients of viscosity and thermal conduction in dense gases and liquids have never been deduced from the molecular point of view owing to the difficulties arising from the statistical treatment of the dense and disordered state. Since a general kinetic theory of liquids has been successfully formulated by Born and Green[1], it has been found possible to deduce these coefficients apart from constant factors. Each of them is seen to consist of two parts, one due to the thermal motion of the molecules and the other to molecular attraction. In every case the radial distribution function plays an important part. For dilute gases, the first part predominates, while for liquids the second part is by far the more important. The different behaviour of liquids and gases in respect to viscosity and thermal conduction can thus be accounted for.

The general expressions for the coefficients of viscosity (μ) and thermal conduction (λ) are, in first approximation,

$$\mu = \frac{(mkT)^{1/2}}{a}\left(1 + \frac{L}{nkT}\right)\left(C_k + C_p\,\frac{L}{nkT}\right);$$

$$\lambda = \frac{k}{a}\left(\frac{kT}{m}\right)^{1/2}\left(1 + \frac{L}{nkT}\right)\left[A_k + A_p\,\frac{L}{nkT}\left(1 - \gamma\,\frac{T\frac{\partial p}{\partial T}}{n\frac{\partial p}{\partial n}}\right)\right];$$

where *a* is the effective collision diameter which for rigid spheres would be constant and for other force laws varies slowly with temperature, while

$$L = -\frac{2\pi}{3}\int_0^\infty n_2(r)\,\varphi'(r)\,r^3\,dr\,;$$

$$p = nkT + L.$$

φ(*r*) is the mutual potential energy between a pair of molecules regarded as a function of the distance *r* between their mean centres only, *m* the molecular mass, *n* the number density, *k* is Boltzmann's constant, T the absolute temperature, $n_2(r)/n$ the radial distribution function and C_k, C_p, A_k, A_p, γ are numerical constants.

The first part of μ and λ can be shown to reduce to the corresponding formulæ in gas theory[2] for the case of rigid spheres, and the relation $\lambda = \mu C_v$, where $C_v = 3k/2m$, can be seen to hold for any model.

It should be possible to fix the constant coefficients if sufficient knowledge of the radial distribution function and its rate of change with density and temperature could be obtained. Theoretical investigations of this problem are now in progress in this Department.

I wish to express my thanks to Prof. Max Born, who suggested this problem to me, and to Dr. H. S. Green for his advice.

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Dec. 18.

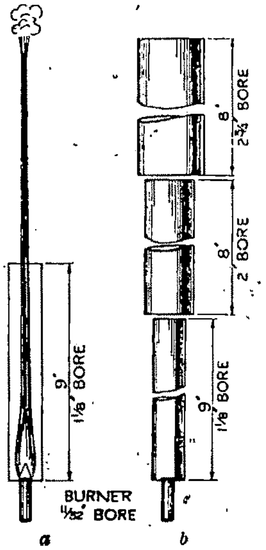
[1] Born, M., and Green, H. S., *Proc. Roy. Soc.*, A, 188, 10 (1946). Green, H. S., *Proc. Roy. Soc.*, A, 190, 455 (1947).

[2] Chapman, S., and Cowling, T. G., "The Mathematical Theory of Non-uniform Gases" (Camb. Univ. Press, 1939).

A Bunsen Flame as a Column of Luminous Gas

The long duration of the luminosity (afterglow) of flame gases after the explosion of a well-mixed inflammable gaseous mixture contained in a large closed vessel, in which cooling takes place slowly[1], suggests that were it possible to secure steady streamlined flow of the flame gases rising from a very large open flame, thus eliminating cooling due to turbulence, they would appear as a column of luminous gas many feet in height. Experimenting recently, we have been a little surprised to find how far we may go in this direction with a small Bunsen flame resulting from the combustion of fully aerated coal-gas. It is easily possible to obtain a column of luminous gas which, viewed in a dark room, extends to a height of 2 ft., whereas with the ordinary Bunsen flame luminosity ceases at a height of only 7 or 8 in.

All that is necessary is to hold an open-ended tube around the flame, as shown in Fig. *a*. It is important that a tube of the right diameter and length in relation to the burner diameter should be selected. The dimensions of the tube used in our experiments are given in the figure.



An even greater height of luminous gas column—approaching 3 ft.—may be attained by the use of a series of open-ended tubes of increasing diameter placed one above the other, as shown in Fig. *b*.

It would appear that the flame gases become embedded in a column of expanding air rising through the tube, and the turbulent mixing with cold air, which always takes place near the tip of an ordinary flame (see *Schlieren* photographs[2]), is thus inhibited. The provision of additional tubes above the first appears to assist in maintaining the streamline flow.

The first six inches or so of the flame gases are yellow in colour. They then turn to red and quickly afterwards to blue, which persists through the whole length of the column. The yellow coloration indicates continued combustion above the inner cone due to stratification of the gas mixture in the flame resulting from imperfect mixing of the coal-gas and air during their passage up the burner tube. When a perfectly mixed coal-gas and air mixture (with excess air) contained in a tank is supplied to the burner (with the air port closed) there is no yellow coloration—the flame gases attain their reddish colour immediately above the inner cone and this turns quickly to the characteristic blue afterglow which persists as before.

We have obtained a similarly extended afterglow when burning pure carbon monoxide in the Bunsen burner.

We would again like to suggest that it is difficult to account for the long duration of the afterglow unless the presence in the flame gases of metastable molecules formed during combustion is assumed[1]. The excited molecules responsible for the light emission may result from the collisions of these molecules.

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[1] *Nature*, 159, 407 (1947).

[2] Gawthrop, *Rev. Sci. Instr.*, 2, 522 (1931).

Equations of Piezo-electricity

Prof. W. G. Cady's exposition of the basic equations of piezo-electricity in his recent book "Piezoelectricity" contains errors which should be brought to the attention of students and workers in this field.

On p. 44, the first thermodynamic potential is introduced in equation (1), but is incorrectly expressed as a quadratic form in terms of elastic strains and electric field intensities within the piezo-electric material (we are considering only isothermal effects here). This potential is also called Green's strain-energy function, and is identical with the Lagrange function for a statical conservative system. It is well known that, for a linear conservative system, this function can be written either as a quadratic form in the generalized co-ordinates, in which case it is sometimes called the 'first thermodynamic potential', or as a quadratic form in the generalized forces, when it is called the 'second thermodynamic potential'. For an electromechanical system, suitable generalized co-ordinates are elastic strain and electric displacement, and the corresponding generalized forces are elastic stress and electric field intensity. By using elastic strain and electric field intensity in equation (1), however, Prof. Cady mixes generalized co-ordinates and forces in the Lagrange function, which results in erroneous piezo-electric equations. The second thermodynamic potential is introduced in equation (2) on p. 44, and is correctly written as a quadratic form in elastic stress and electric field intensity. Equations based on (1) will be physically inconsistent with equations based on (2).

Theoretical conclusions drawn from the incorrect equation (1) by the usual Lagrange formalism permeate the whole of Chapter 8 on the principles of piezo-electricity. The correct equation (2) is also used as a basis for many of the equations in this same chapter, and the reader is therefore obliged to examine closely the origin of the formulæ he uses. The formulæ affected are the basically important linear equations which give the elastic stresses and electric field intensities as functions of the elastic strains and electric displacements.

The basic formulæ are used in subsequent chapters on the piezo-electric properties of certain crystals, on alternative formulations of piezo-electricity theory, and on secondary piezo-electric effects. On page 252 of the chapter on alternative formulations of theory, incidentally, the author introduces equations (243) and (243*a*), which are similar to (1) and (2), and in which again generalized forces and co-ordinates are incorrectly mixed in the Lagrange function.

Prof. Cady's book fills the need for a comprehensive summary of the recent experimental researches; the mathematical portions, however, require revision.

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The Melanin Problem: a Synthesis of 5:6-Dihydroxyindole

WE have recently submitted to the Chemical Society a paper describing, *inter alia*, a new synthesis of 5-hydroxyindole by reduction with iron powder and acetic acid of 2:β-dinitro-5-acetoxystyrene and deacetylation of the resulting 5-acetoxyindole. As a part of a comprehensive investigation of the chemistry of the natural melanins, we have now successfully extended the method to the synthesis of 5:6-diacetoxyindole (compact hemispherical clusters, m.p. 135–136°; found: C, 61·5; H, 4·9; N, 6·3: $C_{12}H_{11}O_4N$ requires C, 61·8; H, 4·7; N, 6·0 per cent), and of 5:6-dihydroxyindole (colourless needles, m.p. 140°; found: C, 64·7; H, 4·85; N, 9·4: $C_8H_7O_2N$ requires C, 64·4; H, 4·7; N, 9·4 per cent). The latter compound was postulated by Raper[1] as an unstable intermediate in the enzyme-catalysed oxidation of tyrosine to melanin, and has been known hitherto only in solution or in the form of its derivatives.

Treatment of the alkaline deacetylation mixture with dimethyl sulphate, without isolation of the hydroxyindole, yielded the dimethyl-ether (m.p. 155°, in agreement with Raper's 5:6-dimethoxyindole, m.p. 154–155°; found: C, 67·6; H, 6·0; calculated for $C_{10}H_{11}O_2N$ C, 67·8; H, 6·2 per cent).

Crystalline 5:6-dihydroxyindole is surprisingly stable, but in slightly alkaline solution very rapid oxidation occurs with formation of melanin-like products. A study of the oxidation of this dihydroxyindole, its alkyl substitution products and related compounds, which have been synthesized, is in active progress.

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Biochem. J., 21, 89 (1927).

The Carotenoids of the Locust Integument

As part of a research programme into the biochemistry of locust pigmentation, the carotenoids of the integument of *Locusta migratoria migratoroides* R. and F. and *Schistocerca gregaria*, Forsk. have been investigated. There is apparently no reference in the literature to the pigment of *Locusta*, and only two rather tenuous and contradictory reports have appeared concerning that of *Schistocerca*[1,2]. Lederer[1] quotes unpublished work with Volkonsky indicating that the rose pigment of young *Schistocerca* is not a carotenoid but that the yellow pigment of the mature insect is; Chauvin[2] reported an unidentified rose-coloured carotenoid in immature, and a mixture of α- and β-carotene in mature, insects.

The insects used in the present investigation were bred in captivity and fed solely on grass. The pigment in the hypodermis of both *Locusta* and *Schistocerca* is the same and undoubtedly astaxanthin[3]. Its identity has been established by comparing its properties with an authentic specimen of astaxanthin isolated from lobster carapaces. Both compounds gave identical absorption spectra in three solvents, namely, petroleum-ether, b.p. 40–60°, pyridine and carbon disulphide; a mixture of the two pigments could not be separated chromatographically. Further, the locust astaxanthin reacted with potassium butoxide *in vacuo* to form a purplish-blue enol salt, and was converted into astacene by alkali in the presence of oxygen. The astacene formed was indistinguishable from lobster astacene.

Partition experiments indicate that astaxanthin occurs in the free form and is not esterified. It occurs in both the solitary and gregarious phases, and at all stages of development up to sexual maturity; up to this stage it is the predominant carotenoid present. It must be formed by the insect, for it does not occur in the diet.

At sexual maturity β-carotene, always present in the fatty tissues of the insects, begins to accumulate in the hypodermis and the astaxanthin to disappear. This observation confirms and explains the work of Chauvin and of Lederer on mature insects. It is, however, difficult to accept unreservedly Lederer's contention that the yellow pigmentation of mature *Schistocerca* is entirely due to carotenoids; so-called acridioxanthin[4] undoubtedly plays some part. This disappearance of astaxanthin, with replacement by β-carotene, at sexual maturity has no obvious explanation at present; but it is another addition to the growing mass of observations which suggests a relationship between carotenoid metabolism and sexual function. It is interesting to note that astaxanthin is also present in the eyes of locusts in both mature and immature insects.

The pigmentation of the gonads and fatty tissues of both species is due almost completely to β-carotene; there may be a little α-carotene present but no traces of xanthophylls could be detected; the amount of β-carotene which accumulates, especially in older insects, is considerable. Previous workers[1] have claimed that this pigmentation is due to a mixture of carotenes and xanthophylls but, more recently, Grayson[5], and Grayson and Tauber[6] have reported findings on another acridid (*Melanoplus bivattus* Say.) which are in substantial agreement with ours, although they report the presence of traces of xanthophylls.

The demonstration of astaxanthin in locusts is particularly interesting because, apart from its detection in the retina and eye colourings of birds[7,8], this is the first time it has been reported in land animals. This is perhaps less surprising when one considers that locusts are quite closely related to the Crustacea, the typical carotenoid of which is astaxanthin.

We are grateful to the Anti-Locust Research Centre for supplying material and for a grant towards expenses.

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Dec. 22.

[1] "Les Carotenoïdes des Animaux", 28 (Hermann, Paris, 1935).
[2] *Ann. Soc. Ent. France*, 110, 133 (1941).
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[4] Chauvin, R., *C.R. Soc. Biol.*, 211, 339 (1940).
[5] *Iowa State Coll. J. Sci.*, 17, 69 (1942).
[6] *Iowa State Coll. J. Sci.*, 17, 191 (1943).
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Isolation in Chick Embryos of a Filtrable Agent possibly related etiologically to Lumpy Skin Disease of Cattle

The widespread occurrence of lumpy skin disease[1] in dairy herds of the Cape Peninsula offered suitable material for investigations on the etiology of this disease.

Skin nodules or lymph gland excised under local anæsthesia from cases in the early stages of the disease as well as tissues obtained at post mortem were made available to us. Emulsions of these tissues, treated with antibiotics or freed of bacteria by filtration through 'Gradocol' membranes[2], were used for the inoculation of laboratory animals and chick embryos.

Inoculation of laboratory animals by the usual routes has so far proved unsuccessful.

One series of experiments using chick embryos has, however, resulted in the isolation of a virus. The starting material was obtained from a calf which died at a stage of the disease when active skin and lymph gland lesions were still present. An emulsion was made in broth of a lymph gland and a skin nodule. After light centrifugation and removal of the supernatant, penicillin (100 μ per ml.) and streptomycin (50 γ per ml.) were added, and the emulsion then filtered through a 'Gradocol' membrane with an average pore diameter of 600 mμ. The filtrate was used for the inoculation of six nine-day-old chick embryos by the combined amniotic and chorio-allantoic routes.

The eggs were returned to an incubator and maintained at 35–36° C. Four of the embryos were dead on or before the sixth day after inoculation. One of the survivors, opened on the sixth day, showed a marked gelatinous œdema of the chorio-allantois and numerous hæmorrhages into the shafts of the feather follicles.

Serial passages of embryo and chorio-allantois have been maintained since then for more than a year. Nine-day embryos are usually employed, and lesions developed by them are constant. On the fourth day after inoculation, the embryos present a characteristic shrivelled appearance—tightly rolled up in a dry, thickened amniotic membrane. Feather development is usually absent, or only irregularly swollen cystic or hæmorrhagic feather follicles are present. The chorio-allantoic membrane almost invariably shov gross gelatinous œdema. That the agent responsib for these lesions is a virus is suggested by: (*a*) th presence of numerous inclusion bodies in histologic sections of affected embryos; and (*b*) the develo ment of lesions following the inoculation of filtrat through 'Gradocol' membranes with A.P.D. of 52 m or more; filtrates through 21 mμ membranes hav regularly failed to elicit the characteristic lesions.

Successful neutralization experiments have bee carried out in eggs, with immune sera from adu fowls that had received repeated injections of th virus cultivated in chick embryos, as well as se from convalescent bovines. Results of neutralizatio tests have, however, not always been conclusiv because positive results have been obtained with th serum of occasional apparently normal bovines. Th possibility that these apparently normal animals ha suffered subclinical infections could not, however, b excluded. Also, one serum from a bovine convalescen after a typical attack of lumpy skin disease co tained no demonstrable neutralizing antibody.

A small number of normal bovines obtained fro areas where the disease was not endemic have bee tested for their susceptibility to the virus cultivate in eggs. None of these has developed lumpy sk disease. The experimental transmission of the disea in its natural host has, however, proved uncerta even when presumably infective inocula obtaine from other bovines have been used. Furthermore, would not be surprising in the light of experien with other animal viruses if serial transfer in eggs ha resulted in a loss of virulence for the original host.

Although the identity of the virus has not yet bee definitely established, it is felt that the successf neutralization by the majority of lumpy skin co valescent sera tested indicates the possible etiologic relationship of this virus to lumpy skin disease.

Full details of the experiments will be publishe elsewhere.

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[1] de Boom, H. P. A., *S. African Sci.*, 1, 44 (1947). Thomas, A. I and Maré, C. v. E., *J. S.A. Vet. Med. Assoc.*, 16, 36 (194 von Backstrom, U., *J. S.A. Vet. Med. Assoc.*, 16, 29 (1945).

[2] Elford, W. J., *J. Path. Bact.*, 34, 505 (1931).

Effect of Calcium Ions on the Charge of Myosin

During a preliminary investigation of the electr phoretic behaviour of the crystalline myosin prepare according to Szent-Györgyi[1] we found, in a Tiseli electrophoresis cell, that myosin was negativel charged when dissolved in potassium chloride pH 7·1.

Based upon these data, Szent-Györgyi suggeste that myosin dissolved in an excess of calcium chlori at the same pH ought to be positively charged. O present experiments confirm this suggestion.

Some data of our preliminary work are summarize in the accompanying table.

Once-crystallized myosin dissolved in the given buffer. Concentration of myosin 0·3 per cent

	*p*H	Mobilit
0·28 *M* KCl	7·1	−2·5
0·12 *M* K-veronale-acetate-HCl buffer of Michaelis	5·6	+1·6
0·22 *M* $CaCl_2$	7·5	+1·2
0·04 *M* K-veronale-acetate-HCl buffer of Michaelis	8·7	+1·2

The isoelectric point of myosin is about pH 5·4. The figures show that the isoelectric point of our calcium myosinate is at a pH greater than 8·7. Myosin is precipitated under our experimental conditions in the presence of potassium chloride in the pH-range 5–6, but in the presence of calcium chloride the myosin is completely soluble in this range.

The difference between the isoelectric points of potassium myosinate and calcium myosinate is undoubtedly unusually large, and it seems to us that this example of potassium – calcium antagonism is of physiological importance.

The investigations are being continued and a detailed description will appear elsewhere. We wish to express our thanks to Prof. Arne Tiselius for his interest in the work. The investigation is financially supported by Svenska Naturvetenskapliga Forskningsrådet.

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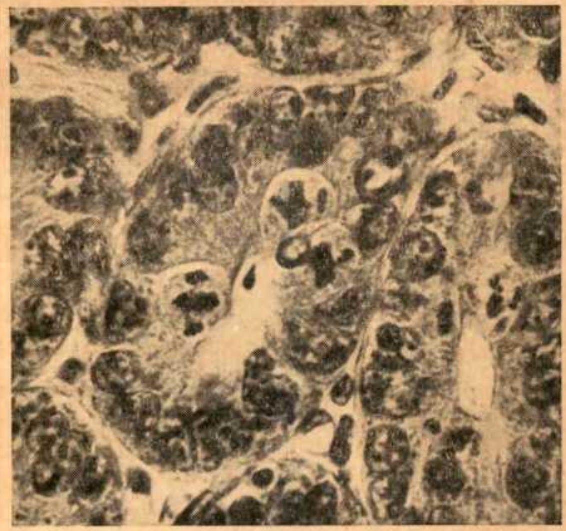
[1] Szent-Györgyi, A., *Acta Physiol. Scand.*, 9, suppl. 25 (1944).

Early Effects of Hydroquinone on Mitosis

ONE of us recently directed attention[1] to the 'radiomimetic' action of hydroquinone. In the intestine of the mouse, extensive nuclear destruction, occurring before the onset of prophase in the cells of the germinative region, was observed four hours after an injection of 0·125 mgm./gm. The interest taken in this type of mitotic poisoning has been increased by the description by Mitchell and Simon-Reuss[2] of the synergic effects of X-rays and a vitamin K substitute (diphosphoric ester of methylnaphthoquinone) on mitosis in normal and cancerous tissues. Naphthoquinone is known to be a mitotic poison[3]. A further investigation of the cytological disturbances following the injection of various quinone and phenolic compounds has led to the observation in the small intestine of the mouse of a new type of abnormal mitosis.

During the first two hours after hydroquinone injection, preceding the 'radiomimetic' (pycnotic) effect, there is a progressive accumulation of arrested metaphases. After intraperitoneal or subcutaneous doses of 0·15 or 0·175 mgm./gm., the percentage of metaphases may rise as high as 92 per cent, while normal ana- and telo-phases nearly completely disappear. Some of the metaphases show an irregular distribution of the chromosomes, which are short and thick and may clump together in the middle of the cell. Most of the divisions, however, assume a very peculiar appearance (see accompanying reproduction). On each side of the metaphase plate, little groups of chromosomes migrate towards the poles. These chromosomes are usually the smallest ones, and their movements are caused by the presence of an [illegible] ently well-developed spindle, easily demo[illegible] after Carnoy fixation.

Various hypotheses may be used to ex[illegible] origin of these abnormal mitoses, whic[illegible] curious resemblance to those normally fo[illegible]



GERMINATIVE REGION OF THE SMALL INTESTINE OF MOUSE

Carnoy fixation, iron-hæmatoxylin staining. In one crypt, three mitoses are arrested. The greatest part of their chromosomes lies in the equatorial region, while small groups of chromosomes have already reached the poles (two hours after 0·135 mgm./gm. hydroquinone)

30 min. and one hour after the injection, when the chromosomes are still clearly defined, only a few of them have migrated to the poles, and there is no evidence that these have yet been broken.

(2) Signs of chromosome 'stickiness' are particularly apparent from one hour onwards after the injection. The central mass of chromosomes clumps more and more together, and bridges may be observed between it and the polar chromosomes. But this is only a secondary change, the abnormal migration taking place when the limits of the equatorial chromosomes are still visible.

(3) Through a defect of the spindle, chromosomes could be 'lost' before the anaphasic migration: v. Moellendorff, in tissue cultures treated with various mitotic poisons, has described such 'detached' chromosomes[5]. However, after hydroquinone poisoning, the spindle appears to be normal, its fibres are quite conspicuous, and it is difficult to understand how so many chromosomes at a time could break loose from the spindle.

(4) An intrinsic cause of the abnormal chromosome migration appears to be the most probable. It is suggested that an impeded division of the centromeres of the longest chromosomes gives the best explanation of the peculiar mitotic figures.

These results help to explain why benzoquinone and naphthoquinone have been considered as mitotic poisons of the colchicine type by several authors[3], while hydroquinone and other diphenols appeared to have in mice a typical radiomimetic effect[1]: the early modifications of mitosis described above have some resemblance to the colchicine effect (accumulation of metaphases), whereas later, when no more cells enter division, pycnosis and cellular disintegra[illegible]on sets in, as after irradiation. It is of interest to [illegible]te that mitotic abnormalities similar to those [illegible]strated above have been described as one of the [illegible]nary or 'physiological' effects of irradiation[6]. [illegible]search now in progress may eventually help to

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Antagonism Between Molybdenum and Certain Heavy Metals in Plant Nutrition

It has been recognized in the literature that an excess of either manganese, zinc, copper, cobalt or nickel will induce iron-deficiency chlorosis in plants. Other toxic effects such as stunting and lower leaf necrosis may also occur. These effects have been confirmed in water-culture experiments with flax, conducted at the Plant Research Laboratory, Department of Agriculture, Burnley, Victoria.

In these experiments, it has been further shown that it is possible to reduce the severity of iron-deficiency symptoms, caused by an excess of any one of the above elements, by increasing the supply of molybdenum to the solution. Various concentrations of added molybdenum up to 20 parts per million have been used.

In the case of excess manganese (5–100 p.p.m.), which has been the heavy metal treatment most intensively studied, the added molybdenum reduced the severity of lower leaf necrosis, which is a characteristic manganese-toxicity symptom. A preliminary paper on this subject will be published in a forthcoming issue of the *Journal of the Australian Institute of Agricultural Science*. This describes experiments with flax. Manganese/molybdenum antagonism has since been demonstrated in water-culture experiments with peas, cabbages and tomatoes.

In Victoria, on highly acid soils, a previously undescribed disease of flax occurs which has been called 'lower leaf scorch'. Previous to the water-culture work outlined above, it was found that lower leaf scorch could be prevented by liming, and aggravated by sulphur, steam sterilization, or manganese sulphate. Affected plants were found to contain a higher manganese concentration than normal. In the past two seasons the disease has been prevented, in both pot and field experiments, by applying small amounts of ammonium molybdate (1–2 lb. per acre). In further pot experiments with highly acid soils (*p*H 4·8), heavy dressings of manganese sulphate (up to 10 cwt. per acre) caused severe lower leaf scorch. However, where ammonium molybdate (2 lb. per acre) was added with the heavy dressings of manganese sulphate, the severity [illegible] manganese-induced lower leaf scorch was mu[illegible] reduced. Applications of some samples of sup[illegible] phosphate have been effective in preventing lower-[illegible] scorch of flax. Such samples have been found [illegible]

but with a normal supply of manganese and iron, has shown a slight general chlorosis, and a necrosis of the lower leaves commencing at the edges. These symptoms appeared to be similar, if not identical, with those of lower leaf scorch or manganese toxicity.

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Synonymy of the Nudibranch Genera *Pellibranchus* and *Okadaia*

Since the publication of a paper[1] describing *Pellibranchus cinnabareus* as a new genus and species of non-pelagic nudibranch mollusc, Dr. Nils H. J. Odhner, of the Riksmuseet, Stockholm, has pointed out to me that *Pellibranchus* is a synonym of *Okadaia* Baba[2]. *Okadaia* contains small nudibranchs less than 5 mm. in length, limaciform, head and foot not carinate; rhinophores simple, contractile, without sheaths; mouth slit-like; gills absent; anus and nephroproct opening slightly to the right of the mid-dorsal line, about a third of the way back from the head; genital orifices obliquely in front of the anus on the right side of the body; jaw plates absent; radula formula, 3, 0, 3; liver divided into three or four lobes; true heart not enclosed in a pericardium; gonads consisting of two or three testes and five or six ovaries; development is direct. These are the characters of the nudibranch described in my paper, and *Pellibranchus* is clearly a synonym of *Okadaia* which now contains *Okadaia elegans* Baba, 1930, the type from Japan, and *Okadaia* (= *Pellibranchus*) *cinnabareus* (Ralph, 1944) from New Zealand.

Both *O. elegans* and *O. cinnabareus* frequent the intertidal zone. Towards the beginning of October, *O. elegans* begins to lay eggs underneath stones. Adult animals and eggs of *O. cinnabareus* can be found under the surface of stones at all seasons of the year. *O. elegans* is most abundant from January to April. Specimens of *O. elegans* are known to occur along the Pacific Ocean side of Japan from Tomoika (Amakusa) to as far north as Akkeshi (Hokkaidô). At present *O. cinnabareus* is known only from tidal runnels along the shore at Island Bay, Wellington.

O. cinnabareus is distinguished from *O. elegans* principally on the structure of the teeth comprising the radula. The first lateral of *O. elegans* has one denticle outside the cusp and two inside, whereas in *O. cinnabareus* the first lateral has only one denticle, which is situated inside the cusp. The third lateral of *O. elegans* takes the form of a squarish plate; but in *O. cinnabareus* it is more conical. Baba[3] gives the colour of *O. elegans* as light orange-yellow. *O. cinnabareus* is bright red. Baba counted 27–54 heart-beats per minute through the transparent integument of *O. elegans*. It is not possible to count the heart-beats in *O. cinnabareus* as the integument is heavily pigmented and non-transparent. Full accounts of the two species have appeared in the *Japanese Journal of Zoology*[2] and the *Transactions of the Royal Society* [illegible] *Zealand*[1].

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MASS-DEFECTS OF THE HEAVY ISOTOPES

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IN preparing the tables for Prof. L. Rosenfeld's book[1] I noticed that an error was made in the mass-defects of the heavy isotopes as given in the "Isotopenbericht 1942" of Flügge and Mattauch[2]. The difference of the mass-defects $\Delta\varepsilon$ in every β-decay was taken equal to the maximum energies of the β-particles, eventually increased by the γ-energies. No correction was made for the fact that a neutron changes into a lighter proton, so that the mass-defect difference is

$$\Delta\varepsilon = 0{\cdot}754 \text{ MeV.} - E_{\beta}.$$

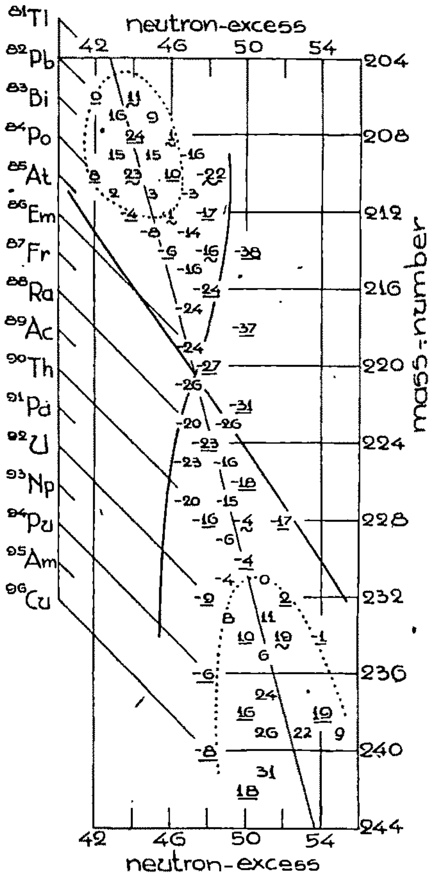
Because this error accumulates in each successive β-decay, the error in the mass-defects difference between the extreme members of each radioactive family is about 4 MeV.

In the accompanying table we give more correct data for the differences in mass-defects relative to Pb^{206}. For the α- and β-energies used, see refs. 3 and 4. The mass-defects of the thorium family are adjusted to those of the uranium family on the assumption that the mass-defects of the lead, polonium and thorium isotopes, all of which belong to the even-even type, should each lie on a parabola. This adjustment can be made with a mean error of 0·5 MeV.

The position of the isotopes of the actinium and neptunium families was more difficult to determine. We used for this purpose a special diagram[5]. In this diagram the difference of the mass-defects from a well-chosen linear function of the mass-number A is written instead of the isotopes in an A—n diagram (n = neutron-excess). This diagram permits the study of the energy surfaces in greater detail than has hitherto been possible. With its aid we discovered that to a close approximation the three energy surfaces (of the even-even, odd-odd and even-odd nuclei) are parallel even in detail: it was possible to bring the diagrams of the three kinds of isotopes on to one drawing by only varying the constant in the linear functions. This has been done[1] for the lighter elements (A less than 65) using the linear functions

$$\begin{aligned}&(\text{even-even})\ 9{\cdot}175\,A - 25{\cdot}0 \text{ MeV.}\\ &(\text{odd-odd})\ \ 9{\cdot}175\,A - 28{\cdot}5 \text{ MeV.}\\ &(\text{even-odd})\ 9{\cdot}175\,A - 27{\cdot}0 \text{ MeV.}\end{aligned}$$

The difference between the (ee)- and (oo)-surface is thus 3·5 MeV., and the (eo)-surface is almost midway between them. Now, from the results for the uranium family it is possible to deduce the difference between the (ee)- and (oo)-surface in the region of the heavy isotopes by assuming that the two (ee)- and the two (oo)-isotopes in it with mass-number 210 should be situated on two parallel parabolas. The difference is 2·03 MeV. If we may suppose that the (eo)-surface is situated halfway between the (ee)- and the (oo)-surfaces, we can give also the mass-defects of the (eo)-isotopes, that is to say, the actinium and neptunium families. It is thus necessary to see if the (eo)-surface is parallel to the other energy surfaces in this case also.



PODOLANSKI DIAGRAM FOR THE HEAVY ISOTOPES (IN UNITS OF 0·1 MeV.). EVEN-EVEN ISOTOPES, STRAIGHT UNDERLINE; ODD-ODD ISOTOPES, WAVY UNDERLINE; EVEN-ODD ISOTOPES, NO UNDERLINE. CONTOUR LINES FOR 0 AND −2·5 MeV. THE STRAIGHT LINE IN THE MIDDLE IS THE LINE OF MAXIMUM MASS-DEFECTS FOR ISOBARS

MASS-DEFECTS OF THE HEAVY ISOTOPES RELATIVE TO Pb^{206}

U family			Th family			Ac family			Np family	
		(MeV.)			(MeV.)			(MeV.)		(MeV.)
Cm^{242}		199·82	Cm^{240}		186·26	U^{239}		181·29	Am^{241}	194·74
Pu^{238}		177·62	Pu^{236}		164·43	Np^{239}		182·60	Np^{237}	172·11
U^{238}	UI	177·90	U^{232}		142·09	Pu^{239}		183·03	Pa^{233}	148·77
Th^{234}	UX$_1$	153·92	Th^{232}	Th	143·22	U^{235}	AcU	160·09	U^{233}	148·47
Pa^{234*}	UX$_2$	153·47	Ra^{228}	MsTh$_1$	119·31	Th^{231}	UY	136·49	Th^{229}	125·19
Pa^{234}	UZ	153·86	Ac^{228}	MsTh$_2$	118·61	Pa^{231}	Pa	136·09	Ra^{225}	101·94
U^{234}	UII	155·04	Th^{228}	RdTh	119·41	Ac^{227}	Ac	113·04	Ac^{225}	101·23
Th^{230}	Io	131·64	Ra^{224}	ThX	96·74	Th^{227}	RdAc	112·51	Fr^{221}	78·94
Ra^{226}	Ra	108·21	Em^{220}	Tn	74·34	Fr^{223}		89·95	At^{217}	57·17
Em^{222}	Rn	84·90	Po^{216}	ThA	52·55	Ra^{223}	AcX	90·48	Bi^{213}	36·13
Po^{218}	RaA	62·30	Pb^{212}	ThB	31·26	Em^{219}	An	68·11	Po^{213}	36·73
Pb^{214}	RaB	40·22	Bi^{212}	ThC	31·10	Po^{215}	AcA	46·87	Tl^{209}	13·91
Bi^{214}	RaC	40·39	Po^{212}	ThC′	32·60	Pb^{211}	AcB	26·19	Pb^{209}	17·03
Po^{214}	RaC′	43·39	Tl^{208}	ThC″	9·10	Bi^{211}	AcC	26·84	Bi^{209}	16·95
Tl^{210}	RaC″	17·81	Pb^{208}	ThD	13·36	Po^{211}	AcC′	26·72		
Pb^{210}	RaD	23·03				Tl^{207}	AcC″	5·39		
Bi^{210}	RaE	22·32				Pb^{207}	AcD	6·11		
Po^{210}	RaF	22·79								
Pb^{206}	RaG	0								
Tl^{206}		−0·95								

For this purpose we have again used a similar diagram. The figures on this diagram of both new families were easy to find by assuming that the lead, polonium and thorium isotopes should be situated on the same parabolas we have already used for the uranium and thorium families. This adjustment was made with a mean error of 0·7 MeV. for the actinium family and 0·5 MeV. for the new neptunium family. This last result is interesting as showing that the experimental values given for the decay energies of these new isotopes are rather accurate. The reliability of the mass-defects we have found from them is still more strikingly confirmed by the fact that the resulting diagram exhibits a much better consistency than was expected. The linear functions used were :

$$\text{(ee) } 5{\cdot}5(A-206) + \varepsilon(\text{Pb}^{206})$$
$$\text{(oo) } 5{\cdot}5(A-206) + \varepsilon(\text{Pb}^{206}) - 2{\cdot}03$$
$$\text{(eo) } 5{\cdot}5(A-206) + \varepsilon(\text{Pb}^{206}) - 1{\cdot}0.$$

We feel justified, therefore, in placing the (oe)-isotopes midway between the (ee)- and (oo)-surfaces. By this means we have made the accompanying table of the differences of the mass-defects of the heavy isotopes from that of Pb^{206}. They are believed to have an error of about 0·8 MeV. Differences for members of the same family are much more accurate, except in the actinium family, where the decay energy of uranium Y (Th^{231}) is unknown. We have taken for its mass-defect that situated on the thorium parabola used above.

Notes added in proof. (*a*) The value for U^{236} in the diagram should be 16 instead of 6 ; (*b*) with the decay scheme of N. Feather (*Nature*, **160**, 749 ; 1947) the mass-defect of U^{239} in the table becomes 182·15 and its value in the diagram 17.

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CONSTITUTION OF CERTAIN BINUCLEAR METALLIC CARBONYLS AND NITROSYLS

By Dr. R. V. G. EWENS

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JENSEN AND ASMUSSEN[1] have recently made some interesting suggestions concerning the nature of the bridge links in polynuclear complex inorganic compounds, and one of the examples they discuss is iron enneacarbonyl, $\text{Fe}_2(\text{CO})_9$. Now the X-ray evidence[2] shows that the structure is essentially that shown in Fig. 1,

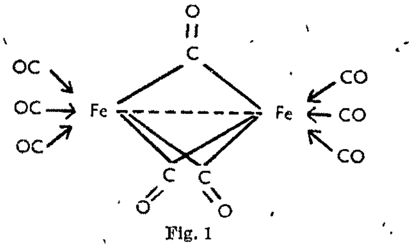

Fig. 1

in which a direct Fe–Fe link accounts for the observe interatomic distance and for the diamagnetism of th molecule. Without such a bond, each iron would b trivalent, with an effective atomic number of 35, a in the paramagnetic $\text{K}_3[\text{Fe(CN)}_6]$ and in the binuclea 1 : 10-phenanthroline iron (III) complex (Fig. 2)

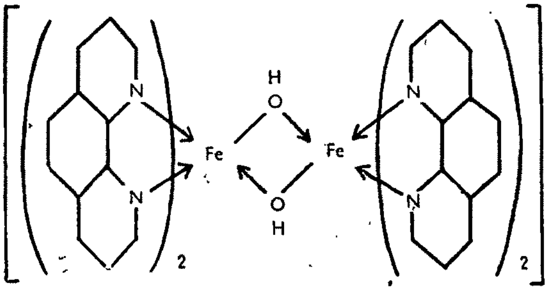

Fig. 2

where an unpaired electron spin is associated wit each iron (III) atom[3] : but with the metal–meta bond the effective atomic number becomes 36 as i the diamagnetic compounds $\text{K}_4[\text{Fe(CN)}_6]$ and Fe(CO)

Jensen and Asmussen make the alternative sugges tion that the diamagnetism of the enneacarbony could be accounted for by resonance between bridg structures which may readily be simplified (Figs. and 4) *without* the assumption of a metal–metal bond

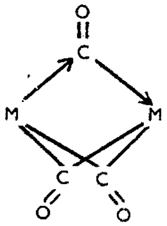

Fig. 3

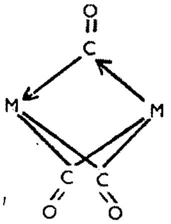

Fig. 4

While such a formulation gives even effective atomi numbers to both iron atoms, 34 to the 'donor' and 3 to the 'acceptor' (numbers which are not affected by the resonance $\text{O} \overset{\rightarrow}{\equiv} \text{C} \rightarrow M \sim \text{O} = \text{C} = M$ in th terminal carbonyl groups), and might thus explai the observed diamagnetism, it does not, in fact dispense with an Fe–Fe bond. For if these structure are written in the alternative way with $\overset{+}{B} - \overset{-}{A}$ instead of $B \rightarrow A$, they become Figs. 5 and 6. I

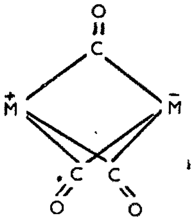

Fig. 5

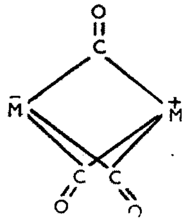

Fig. 6

is thus clear that Jensen's scheme simply replace the symmetrical covalent M—M link by a resonance hybrid $\overset{+}{M} : \overset{-}{M} \sim \overset{-}{M} : \overset{+}{M}$ derived from the extrem ionic forms. Such a mesomeric state is tantamount to a link with sufficient covalent character to justify the use of the single symbol Fe–Fe, any contribution from such ionic states being implied in the customary manner.

Moreover, Jensen and Asmussen's supposition demands a resonance between two valency states (formally II and IV). Now numerous complexes of this type are known and, as these authors point out elsewhere in the same paper, the resonance is associated with intense colour. But the colour of iron enneacarbonyl is only orange-yellow, and the cobalt carbonyl $Co_2(CO)_8$, the formulation of which entails the same difficulty, is but a pale yellow, so that this evidence certainly offers no support for Jensen and Asmussen's view.

It would, however, be very curious if this rare type of metal–metal linkage were confined to iron enneacarbonyl; but it appears certain that other examples exist. Thus the dimeric and diamagnetic cobalt tetracarbonyl $Co_2(CO)_8$ can be formulated as in Fig. 7,

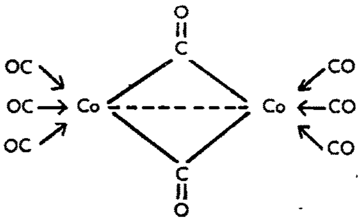

Fig. 7

in which the cobalt, initially with one electron more than iron, requires one carbonyl bridge less to become isoelectronic (effective atomic number 36) with the metal atom in the diamagnetic $K_3[Co(CN)_6]$ and the diamagnetic iron compounds above.

'Roussin's red salt' and its analogues form an even more interesting group of compounds, the structures of which may be explained in a similar manner. These compounds are all of the type $Fe(NO)_2X$, where X may be $—S^-K^+$ (the original red salt), —Cl[4], —I[5], $—S.C_2H_5$, $—S.C_6H_5$, or $—S.SO_3^-K^+$ (the thiosulphate). Of these the chloride and the ethyl and phenyl esters have been shown to be dimeric, while Roussin's red salt itself[6] and the thiosulphate[7] have been shown to be diamagnetic, so that we may fairly assume the degree of polymerization and the magnetic behaviour to be the same for all these substances. They may then be assigned the general structure shown in Fig. 8, in which each nitrosyl

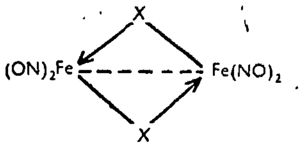

Fig. 8

group contributes three electrons to the metal atom (as in $\overset{=}{M} - \overset{+}{N} \equiv \overset{+}{\mathrm{O}} \sim \overset{+}{M} = \overset{-}{N} = \mathrm{O}$[9]). In addition, each iron atom acquires three electrons from the bridging groups and one from the Fe–Fe link, giving 26 + 2 × 3 + 3 + 1 = 36 as the effective atomic number.

An earlier view, that these compounds are really hyponitrites, has been criticized by Manchot[9], and is rendered the more unlikely by the observations that iron dinitrosyl dicarbonyl $Fe(NO)_2(CO)_2$, in which the NO groups are distinct[8], reacts smoothly with iodine[6] and with benzenethiol[10] to give the corresponding Roussin-type compounds. This being so, the above bridged structure is the only plausible alternative, and the Fe–Fe link is then necessary to explain the diamagnetism.

Even the more complicated Roussin's black salt $K[Fe_4(NO)_7S_3]$ can be explained on similar lines. A fuller account of this and other matters related to the above discussion will be published elsewhere in due course.

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CHROMOSOMAL EVOLUTION IN THE EUROPEAN MOLE-CRICKET

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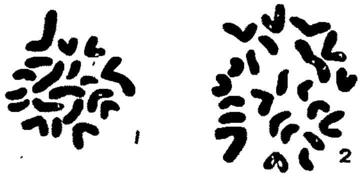
IT is well known that species belonging to the same genus frequently differ in their chromosomal numbers. Special interest is attached to this diversity, since it may furnish a clue to the mode of evolution of the species. Although reduction in number of chromosomes appears to occur fairly frequently, practically nothing is known about their increase in numbers except by polyploidy, which occurs very rarely in animals. The European mole-cricket (*Gryllotalpa gryllotalpa* L.) is a most interesting example of a progressive increase in chromosome number within the limits of the same species. It would appear that speciation based on diversification of chromosome numbers is here at work.

The species *G. gryllotalpa* may be divided into four geographical races which differ in their chromosomal numbers. The northern race found in Belgium, Germany, France and northern Italy has 12 chromosomes (10 autosomes and XY)[1,2]. In Roumania there is a second race with 14 chromosomes (12 autosomes and XY)[3]. A third race in central Italy is characterized by 15 chromosomes in the male (14 autosomes and X)[4], while a type with 17 chromosomes was observed in southern Italy[5]; the same type has recently been found by Barigozzi[6].

Barigozzi[7] and de Winiwarter[2] suggested that fragmentation of two pairs of anisobrachial metacentric chromosomes of the northern race may have given rise to the two additional small pairs characteristic of the central Italian type. This hypothesis is certainly much too simple, as it is well known that acentric fragments are non-viable. White[8], on the other hand, postulated that evolution occurred by reduction of the number of chromosomes, since two species of *Gryllotalpa*, namely, *G. borealis* and *G. africana* and a related genus *Scapteriscus*, have 23 chromosomes (22 autosomes and X).

In a cytological study of the Palestinian mole-cricket, which belongs to *G. gryllotalpa*, we observed two new races, one with 19 chromosomes (18 autosomes and X, Fig. 1), and the second with 23 (22 autosomes and X, Fig. 2). The first (19 chromosomes) is common throughout Palestine (Judean Hills, the coastal plain, Valley of Esdraelon, Beisan



Figs. 1 and 2. SPERMATOGONIAL METAPHASE OF MOLE-CRICKET: (1) PALESTINIAN RACE, 19 CHROMOSOMES; (2) DEAD SEA RACE, 23 CHROMOSOMES; FROM PREPARATIONS FIXED IN 15 PARTS PICRIC ACID, 5 PARTS FORMALIN, 1 PART 45 PER CENT ACETIC ACID

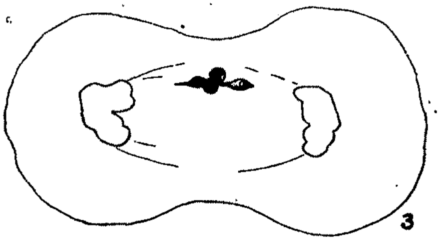


Fig. 3. TELOPHASE OF MEIOTIC DIVISION, AN OCTAD LAGGING IN EQUATORIAL PLANE, PREPARATION FIXED IN BOUIN'S SOLUTION. ALL SECTIONS 10 μ THICK, STAINED IN HEIDENHAIN'S HÆMATOXYLIN. × 2100

Valley and Galilee), while the second (23 chromosomes) is restricted to a single locality very close to the Dead Sea.

All the elements of the Palestinian race seem to be homologous with those of the central Italian race, except that six small chromosomes occur instead of only two of the same size which are found in the Italian type. In the Dead Sea race there are ten such small chromosomes. In the light of these facts, it was difficult to assume that the direction of evolution was towards reduction, as all the remaining elements appear identical in the three races, a fact which argues against the possibility of translocation. On the other hand, it is also difficult to assume that eight elements would disappear from the chromosome pattern, leading from the Dead Sea type to that of central Italy.

The behaviour of these chromosomes at meiosis was found to be peculiar. In approximately 13 per cent of the observed cases, certain chromosomes lag in the anaphase and telophase. These chromosomes, which can be identified as the small ones, remain as tetrads in the equatorial plane during the anaphase movement of the other dyads. Sometimes plates with octads are seen, linked by means of chiasmata (Fig. 3), a fact which clearly demonstrates the common origin of these small chromosomes. In most of these cases the normal separation of the dyads finally occurs, the dyads joining the nuclei almost at the termination of telophase. But in a considerable percentage of cases a whole tetrad passes to one daughter nucleus, and sometimes even an octad passes to one pole. As a result of this non-disjunction, among second spermatocytes there are cells containing eleven dyads as well as others containing only seven. Since spermatids with varying numbers of chromosomes are formed, one might expect to find mole-crickets with varying numbers of chromosomes, 17, 18, and 21. Examination of 140 mole-crickets from six localities in Palestine has shown that 19 is the only chromosomal number found. Hence it may be concluded that the exceptional gametes or the new types emerging from them are non-viable at some stage in development.

The six small chromosomes show no heteropycnosis at the meiotic prophase, whereas the two small chromosomes in the Italian race exhibit a typical heteropycnosis during meiosis, and become precociously condensed at prophase together with the X-element. In the light of this evidence, it is difficult not to conclude that we are dealing with the establishment of permanent from supernumerary chromosomes, in other words, a transition from hetero- to euchromatin. While the transformation of euchromatin to heterochromatin by mutation of active genes to inert ones is more frequently postulated by geneticists, the reversion of this process appears equally plausible.

It may be significant that heterochromatic chromosomes are still present in the Roumanian race and that they behave as typical supernumeraries, that is, their number in the population fluctuates. Thus mole-crickets with 15 or 16 chromosomes are found in addition to the common type with 14 elements[3]. In size and form the additional chromosomes correspond to those described in the Palestinian material. Supernumerary chromosomes of a similar type were also found in *G. africana*[4].

Due to their inertness, supernumerary chromosomes may increase in number in some individuals without causing conspicuous damage. On the other hand, Darlington claimed that in some cases (*Zea Mays*, *Cimex*, etc.) they possess adaptive advantages[9,10]. It may be that a further step involving a certain number of new viable mutations establishes them in certain types.

In this connexion it is interesting to note that the highest chromosome number among the Palestinian mole-crickets (23) is found in the Dead Sea locality, where temperature fluctuation and salinity of soil are extreme. It is an almost inevitable conclusion that the two additional pairs of small chromosomes contain a set of polygenes which enable this race to survive under extreme conditions.

The chromosomes of *G. africana* (23) from the southern Dead Sea fully conform to the description of previous authors[4]. They differ fundamentally from the 23 chromosomes of the Dead Sea race of *G. gryllotalpa*. The 23 chromosomes of *G. africana* can be arranged in a series of fours, which makes it probable that the species is a tetraploid.

Thus the number 24 (in the female) was reached twice by independent methods in the mole-crickets. Whereas in *G. africana* (and probably *G. borealis* and *Scapteriscus*) 24 were obtained by doubling of the original set of 12, in *G. gryllotalpa* a progressive accumulation of small (heterochromatic) chromosomes led to the establishment of a whole series of geographical races and found its climax in the Dead Sea race with the same number, 24. A fuller discussion of this problem and of the origin and behaviour of the small chromosomes will be published elsewhere.

I would like to express my appreciation to Dr. E. Goldschmidt for her aid and encouragement during the progress of this work.

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WRITTEN EXPRESSION IN SCIENCE

A CONFERENCE at the City Boys' School, Leicester, convened and presided over by the headmaster, Mr. R. W. Crammer, was held on March 12 to discuss the problem of the difficulty experienced by science graduates in writing reports and the ways in which the grammar schools could help in overcoming it. Dr. U. R. Evans, reader in the science of metallic corrosion in the University of Cambridge, who had raised the matter in the University Senate House, addressed the conference in a private capacity. There were seventy people present, including the heads of grammar schools in the City and County of Leicester, their English and science masters and mistresses and representatives from Leicester University College, the Domestic Science College and the Women's Training College. The conference was welcomed not only because of the importance of its subject but also because it brought together representatives of the grammar schools and of institutions of higher education for the discussion of a common concern.

In his address, Dr. Evans said that one of the few serious complaints raised to-day against the young scientific graduate refers to his alleged inability to express findings in a written report. Since a report still represents the best means available for a scientific worker to share his knowledge with others, the complaint is a serious one, and suggests that the writing of English does not receive sufficient attention at schools and universities. The dreary character of many papers printed to-day in scientific journals provides further evidence. Complaints are heard of the excessive length of papers submitted for publication, and it is often felt that the mode of presentation is such that a paper fails to hold the attention of those whom it ought to interest; a common fault is the omission to make clear the reasons for selecting the subject of investigation, and to emphasize the significance of the results for those working on other subjects.

The main trouble seems to arise from the fact that often the young scientific worker has no love for writing. Whatever disciplinarians may say, it is doubtful whether anyone makes a real success of a ask which gives him no sort of satisfaction. Enhusiastic and hard-working experimenters show an obvious reluctance to produce reports by the appointed day, and require a surprising length of time o produce a very simple memorandum. Even if the results, when ultimately completed, were perfect, the bvious disinclination to use the pen in the communication of ideas reveals an unsatisfactory state of affairs. This aversion to writing is often shown by men who are extremely successful in explaining their ideas by word of mouth.

It is significant that the difficulties affect many who have attained conspicuous success in the examination hall; there they may have been helped, in manner of which they were scarcely aware, by the fact that they were writing down facts or arguments previously read in a book or heard at a lecture. When suddenly confronted with the task of discovering for themselves a sequence of words to express something hitherto unreduced to verbal form, they experience the same difficulty as is met with y someone who, at the age of twenty, starts to express himself in French or German. In both cases the difficulty would probably be lessened if the first attempts were made at an earlier age.

There are certain grammatical problems met with in reports which, unless solved, can endanger correct understanding. A report usually refers to work accomplished within some definite period, and starts with a statement of the position at the outset, largely based on the work of the previous period; here the correct employment of pluperfects and perfects often presents difficulty. Next will come the programme for the new period, and now the periphrastic constructions needed to express plans made in the relatively distant past for work in the immediate past sometimes involve perplexity—especially since subjunctives and conditionals must often be introduced (for example, where there has been doubt as to how the plans would work out). In the experimental section the problems of expression are mainly technical, but the author's interpretation of his results, involving comparisons with the views of others, may necessitate passage between *oratio recta* and *oratio obliqua*, which some writers find far from easy.

The understanding of a report can be greatly helped by consistent use of the different classes of headings available for division into sections and subsections; conversely, if headings are used indiscriminately, understanding is hindered. Again, punctuation used on any consistent plan will assist comprehension; stops thrown in at random are worse than useless.

It would seem that definite instruction, which need not occupy many hours of school time, is needed in certain subjects—such as punctuation and systematic division into sections and subsections; but that most of the troubles would pass away if the boys received plenty of practice under conditions favourable to the cultivation of a taste for writing. Essay-writing seems to be accepted as the standard method of gaining experience in the arrangement of words, but only a certain type of essay will aid report-writing—namely, that dealing with some subject which the writer has never before seen or heard described in words. A commentary upon a stage-play or film may be a better choice than a discussion of matters described in printed books. The reading of books by great authors is advocated by many. Clearly such reading is worth while for its own sake, but it is doubtful how far literary masterpieces can help the writing of scientific reports; it is scarcely a compliment to their authors to suggest that a style skilfully developed for one purpose should be adopted for another. Nevertheless, the reading of certain authors may serve to enlarge the reader's vocabulary and may show him how the skilful selection of words can introduce delicate shades of meaning into the picture presented. Perhaps others may be found to provide examples of terseness—a matter of practical importance in days when the supply of paper is short and the patience of readers not inexhaustible.

Mr. Crammer, in opening the discussion, pointed out the psychological and sociological difficulties encountered by the grammar schools in the teaching of written expression in English. The grammar schools have in recent years admitted more and more pupils coming from homes in which there is little or no culture or encouragement in the reading of good books or conversation, let alone in writing. The social atmosphere generally has tended to counteract the training in writing given in the schools, a point which was taken up and emphasized by subsequent speakers, who laid stress on the decline in reading due to the cinema and the radio, as well as on the absence of æsthetic and literary standards in the home.

Others blamed the too early and the excessive specialization in the schools, a fault which the latter referred back to the universities and the increasingly high standard of attainment required by them for the award of scholarships. The 'objective' tests, consisting of one-word answers often used in the examinations for entrance to the grammar schools, were also criticized as not encouraging the teaching and practice of continuous written English in primary schools.

The vital importance of frequent practice in writing was admitted, but the burden of marking it imposed upon the teachers of English would be intolerably heavy if more practice was to be given without an increase in free periods for marking. The position would be better if all teachers, and not only those directly responsible for the teaching of English, regarded themselves as teachers of English as well as of their special subjects, and took the trouble to correct faulty English in all written work. One speaker rightly objected to the division of English into 'Science' English and 'Literary' English; the science graduate's difficulty in written expression is part of the general problem of the teaching of English to all pupils, irrespective of the forms of their later specializations.

After Dr. Evans had replied to the various points raised, Mr. Crammer summed up the discussion. It was clear, he said, (1) that there was general agreement about the necessity of all teachers, and not only the teachers of English, making the writing of English their concern, and (2) that continuous practice in writing is essential and must go on into and throughout the university course as well as throughout school life. It was worth considering whether in science scholarship examinations an essay and a general paper should be made compulsory and should be given considerable weight in deciding the awards. A committee representative of both schools and colleges was formed to investigate the problem further with a view to the formulation of constructive suggestions.

PHYSIOLOGY AND BIOCHEMISTRY OF FATS AND LIPOIDS

A PHYSIOLOGICAL symposium on fats, arranged by Le Centre National de la Recherche Scientifique and supported by the Rockefeller Foundation, was held in Paris during January 5–12. The meetings took place in the Department of General Physiology (Prof. G. Schaeffer) at the Sorbonne. Prof. E. F. Terroine presided.

The conference was opened with a paper by Prof. A. C. Frazer (Great Britain), who described new methods for the study of fat absorption problems, and presented the results of his investigations on the nature of the intestinal emulsifying system and hydrolysis of triglyceride. Prof. P. Desnuelles (France) reported experiments which have confirmed and extended Prof. Frazer's work on the formation of di- and mono-glycerides as end-products of pancreatic lipolysis. Miss E. Le Breton (France) spoke of her demonstration of A- and B-lecithinases and cholesterol esterase in the pancreatic juice. Its possible importance in the fat absorption mechanism was discussed. Prof. F. Verzar (Switzerland) reviewed his work on fat absorption, dealing particularly with his experiments relating the adrenal cortex to fat absorption. Prof. A. C. Frazer followed with a detailed account of the experimental work of his school on the intracellular and distributive phases of fat absorption. Prof. P. E. Verkade (Holland) gave a short paper which illustrated the inadequacy of the alleged solvent action of bile salt solutions for fatty acids. In the subsequent discussion, agreement was reached on the questions of intraluminar emulsification, the probable importance of hydrolysis, phosphorylation and the adrenal cortex in the fat absorption mechanism, and the possible occurrence of particulate absorption of fat. The extent of hydrolysis, amount of material absorbed in particulate form, the function of phosphorylation, and the nature of the influence of the adrenal gland on the fat absorption mechanism, were fully discussed.

Prof. T. Cahn (France) described investigations in dogs designed to determine the effect of muscular exercise, fasting, hyperthermia and pancreatectomy on fat mobilization; and Dr. G. Clément (France) discussed the effects of unilateral denervation on fat mobilization in rats. The relationship between B-lecithinase and cholesterol esterase in the blood, and its influence in the formation of cholesterol esters, was raised by Miss E. Le Breton. Prof. M. Machebœuf (France) described his work on lipoprotein complexes in blood and gave an account of his extensive investigations into the lipoid content of fractionated plasma proteins, and interesting observations on the replacement of lipoids in lipoprotein by substances of similar molecular structure. Prof. E. Chargaff (United States) gave a survey of the association between lipoids and proteins in biological systems, discussing the possible nature of the forces concerned in the construction of these complexes, with numerou illustrations from his own experiments.

Prof. A. C. Frazer presented an account of som new methods which had been developed for the study of particulate fat in a protein environment. H described his experiments on blood fat and artificia particulate systems. He also reported X-ray dif fraction studies on nerve lipoprotein which demon strated the importance of water in lipoprotei structure, and other useful data. A lengthy discussio on all aspects of blood fat and the methods of stud of lipoprotein complexes ensued. Later, Prof. E Chargaff spoke of his work on blood coagulation with particular reference to the part played b lipoproteins in these reactions.

Prof. K. Bernhard (Switzerland) described th biological degradation of fatty acids. With extensiv references to his own work in this field, he discusse β-, ω- and multiple-oxidation. He suggested tha β-oxidation is most likely to occur under natura conditions and that ketones are mainly formed b condensation of the 2-carbon fragments split off b β-oxidation. Prof. P. Verkade discussed the relatior ship between the ingestion of carbohydrate an triundecylin and the excretion of undecanedioic aci in the urine in healthy human subjects. Administra tion of carbohydrate causes an increase of dioi aciduria. The possible significance of liver glycoge in these experiments was discussed. Prof. R. I Barnes (United States) gave a detailed account recent work on ketogenesis. He described the variou steps in the elucidation of this problem by the u of isotope-labelled materials, and put forward a ne hypothesis to explain the anti-ketogenic action of carbohydrates. A session was also devoted to the consideration of lecithin degradation. Dr. M. Kahane (France) described his investigations into the presence of water-soluble choline esters in the blood and tissues, and Prof. J. Roche (France) gave an account of enzymological studies on the hydrolysis of phosphoryl choline and phosphoryl colamine by phosphatases. The structure and hydrolysis of egg lecithin were discussed by Prof. P. Fleury (France).

The nutritional importance of essential unsaturated fatty acids was discussed after a survey of work in this field had been given by Prof. K. Bernhard and Prof. R. H. Barnes. Miss E. Le Breton described experiments on fatty acid dehydrogenases. She described the relationship of certain vitamins and phosphorylation to the activity of these desaturases. Their possible significance in the problem of essential fatty acids was discussed.

In the concluding session, Dr. C. Paquot (France) described his work on the autoxidation of fats, and presented theoretical considerations, both on this question and on the subject of anti-oxidants. Prof. A. Chevallier (France) described apparent relationships between the oxidation and ultra-violet absorption of glycerides, and Prof. P. Dubouloz (France) spoke of his researches on anti-oxidants in relation to vitamin A. He discussed the mechanism of anti-oxidant action and described preliminary experiments on the physiological properties of peroxidized lipids. Prof. R. H. Barnes gave a survey of recent work carried out in the United States on anti-oxidants, and the development of oxidative rancidity in fats. He emphasized the possible importance of rancidity in biological processes.

The official business of the symposium was completed in eight days and was carried through in a most cordial atmosphere. The full proceedings, including summaries of the various discussions, will be published in due course in the *Archives des Sciences Physiologiques*.

METABOLIC ASPECTS OF CONVALESCENCE

THE *Transactions* of two conferences on "Metabolic Aspects of Convalescence" referred to below* make very stimulating reading. Although they are often so specialized that possibly only those who have themselves worked in the particular fields will fully appreciate the significance of some of the questions and answers, yet the general impression left after reading them is that one has made the 'Grand Tour' and become personally acquainted with very interesting people and ideas.

With the exception of the symposium on bone metabolism (*Trans. Fourteenth Meeting*), the reports are more in the nature of short progress notes rather than balanced statements of experiment and interpretation. As one contributor remarks, "The data presented are of a preliminary nature and are offered in the hope that they may stimulate discussion".

Convalescence is concerned with the repair of injured tissues and the restoration of normal functioning so that, in effect, the study of its metabolic aspects is very similar to the general study of growth and development. The vast mass of interrelated factors—which scientific workers are only at the beginning of unravelling—is well illustrated by the wide range of subjects covered at these conferences. The reader finds himself switched from "A Comparison of the Effect of Testosterone Propionate on the Enzyme Content of the Kidney and Liver of Castrated and Normal Rats" to "Metabolic Studies before and after Operation of Chronically Ill Patients fed entirely by Vein", or from "Partition Chromatography on Paper" to "Peritoneal Lavage in Uremia". There were sixty-five reports at the thirteenth meeting and thirty-five at the fourteenth. Between them they seem to cover the ground remarkably thoroughly, and anyone whose work is concerned with any aspect of growth or development is likely to find some point of interest which may well give a new turn to his line of thought. The symposium on bone metabolism (a subject to which a large part of earlier meetings in the series has been devoted) forms a contrast to the rest of the papers. The reports presented are longer and more detailed; there is a clear exposition of contrasting hypotheses and a series of very clear photographs.

These reports pose questions rather than provide answers, but they give the impression of being full of helpful clues and well worth studying.

M. W. GRANT

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* Conference on Metabolic Aspects of Convalescence. *Trans.* Thirteenth Meeting, Nawshon Island, Woods Hole, Mass., June 11, 1946. Pp. ii+232. 2 dollars. *Trans.* Fourteenth Meeting, New York, Nov. 2–13, 1946. Pp. ii+190. 2.25 dollars. (Josiah Macy, Jr., Foundation, 65 Park Avenue, New York, 1947.)

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, April 5

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Dr. T. Dalling and Dr. A. W. Stableforth: "Bovine Mastitis".

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (joint meeting with the INSTITUTE OF REFRIGERATION, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. G. Eichelberg: "Heat-Pump Problems and Industrial Realizations".

SOCIETY OF ENGINEERS (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. G. Vokes: "Filtration".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. John Lawrence: "The Russian Land and History".

Monday, April 5—Tuesday, April 6

SOCIETY OF CHEMICAL INDUSTRY (in the Mathematics Lecture Theatre, Royal College of Science, Huxley Building, Exhibition Road, London, S.W.7).—Symposium on "Detergents, Wetting and Emulsifying Agents".

Monday, April 5

At 2.15 p.m.—"Synthetic Detergents".

Tuesday, April 6

At 2.15 p.m.—"Wetting Agents and Auxiliary Products".

Tuesday, April 6

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. C. R. Rao: "The Utilization of Multiple Measurements in Problems of Biological Classification".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the GLASGOW SECTION and the GLASGOW AND DISTRICT SECTION of the ROYAL INSTITUTE OF CHEMISTRY, in the Gas Showrooms, Sauchiehall Street, Glasgow), at 2.30 p.m.—Dr. E. C. Bate-Smith: "Refrigeration in Germany"; Mr. H. J. Bunker: "War-time Production of Food Yeast in Germany"; at 7 p.m.—Mr. J. F. Hearne: "German Albumen Substitutes"; Mr. C. B. Brown: "German Synthetic Detergents".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. Leon Underwood: "African Art and its Place in Art Tradition".

Institution of Civil Engineers (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. R. A. Foulkes: "The Use of Light Alloys in Structures".

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. G. Pearce: "Recent Developments in Cast Iron".

Manchester Geographical Society (at the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Miss F. A. Roper: "Places of Interest on the Mediterranean Seaboard".

Royal Statistical Society, Tees-side Sub-group of the Industrial Applications Section (at the William Newton School, Norton, Stockton-on-Tees), at 7 p.m.—Dr. O. L. Davies: "Correlation Problems in the Chemical Industry".

Tuesday, April 6—Friday, April 9

Physical Society (at Imperial College, Imperial Institute Road, London, S.W.7).—Thirty-second Exhibition of Scientific Instruments and Apparatus.

Wednesday, April 7

Institute of Fuel, North-Western Section (at the Engineers' Club, Albert Square, Manchester), at 1.30 p.m.—Annual General Meeting; at 2.30 p.m.—Dr. H. E. Crossley: "External Deposits on the Heating Surface of Boiler Plant".

Royal Society of Medicine, History of Medicine Section (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Symposium on "Conan Doyle and the Doctor and Detective Fiction".

Royal Statistical Society, Birmingham Group of the Industrial Applications Section (at the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Dr. D. G. Beech: "Statistics Applied to Pottery Problems".

Institute of Welding, Manchester and District Branch (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Annual General Meeting; Mr. G. Foster: "Welding in Railway Workshops".

Society of Public Analysts and other Analytical Chemists (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Thursday, April 8

Physical Society, Acoustics Group (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 5.15 p.m.—Annual General Meeting; at 5.45 p.m.—Discussion on "The Use of Microphones and Loudspeakers in Buildings and Sound Amplification and Distribution" (to be opened by Mr. Hope Bagenal).

Institute of Physics, Electron Microscopy Group (in the Anatomy Lecture Theatre, King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. V. E. Cosslett: "Recent Advances in Electron Microscopy in Great Britain".*

British Institution of Radio Engineers, London Section (at the E.M.I. Studios, Ltd., Abbey Road, London, N.W.8), at 6 p.m.—Mr. W. S. Barrell and Dr. G. F. Dutton: "High Fidelity Recording and Reproduction".

Chemical Society (in the Chemistry Department, The University, Manchester), at 6.30 p.m.—Scientific Papers.

British Institution of Radio Engineers, North-Western Section (in the Reynolds Hall, College of Technology, Sackville Street, Manchester), at 6.45 p.m.—Mr. H. Stibbe and Mr. K. G. Lockyer: "Factors Governing the Performance of I.F. Amplifiers".

Friday, April 9

Biochemical Society (at University College, Dublin), at 1.30 p.m.—Scientific Papers.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. Bertil Lindblad: "The Dynamics of the Stellar Systems" (George Darwin Lecture).

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Annual General Meeting.

Sheffield Metallurgical Association, Methods of Analysis Group (at 198 West Street, Sheffield), at 7 p.m.—Mr. B. Bagshawe: "Absorptiometric Determination of Silicon".

Society of Instrument Technology, Midland Section (at the Chamber of Commerce Buildings, New Street, Birmingham), at 7 p.m.—Mr. E. E. Hancox: "An Introduction to pH and its Measurement".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Herman F. Mark: "Mechanical Properties of High Polymers as related to their Structure".

Saturday, April 10

British Psychological Society (at the University, Edmund Street, Birmingham), at 12.15 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Mycologist in the Plant Pathology Department—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (April 10).

Laboratory Steward for the Department of Zoology—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (April 10).

Lecturer in Taxonomy (Zoology)—The Secretary of University Court, The University, Glasgow (April 14).

Vice-Chancellor, a Professor of Chemistry, a Professor of Mathematics, a Professor of Medicine, a Professor of Surgery, a Professor of Pathology, a Lectureship in Psychology, a Lectureship in Chemistry, a Lectureship in Economics, and a Junior Lectureship (Tutorship) in English, at the University of Hong Kong—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (April 16).

Educational Psychologist in the University Education Centre—The Secretary, The University, Edmund Street, Birmingham 3 (April 17).

Assistant Agricultural Economist in the Department of Agriculture—The Registrar, The University, Leeds 2 (April 19).

Lecturers or Assistant Lecturers in the Department of Physics—The Registrar, The University, Manchester 13 (April 24).

Assistant Archæology Officer—The Deputy Director of Establishment and Finance, Ordnance Survey, Leatherhead Road, Chessington, Surrey (April 26).

Assistant Lecturer in Chemistry (Inorganic and Physical)—The Registrar, University College, Singleton Park, Swansea (April 28).

Lecturer in Biochemistry, and Demonstrators (2, one in Biochemistry and one in Physiology)—The Registrar, University College of South Wales, Cathays Park, Cardiff (April 30).

Lecturer in Botany, an Assistant Lecturer in Mathematics (Pure Mathematics), an Assistant Lecturer in Chemistry (preferably with interests in Inorganic and Physical Chemistry), and an Assistant Lecturer in Botany—The Principal, Royal Holloway College, Englefield Green, Surrey (May 3).

Headships of the Departments of Physics, Mathematics, Chemistry at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (May 10).

Principal of the Canberra University College—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (May 15).

Assistant Chemists (Honours degree majoring in chemistry), an Assistant Chemist (Honours degree specializing in colloidal chemistry for research on rotary drilling fluid controls), Assistant Physicists (1st class Honours degree in physics with mathematics and some chemistry), a Chemical Engineer, and "Mud" (Trainee) Engineers (Graduate chemists with working knowledge of colloidal chemistry), to undertake research duties with a large industrial organization in the Middle East—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F.263/47A (May 20).

Junior Lecturer in Applied Mathematics—The Secretary of Faculties, University Registry, Oxford (June 2).

MacLeod-Smith Chair of Biological Chemistry—The Secretary, The University, Aberdeen (June 15).

Principal of Auckland University College, Auckland—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (June 30).

Chair of Geology, and the Chair of Zoology, at the University, Sydney—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Sydney, June 30).

Lecturer in Bacteriology and Parasitology—The Principal, South African Native College, Fort Hare, C.P., South Africa (applications to be made by air mail).

Scientific Officer, and Assistant Experimental Officers (2), for research on the antibiotic substances of streptococci—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

Assistant Engineer (Grade BI) for Filtration Research—The Clerk to the Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1, quoting Ref. N.

Chemist (Organic) for the Department of Chemical Pathology—Prof. N. F. Maclagan, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1.

Scientific Officer to assist in research problems connected with steel castings—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Technical Engineer in the Department of Atomic Energy (Production)—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

Laboratory Assistant (Grade I) for the Physiology Department—The Secretary, King's College of Household and Social Science Campden Hill Road, London, W.8.

Chief Chemist to take charge of the work of the Chemical Department at laboratories at Elmstead Woods—The Director, British Scientific Instrument Research Association, 26 Russell Square, London, W.C.1.

Demonstrator in the Department of Physics—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

Junior Graduate Chemist in the photographic and chemical section of the Optical Department—The Superintendent of Laboratories, British Scientific Instrument Research Association, 'Sira' Southill, Elmstead Woods, Chislehurst, Kent.

Graduate B.Sc. in Chemistry or Biochemistry, with experience of hospital laboratory work—The Medical Officer of Health, Johnston Terrace, Edinburgh 1.

Senior Geologist for Mines Department, Adelaide—The Agent-General for South Australia, South Australia House, Marble Arch London, W.1.

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CONTENTS

Page
Freedom and Loyalty 537
Family and Nation 539
Food Poisoning 540
Organisation, Meteorology and Weather Prediction. By M. K. Miles 540
Mathematics for Electrical Engineering. By V. J. Francis . . . 541
Advances in Physiology. By Dr. O. A. Trowell 542
Biological Applications of Ultra-violet and Infra-red Radiation. By H. G. Jenkins 542
The Argument from Mouse to Man. By Prof. C. H. Waddington, F.R.S. 543
Scientific Aspects of the Work of the National Coal Board. By John Crossland 546
The Future of the New Forest. By Prof. H. G. Champion, C.I.E. . 547
The Status of the Protozoa. By Dr. John R. Baker 548
The Artificial Production of Mesons. By Dr. G. P. S. Occhialini and Dr. C. F. Powell 551
News and Views 552
Letters to the Editors :
  Distribution of Alkaline Phosphatase in the Eggs of a Sea-urchin.—Elsa Wicklund 556
  Alkaline Phosphatase in Various Cell Types of the Anterior Pituitary of the Guinea Pig.—Prof. Leo Abolins 556
  Influence of Vitamin P (Vitamin C_2) upon the Amount of Ascorbic Acid in the Organs of the Guinea Pig.—H. Cotereau, M. Gabe, E. Géro and Prof. J.-L. Parrot 557
  The Nucleolus of the Apodan Sertoli Cell.—B. R. Seshachar . 558
  A Cytochemical Study of the Perinuclear Lipidic Layer in the Liver Cell.—Dr. C. A. Baud 559
  Staphylokinase: an Activator of Plasma Protease.—Charles H. Lack 559
  Hæmolytic System in the Blood of Malaria-infected Monkeys.—Dr. H. Laser 560
  Nitrogen Metabolism After Fracture.—Dr. H. N. Munro and Miss M. C. Cumming 560
  Effect of Colchicine Treatment on the Alkaloidal Content of *Datura metel*.—A. E. Beesley and Dr. G. E. Foster 561
  Structure of Yeast Ribonucleic Acid.—The late Prof. J. Masson Gulland, F.R.S., and D. O. Jordan 561
  Adsorption of Calcium Ions by an Acid-extracted Brown Alga under Continuous Flow Conditions.—Dr. A. Wassermann . 562
  Ferromagnetic Structure of Cold-Worked Austenitic Stainless Steels.—P. T. Hobson and W. P. Osmond 562
  Effect of the Electron Beam on the Voltage Distribution of a High-Voltage Multi-Stage Electron Accelerator.—F. W. Waterton 563
  Apparent Emission of Positive Electrons from β-Emitters.—C. B. A. McCusker 564
  Relation Between Photoconduction and Luminescence in Zinc Sulphide.—Dr. M. H. F. Wilkins and Dr. G. F. J. Garlick . . 565
  Ozone and Auroral Spectra.—Dr. A. Vassy and E. Vassy . . 566
  Mass-Spectrographic Separation of Isotopes of Gaseous Elements.—Dr. J. Koch 566
  Normal Stress Coefficient in Solutions of Macromolecules.—R. S. Rivlin 567
  Jellyfish from the Basal Cambrian in South Australia.—Reg. C. Sprigg 568
  Cementiferous Paints and their Uses.—Prof. G. Wesley Austin . 569
  Flint Flaking.—S. Hazzledine Warren 569
Hormone-Mimetic and Other Responses of the Silkworm (*Bombyx mori* L.) to Some Polyploidogenic Agents. By L. J. Havas and J. Kahán 570
Industrial Co-operation. By T. H. Hawkins 571
History of Science in Education 572
The Government Social Survey. By Maurice Goldsmith . . . 573
Insecticidal Smokes 574

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FREEDOM AND LOYALTY

IN the course of his inspiring address on "The Scientist in Industry" to the Federation of British Industries at a meeting held at the Royal Institution on March 19 in honour of him and Sir Robert Robinson as Nobel Prize winners in 1947, Sir Edward Appleton referred to the vital importance of avoiding any segregation or isolation of research effort. He spoke also of the need for interpreting as liberally as possible whatever restrictions may have to be imposed in the interests of Government departments or industrial firms on men of science serving such organisations. Sir Edward's address was pervaded with a lively sense of the value of human factors; and above all of the importance of freedom of intercourse and movement; his words, indeed, contrast strongly with the restrictions which the Government announced a few days earlier on the employment of members of Communist and Fascist organisations in the service of the State. On grounds of national security, the Government has concluded that the only prudent course to adopt is to ensure that no one who is known to be a member of the Communist Party, or to be associated with it in such a way as to raise legitimate doubts about his or her reliability, is employed in connexion with work the nature of which is vital to the security of the State.

No reasonable exception can be taken to the terms of the Prime Minister's statement. The State, he said, is not concerned with the political views as such of its servants, and so far as possible alternative employment on the wide range of non-secret Government work will be found for those who are deemed to be unsuitable for secret work. Experience both in Great Britain and elsewhere has shown that membership of, and other forms of continuing association with, the Communist Party, may involve the acceptance by the individual of a loyalty which in certain circumstances can be inimical to the State.

However regrettable this decision may be—and there are consequences that involve some further consideration—no Government could pretend that there are not certain duties of such secrecy that the State ought not to employ in connexion with them anyone whose political discretion is in doubt. It shows a misconception of the Prime Minister's statement and purpose to urge that such action should only be taken after the individual concerned had had opportunity of appeal to some form of tribunal, or after weighing evidence by a judicial process. The point is that there is no specific charge brought against the individuals affected. As Mr. Attlee said, it is not suggested that in matters affecting the security of the State all Civil servants who adhere to the Communist Party would allow themselves to forget their primary loyalty to the State; but there is no way of distinguishing such people from those who might endanger the security of the State.

The Government in this precautionary measure has manifestly stopped well short of the point at which liberty and conscience are imperilled or economic sanctions raised against particular political creeds. Western democracy works by toleration and governs by consent, and the Government's moderation is in startling contrast to the methods pursued by Eastern communism—its rigid intolerance, intransigence and persistent attempts to over-run the frontiers of sincere democratic patriotism, and to crush freedom wherever it exists. To survey the plight of freedom in the satellite countries of the U.S.S.R. is to realize the enormous contrast, and also the moderation and realism of the British Government's action.

The University of Prague, which has been celebrating its sixth centenary, provides a case in point. In view of their information that for the time being the Charles IV University is subject to Government controls which deny to it the academic autonomy essential to all free and responsible university work, the universities of Great Britain reluctantly decided that their official representation at the celebrations would be inappropriate. Every university felt itself honoured by the invitation to Prague, and desired to pay tribute to the high and historic service of the Charles IV University to scholarship and science, and to the making of our common heritage of truth and freedom; but Sir Hector Hetherington, acting chairman of the Committee of Vice-Chancellors, has stated in *The Times* that it has seemed necessary to the universities to give no ground for the opinion that British universities are favourable to the changes wrought in the universities of Czechoslovakia.

That action, moreover, illustrates further a point made in a recent article in *The Economist*. There is urgent need, it was argued, for an effective counter-attack on communist activities and propaganda in all walks of life, in public affairs, in science particularly, and above all in the factories. Recent events have made a little plainer whither divided loyalties may lead us; but if the free nations are to preserve their liberties and their great traditions, they cannot continue to tolerate intolerance. They must, it is true, work out their own means of self-protection by their own democratic method; but they must not allow themselves to be deceived by the professions of those who reject these methods and only use them to subserve their purpose of intolerance and disruption.

In contrasting Sir Edward Appleton's words with the new policy, it should have been noted that in his plea for freedom he stressed the discipline of science. That should be the first loyalty of the man of science; and it is because that discipline and loyalty are rejected by the communist that science itself is endangered by communism as we know it in Soviet Russia. The totalitarian regime is inconsistent with the free pursuit of science, and professional workers would do well to address themselves more carefully to this question of professional loyalty. Without loyalty to the highest professional ideals and traditions, inherent in which is the tradition of faithful service to the society for whose welfare a profession exists, the pursuit of truth and the advancement of learning cannot long endure.

In this connexion Mr. Middleton Murry has a significant passage in his recent book "The Free Society"*. He is convinced that the contemporary confidence in the autonomy and invulnerability of science has no solid foundation. Science, he holds, is as vulnerable as the free society and is ultimately dependent on it. "'The matrix of science has been the politically free society, first in Greece, then in the final form of the Christian society. It was only when the Christian impulse, with the aid of the Roman tradition of law, had created for the intellectual freedom of Greek speculation a body politic which assured it of an abiding home that science, in the modern sense, became possible.' For science lives by a continuous tradition of scientific integrity, created and continually renewed by conscience. The scientific community is the child of the free society."

If Mr. Murry had done no more than direct attention to the new threat to scientific integrity which the spread of Russian communism offers, his book would have deserved attention. Men of science who were alert to the threat which the rise of Nazism and Fascism a decade and a half ago offered to science have sometimes been unhappily blind to the new danger. As Mr. Murry observes, members of the scientific community in the free society are frequently engaged in undermining that free society in the name of science, and there could not well be more alarming evidence of our peril. If the pursuit of research and of learning depends upon a consensus and community of consciences which are obtainable only within the free society, men of science must act in defence of that society.

That defence must be based upon understanding, and it is as a contribution to the clear thinking here required—which is the more imperative if the discrimination referred to in the Prime Minister's statement of March 15 is to be used wisely and without detriment to the democratic tradition or the growth of the free society—that Mr. Murry's book is most welcome. He is indeed challenging and provocative; and it would be a misfortune if the slightly dramatic character of the book diverted attention from the more fundamental issues which are raised.

What distinguishes the free society from other forms of society, according to Mr. Murry, is the prevalence within it of the fundamental liberties of the subject of freedom of conscience, of speech, of expression and of association. Those liberties are indeed subject to restraints, and he insists that it is by the achievement of tolerance that the free society becomes possible. Nevertheless, he argues cogently that in a world such as exists to-day, a free society can only be established by a government which, believing in the free society, is convinced of the necessity of refusing to tolerate the intolerant, and possesses the power to repress them with even-handed justice, both on the Right and on the Left.

Mr. Murry thus advances powerful reasons in support of the Government's decision; but in displaying the tension between the need for the satisfaction of conscience and the need for ordered society which the free society seeks to release, he brings to the front the immense moral issues involved. A free society, he says, lives by a firm belief that its citizens have the moral energy to correct their own mistakes, and to correct them before serious or irreparable harm is done to the fabric of the free society. It is a question of responsible power, conferred by the democratic process and exercised responsibly with respect to the rights of the minority and also to the welfare of the whole society. The free society, in fact, is a great experiment, and it is above all for his clear indication of the collective and moral responsibility of individuals and groups in Great Britain involved in this affirmation of the dignity, the freedom and responsibility of man that this book deserves to be pondered.

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* The Free Society. By John Middleton Murry. Pp. 292. (London: Andrew Dakers, Ltd., 1948.) 12*s*. 6*d*. net.

There is first, as Mr. Murry justly observes, room for doubt as to whether the workers appreciate the necessity of dealing justly with one another or with society as a whole. Here his words should be weighed by the trade unions as well as by professional associations in general. Before the free society can be regarded as reasonably secure, the workers must be taught their new responsibilities.

That may well be the most important and urgent task a free society has to undertake; but with it, and of it, must go an increasing consciousness of the whole in existing groups and associations. An ordered society requires discipline ; but in a free society that social discipline must be a self-discipline ; and here, as Mr. Murry reminds us, is the importance of voluntary groups and associations within the free society. To the degree to which they are inspired by an understanding of the free society, they will establish the patterns of just legislation before the need of legislation becomes acute. They will anticipate the social disciplines which the free society needs.

Now while Mr. Murry pertinently reminds us that in the free society the loyalty demanded is no longer primarily loyalty to the fellow-members of a group or section but to the free society as a whole, it is as well to remember that there is a converse side. The disciplines voluntarily accepted in the free society are disciplines which must be accepted above, by the government, as well as the governed ; and they too must be inspired by an understanding of the free society as well as by a vision of its potentialities. To take only one instance at present in the public mind. It would be a grave mistake for the Government to imagine that the uneasiness of a large part of the medical profession over the new Health Act is not due to misgivings as to whether the profession will be able under the Act to give the public service which its professional ideals and traditions require it to render.

In dealing with the danger to the State of communist activities, a profound saying of Burke may be recalled : "It is no inconsiderable part of statesmanship to know how much of an evil ought to be tolerated". The Government has rightly decided that democratic principles do not call for the toleration of treason and terror, and it has wisely left it to the community to decide on the larger and fundamental issue, whether, in a democratic society, free scope should be given to those who seek to destroy democracy and to set up an intolerant regime.

If, therefore, the Government, in administering the decision, makes sure that impartial justice is done where the person concerned is not a member of the Communist Party but charged with "continuing association with it", it may well be claimed to have met Burke's test of statesmanship. That will not indeed avert the need for constant vigilance within and without Parliament. The debate on March 25 should have reassured those who fear that the cloak of security may be used to stifle the integrity of science and the ability of the scientific worker to serve mankind. But it is for scientific workers individually and in their professional associations to take up the challenge to fundamental thinking and constructive action which Mr. Murry throws down to them in "The Free Society" ; in that way only can freedom be ultimately safeguarded in science or among the free nations of the world.

FAMILY AND NATION

THE broadsheet series entitled *Planning* issued from time to time by P.E.P. (Political and Economic Planning) has produced many excellent and stimulating documents, and has made a valuable contribution to the solution of several of the social and economic problems with which Britain has been and still is confronted. The latest issue, entitled "Family and Nation", is, however, frankly disappointing. Much of the information in it is of great interest, and it raises many important issues which need to be raised and to be raised frequently. Admittedly the family is difficult to plan for, being so variable and so individual; and there is unconscious or perhaps conscious humour in the statement that it "must be strengthened in the functions for which it is peculiarly suited, such as the production of children". After an excellent section reviewing the fluctuation in the birth-rate, the introduction of family allowances, and the present state of income-tax rebates, the broadsheet goes on to outline a plan whereby the 'para-medical' services, together with marriage guidance, can all be combined in a family welfare service.

Such a proposal needs the most careful consideration at the present time, for it presupposes a large expenditure of public money and it also cuts across the recommendations of the Denning Committee[1]. Both are serious matters, and one would therefore expect weighty reasons to be given in support of the proposal.

The functions of the proposed new organisation would be to "improve the conditions in which children grow up, increase the number of 'wanted' children and help to reduce the number of children whose birth is not desired either by their parents or by the community . . ." This is a wide programme involving many issues, some highly controversial ; but the broadsheet suggests that "the existing arrangements for maternity and child welfare would provide a foundation" for implementing it, "other provisions being added as they were shown to be desirable and practical". But suppose for the sake of argument that the controversial difficulties had been surmounted and that the experts were agreed on such subjects as sterilization, abortion and artificial insemination; would not the case for incorporating these para-medical matters into the already existing maternity and health services, rather than vice versa, be overwhelming?

Marriage guidance deals primarily with the personal relationship of two people. It is true that there may be, and often is, a family in the background; but nevertheless it is the personal problems of two partners that are involved, and marriage guidance[1] as such cannot be undertaken merely as part of a larger service for the family. This is not to say that secondary questions such as childlessness and family planning do not come into the picture—they do very often—but they are incidental to the main problem. This is recognized in the Denning Report, which recommends that grant-aid be made to voluntary organisations engaged in marriage guidance. Yet the reasons given in the broadsheet for rejecting the recommendations of the Report do not seem to be convincing; "marriage guidance has such an important function to perform that there would be serious objections to leaving it outside the Family Welfare Service". What the serious objections are is not stated.

One may suggest finally that many couples, though willing that the State should ensure them a safe passage from the cradle to the grave, may prefer to keep their marriage relationships to themselves. This raises the larger question now under consideration by a Home Office committee, on what lines marriage guidance as a form of social service can be most advantageously developed. There is nothing in the broadsheet to indicate that this aspect of the question, namely, State interference in what is perhaps the most intimate personal relationship that exists, has been seriously taken into consideration.

[1] Final Report of the Committee on Procedure in Matrimonial Causes. Cmd. 7024. (London: H.M. Stationery Office, 1947.)

FOOD POISONING

Food Poisoning

Its Nature, History and Causation, Measures for its Prevention and Control. By Elliot B. Dewberry. Second edition. Pp. xii+246+24 plates. (London: Leonard Hill, Ltd., 1947.) 17*s.* 6*d.*

THE subject of food poisoning was once largely a series of disconnected observations and records of outbreaks; but during the last three decades the facts have been associated and the discrepancies and fallacies removed. For example, the old expression 'ptomaine poisoning' has been shown to be without meaning and entirely incorrect. Now it is possible to give a clear account of food poisoning, including the various causal agencies, the paths of infection and the reservoirs of the various bacteria responsible. In the first edition in 1943, the author of the book under notice gave a clearly written account of the subject, and the second edition has brought it up to date. The first edition dealt very inadequately with staphylococcus food poisoning; but this has now been remedied by the addition of a new, separate chapter of 22 pages on this subject which gives all the essential facts. An additional section (appendix I) on laboratory investigation of food poisoning cases is of doubtful utility, as this very technical subject is mainly of interest to the laboratory worker, and for him the account is barely adequate and is available elsewhere.

There are five main types of food poisoning, namely, *Salmonella* infections, toxin outbreaks due to special staphylococci, botulism, poisoning from contamination of the food with poisonous metals and other chemicals, and food poisoning from the consumption of poisonous plants, toxic mushrooms and other fungi, and poisonous fish or shellfish. Each group is separately and adequately treated. Most space is devoted to *Salmonella* food poisoning, which used to be, and may still be, the commonest type in Great Britain, and this is well done. The important recent work on the increase of this type of food poisoning due to the great increase in the use of dried egg mixtures is not mentioned; but this was probably too recent for inclusion.

Botulism is described in great detail, although not more than four outbreaks have ever been recorded in Great Britain. Its deadly nature justifies the detail, for it is more prevalent in some other countries. Food so infected usually shows signs of spoilage, but not invariably. This fact is just mentioned but should have been more emphasized, and the factors explained which determine whether signs of spoilage are or are not present.

The other types of food poisoning are adequately discussed, and no important inaccuracies were detected and few omissions. Examples of the latter are that cadmium poisoning should have been included in the chapter on poisonous metals, the value of the coagulase test is not given in discussing *Staphylococcus* poisoning and that more types of *Clostridium botulinum* are known than those mentioned. These are all small points, and the author has obviously been diligent to keep his book up to date.

The book is frankly a compilation not written by one personally an authority on the subject, but he has included all the essentials, and the volume may be accepted as an adequate and reliable account of food poisoning in its various manifestations. It is attractively illustrated and well printed.

ORGANISATION, METEOROLOGY AND WEATHER PREDICTION

"Here is the Weather Forecast"

By E. G. Bilham. (Binnacle Books Series.) Pp. 220 (36 plates). (London: Golden Galley Press, Ltd., 1947.) 10*s.* 6*d.* net.

WEATHER and the causes of weather are not easy subjects for the writer who addresses himself to a mixed audience. If he aims at strict accuracy, the writing must abound in saving clauses and qualifications, and the result will be anything but a clear-cut picture. Should he largely leave out the qualifying phrases, then the end result will not correspond to reality. Mr. Bilham, in this book, does manage to avoid these two dangers, and gives a clear and highly authoritative account of the way in which weather forecasts are prepared.

The account of the organisation for collecting and distributing weather observations, warnings and forecasts is excellent, and there is much highly interesting information about upper-air measurements by *radio-sonde* balloons and the war-time applications of radar to wind finding, and more recently to cloud observations. The importance of the work of the weather observers on land, on sea and in the air is rightly stressed, and a survey is given of their work and the instruments they use in making routine measurements of atmospheric pressure, temperature and humidity, wind speed and direction, rainfall and cloud height.

The preparation of weather charts and the meaning of the various pressure systems in terms of weather and wind are discussed, and the author valiantly attempts a non-mathematical explanation of Buys Ballot's law, or, strictly speaking, of Coriolis force. This, if a little inelegant because apparently different arguments are applied to meridional and latitudinal motion, serves to indicate the effect, although to a non-mathematical reader the exact variation with latitude will not be readily seen.

The reader is introduced to the extremely important notion of air masses and fronts, which did so much to improve forecasting when first recognized during the First World War and is still the basis of forecasting up to twenty-four hours ahead.

In a book rich with information one hesitates to ask for more; but an account of the different effects on weather of coastal waters, as between winter and summer, and the modifying effects of high ground and long passage overland on cloud and weather, would have been extremely valuable. A man in London hearing overcast conditions and maybe drizzle forecast for south-west England on a fine August morning would then go his way confident that for once the weather is not spreading east.

The principal causes of bad forecasts are lightly touched upon; but many meteorologists would wish that more stress had been put on changes in the weather associated with fronts as they cross Great Britain in particular. After all, if it rains two or three hours after the forecast time, that is a small thing to the man in the street; if it does not rain at all he is little impressed by being told that the warm front passed him exactly on time!

Within the two hundred pages of this book there is a vast amount of information; but the reader is not likely to feel he is being crammed: the frequent plates (there are thirty-six of them in all) and clear line diagrams aerate the text, and Sibley's drawings do much more than illustrate points in the text.

M. K. Miles

MATHEMATICS FOR ELECTRICAL ENGINEERING

Modern Electrical Engineering Mathematics

An Introduction to the Mathematical Methods more Recently Employed in Electrical Engineering Theory, with Special Reference to Stationary Linear Networks. By S. Austen Stigant. Pp. 372. (London: Hutchinson's Scientific and Technical Publications, n.d.) 31*s*. 6*d*. net.

THERE are few branches of mathematics which have not found useful application to electrical phenomena, and the engineer is continually receiving new tools of a theoretical nature to add to his equipment. He has long since had to become familiar with the use of infinite series, with Fourier analysis and with many of the differential equations and functions of mathematical physics. More recently, however, matrix theory and tensor analysis have been added to the list, and the operational methods of approach to circuit problems, including that of the Heaviside calculus, are becoming increasingly important.

In these circumstances, many engineers must be wondering whether it is better to be thoroughly conversant with a limited field of mathematics, so as to be able to make the fullest and most practical use of the knowledge they possess, or to understand in a general way the vast mass of symbolic theory available for their use, with little hope—unless, indeed, possessing an unusual faculty for mathematics—of being really proficient in any of it. There is no general solution to this very real dilemma; it depends upon the individual concerned and upon the degree of specialization within which he works. The author of the book under notice believes that no branch of mathematics likely to have practical application should be neglected by any engineer on the score of its being new or unnecessary: "The advanced engineering theories of to-day become the commonplace practice of to-morrow". It is likely that most engineers would so far agree as to admit the desirability of being at least aware of what analytical methods are available and of their useful range of application.

From this point of view, Mr. Stigant's book is to be welcomed. It deals with a limited number of subjects, having nothing to say concerning differential equations, infinite series or function theory generally, all of which have been discussed adequately before. More than half the book (ten of the eighteen chapters) is concerned with determinants, matrices and tensor algebra; the Heaviside operational calculus, symmetrical components and dimensional analysis in its various forms account for five chapters. The book is thus probably the most comprehensive account of these subjects—with the exception of the operational calculus—that has so far been written for engineers.

The many branches of theory discussed and the large amount of space legitimately and usefully devoted to engineering applications might lead one to anticipate a less detailed treatment than is, in fact, given. On the contrary, a criticism of the reviewer—albeit a minor one—is that in some instances, particularly perhaps in the chapters on tensors, the discussion could be more concentrated. Nevertheless, the writing is careful, and pains have been taken to stress the connexion between the different analytical methods of approach to problems. The original Heaviside method is used in the chapter on operational calculus; the Laplace transform approach is usually preferred nowadays, although the reviewer would agree that, for many, the method adopted in this book would seem a more natural way of introducing the subject. The equivalent of perhaps five chapters is given to examples illustrating the theory, including, among others, the steady state and transient response analysis of networks, three-phase systems, line faults and line protection. Many examples are solved by more than one method.

The book does not make easy reading, which is a fault of the subject rather than that of the author. It could scarcely be recommended as useful reading, however, to anyone who was not already quite familiar with the more usual mathematical methods applied to engineering problems.

There seem to be few errors, and although the production is in conformity with war economy standards, the clarity and lay-out are good. Most useful features are the bibliographies which are given at the end of nearly every chapter. V. J. Francis

ADVANCES IN PHYSIOLOGY

Annual Review of Physiology

Victor E. Hall (Editor), Jefferson M. Crismon and Arthur C. Giese (Associate Editors). Vol. 9. Pp. vii+736. (Stanford University P.O., Calif.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 6 dollars.

THE "Annual Review of Physiology", though published in the United States, was intended to be international in authorship. It started in 1939 and during the War it had to remain, as it had begun, entirely in American hands. The present volume marks the first appearance of European contributors, who are responsible for five of the twenty-seven articles. Next year we are promised two contributions from the U.S.S.R.

This volume maintains the standard of its predecessors and, as is usual if not inevitable, the articles are of very unequal merit, ranging from the hasty compilation of a catalogue of references, to the personal and critical writing of one who has taken the trouble to digest the data under review. In the latter category are three outstanding contributions of general physiological interest. F. Buchthal, in his article on muscle, summarizes the brilliant contributions which he and Szent-Györgyi have made in elucidating the role of actomyosin and adenosine triphosphate. He also deals fully with the vexed question of the status of acetyl choline in neuromuscular transmission, and covers the advances in electromyography which have resulted from war-time research on peripheral nerve injuries. H. Grundfest, dealing with bio-electric potentials in the nervous system and in muscle, presents a very intelligible review of a subject which to many physiologists has become increasingly obscure. The data are carefully sorted out and correlated; the conflicting theories are precisely defined and then critically analysed. C. J. Wiggers, reviewing the peripheral circulation, gives a characteristic and critical appraisal of some of the newer techniques, such as cardiac catheterization. The main feature of his article is a very thorough discussion of the peripheral resistance, which may well become a classic. Recent work on shock and hypertension is also covered.

In his article on exercise, P. V. Karpovich directs attention to the surprising lack of elementary data in this important and practical subject. Some new physical-fitness tests are discussed, recent work having shown the old tests, such as breath-holding and pulse return after exercise, to be of little value. Workers in several different fields have made the rather surprising discovery that many gross nutritional deficiencies have little or no effect on physical performance of short duration. It is also reassuring to read that rats live longer in an atmosphere of tobacco smoke.

Pathologists will find two articles of particular interest. Writing on defence mechanisms, W. C. Boyd and S. Malkiel review the important work of Menkin, who has isolated various factors—pyrexin, necrosin, leucotaxin—from inflammatory exudates. They also attempt to cover the wide field of antibody–antigen reactions and detoxification mechanisms. S. P. Reimann's article on growth deals chiefly with the pathology of growth and is a most interesting account of attempts which are being made to apply recently acquired biological knowledge to some of the classical problems of pathology. For example, the concepts of induction, evocation and organisers derived from embryology are being applied to the study of mixed tumours. Aberrations of growth resulting from nutritional deficiencies open up a promising field, and the trial of various specific growth-inhibiting substances in the treatment of cancer and leukæmia is interesting, although the results so far have been disappointing.

F. K. Sanders, writing on cutaneous sensation, gives a useful summary of the important work of Woollard and Weddell, most of which was published during the War and is already well known in Great Britain. The physiological effects of heat and cold still require a separate article owing to the considerable amount of war-time research which is still appearing. In this article A. P. Gagge and L. P. Herrington attempt a scientific appraisal of some of the experiments carried out by the Germans at Dachau, and add some appropriate ethical comments. War research still accounts for much of the material reviewed under blood gas transport by D. B. Dill and W. H. Forbes, and also under the respiratory system by H. C. Nicholson. W. Dock, writing on the kidney, devotes less space than usual to consideration of the various 'clearances', which he prefers to call 'ratios', and gives a very welcome review of renal morphology and pathology, especially in its relation to shock and hypertension. Under pharmacology, C. C. Pfeiffer and E. R. Loew deal with the new antihistamine drugs; but most of their article is devoted to chemotherapy and deals with newly discovered chemicals active against fungi, viruses, rickettsia, rodents, war gases and cancer. Two new subjects not previously reviewed are the physiology of supporting tissue by P. D. F. Murray, which deals chiefly with bones and teeth, and the experimental neurosis by H. S. Liddell. The articles on metabolic functions of the endocrine glands by F. D. W. Lukens and permeability by W. Wilbrandt present a vast amount of new information from which no very striking advances seem to emerge. O. A. TROWELL

BIOLOGICAL APPLICATIONS OF ULTRA-VIOLET AND INFRA-RED RADIATION

Applications of Germicidal, Erythemal and Infrared Energy

By Dr. Matthew Luckiesh. Pp. ix+463. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1946.) 30s. net.

THE author of this book is the director of the lighting research laboratory of a large electrical firm in the United States and is well known as a prolific contributor to the technical literature of his subject. Much of the material in the present volume has appeared in various technical publications; workers in the field of radiation and its applications will be glad to have the data collected together in a single volume. The scope of the book, the stated object of which is to deal with some major effects of radiant energy, is perhaps sufficiently indicated by the title.

The science of radiation therapy, with which the book is largely concerned, is still in its infancy. Few will dispute the health value of sunlight, although some may question how far this is of psychological origin or the result of associated fresh air and exercise. The benefits to be obtained from exposure to so-called artificial sunlight are far more open to question. This is only one of the controversial subjects discussed in the book under review—discussed, one may add, in no controversial spirit, for the author states his case with almost evangelical conviction which leaves little room for heretical questioning.

One of the most interesting sections of the book is that dealing with the germicidal effects of ultra-violet radiation. The importance of this subject is now fully established and is well brought out in the excellent symposium on aerobiology published in 1942 by the American Association for the Advancement of Science. In Great Britain experimental germicidal lamps have given good results in certain industrial processes which have to be carried out under sterile conditions. British medical interest in the bactericidal possibilities of ultra-violet radiation has, however, been slow to develop.

The book seems to have been put together hurriedly and is, in consequence, sorely in need of careful editing and vigorous pruning. There is much needless repetition and overlapping; some of the sections, for example, that on ultra-violet energy and plant life, are inconclusive and do not appear to lead anywhere. Too much space is devoted to the author's proposals for systems of units for biological effectiveness of ultra-violet energy analogous to those in use for visible radiation. It may, perhaps, be questioned how far these are justified or will find general acceptance.

Most of the discussions centre around the work of the author and his colleagues; there is, however, a fairly comprehensive bibliography. The various discharge lamps and other artificial sources mentioned are those commonly marketed in the United States, but similar sources are available in Great Britain and elsewhere. Despite its defects, the book should be studied by all who are interested in the biological effects of radiation within the range of the sun's spectrum.

H. G. Jenkins

THE ARGUMENT FROM MOUSE TO MAN

Animal Genetics and Medicine

By Dr. Hans Grüneberg. Pp. xii+296. (London: Hamish Hamilton Medical Books, 1947.) 21*s*. net.

Dr. Grüneberg's new book covers some of the same ground as his well-known monograph on the "Genetics of the Mouse". But the genetic facts he brings forward, although drawn from a narrower field than might be expected from his title, relate to the rodents as a whole rather than to the mouse in particular. His volume provides, in a simple and readable form, the most complete available summary of our knowledge of inherited pathological conditions in this whole group, and will be, for that reason alone, extremely welcome to genetical workers in other fields. As in his previous book, it is a particularly valuable feature that he describes not merely the final adult form of the abnormality, but also as much as is known of its developmental antecedents.

The purpose of the book goes much beyond that of a mere summary. Dr. Grüneberg has written his book in the hope "that it will help to make the geneticist more fully alive to the medical value of his material, and that it will show the medical practitioner that invaluable sources of information are only waiting to be opened up by him". The application which Grüneberg wishes to make of the wealth of factual material he presents is partly at a theoretical level. He shows how the animal geneticist, by the use of controlled breeding, can easily discover whether two apparently rather different abnormalities are, in fact, due to the same ultimate genetic cause. If they are, they may legitimately be considered as two aspects of a single unitary disease. An argument of this type is, the author holds, the only kind which can make possible a logically unassailable classification of the clinical conditions in which hereditary disposition plays a large part. Unfortunately, the crucial test of breeding cannot be applied in a controlled manner to human material; but less direct ways of applying the same concepts are sometimes feasible, and the genetic criterion at least indicates the goal towards which effort should be directed.

The other main advantage enjoyed by the animal breeder is the ability to produce as many animals as he pleases of the pathological strain. This makes it possible to carry out an adequate analysis of the epigenetic processes by which the abnormality is produced. Grüneberg has himself made several noteworthy advances in this connexion, showing, to mention only one example, how a complex of apparently unrelated effects in a certain strain of rats may be traced back to an initial hypertrophy of the cartilage. Such studies are scarcely possible for human material. Indeed, some medical men may be tempted to dismiss them as unnecessary for clinical practice, since there is still a tendency to consider pathological conditions as either physiologically conditioned (when they may be curable), or as hereditary (in which case nothing, it is assumed, can be done to obviate them). Such a view is, of course, indefensible. Grüneberg quotes with approval Sewall Wright's dictum that "the attitude of physiological genetics is that characters are determined 100 per cent by physiological processes, and that genes are the ultimate physiological agents". Genetics has already made an important contribution to the detection and conservative treatment of sub-clinical diabetes, and it may be expected to render many more such services to therapeutics.

The numerous genetically controlled developmental processes described by Grüneberg have an important bearing on the fundamental biological problem of the mode of action of genes. In discussing these, the author is perhaps not always so convincing as when he is exhibiting the relevance of his material to medical questions. For example, the discussion of whether gene-action is organ-specific or tissue-specific is surely based on a question which does not go deep enough. Some genes, if classified in such terms at all, could only be called organ-specific (for example, aristopedia or bar eye in *Drosophila*); others would appear (contrary to Grüneberg's statement) to affect more than one type of tissue (for example, the 'white' gene in *Drosophila* also reduces pigment in the testis sheath). Surely the true state of affairs is that a gene is specific for one chemical process, which may be involved in one or a number of different tissue- or organ-differentiations.

C. H. Waddington

Elementary Applied Aerodynamics

By Prof. Paul E. Hemke. (Prentice-Hall Aeronautical Engineering Series.) Pp. viii+231. (New York: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1946.) 26*s.* net.

THIS American volume is essentially a tutorial or class text-book of the type that has not yet made extensive appearance in the field of English aeronautical literature. It treats the subject in logically arranged chapters, each one ending with a number of examples. These are both of the kind that emphasizes the theory already explained, and those giving the technical application of the subject-matter of that chapter. References in these questions to the relevant parts in the discussions, by means of a decimal system of numbering the paragraphs and conclusions reached, make the whole book extremely easy to follow, in a tutorial sense. As an examination crammer it is splendid; whether it is advisable to spoon-feed a student to such an extent is another matter.

The reader will have to take a good deal of the data for granted, especially that given in many of the charts, as reference to the source of the information is not always given. This is, of course, inevitable in a book that attempts to compress the subject into so small a space. It also dates the book rather badly, as the inquiring reader will find it difficult to link up the subject-matter with more recent advances. Aerodynamics is treated in a series of chapters on units, physics of the air, the ideal fluid, viscosity, compressibility, the properties of airfoils, propellers, performance and the helicopter. The author states in his opening remarks that he has dealt with only "the consideration of the more well known and established facts in aerodynamics". The book obviously has been written with the outlook of the exercise class, and in this limited field it can be recommended.

Mathematics of Statistics

By John F. Kenney. Part 1. Second edition. Pp. xii+260. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 21*s.* net.

THIS is the first volume of a second edition of a book first published in 1939. The complete book is intended to be an introduction to the more elementary theory and methods of mathematical statistics. The present volume confines its attention almost exclusively to the descriptive theory of statistics. Within this limit, it provides a very carefully and clearly written and admirably printed introduction to the subject, well suited to a student without mathematical knowledge, or working alone. After chapters on the description of frequency distribution by graphical methods, averages, moments and measures of dispersion, the normal distribution is shortly considered, followed by the fitting of linear and quadratic polynomials and the theory of correlation. These subjects are explained with great clarity and at considerable length; but it seems a pity that in so large a book, costing so much, no room was found for an elementary account of sampling and the testing of statistics. As a consequence the student who wishes to decide how much reliance to put on the results of his calculations will have to turn to volume 2 or some other book. This volume by itself is therefore not very useful to a biologist or other experimentalist.

P. A. Moran

La lutte contre les termites

Par Ch. Noriot et H. Alliot. (Publication de l'Office de la Recherche scientifique coloniale.) Pp. 96. (Paris: Masson et Cie., 1947.) 220 francs.

IT may be said, at the outset, that this publication provides the best short modern account of termites and their control. It is, furthermore, extremely well illustrated and admirably printed on very good paper. The first part deals with the general biology of termites and the outlines of their classification. Part 2 is devoted to the application of various methods for destroying these insects, and Part 3 describes in some detail, and with many structural diagrams, the best methods for protecting woodwork against termite attack, and the special features needed in building construction in guarding against their depredations. Each section is accompanied by a short but adequate list of references to the relevant literature that may be consulted. There is also a list of the various trees stated to be resistant to termite injury.

A. D. I.

Honey Farming

By R. O. B. Manley. Pp. 293+15 plates. (London: Faber and Faber, Ltd., 1946.) 18*s.* net.

MR. MANLEY, who is one of the very few people in the British Isles who can claim to be a honey farmer and to maintain successfully a large number of colonies of bees, is a person whose opinion on all matters relating to bee-keeping is well worth hearing. His latest book, "Honey Farming", is a worthy successor to his earlier excellent and widely read work "Honey Production in the British Isles".

In this new book Mr. Manley draws upon his wealth of practical experience and, in an eminently readable manner, gives some of his ideas about bee-keeping and the methods of management that he is using to-day, relating not only something of his successes but also telling of his failures and how the methods that he is now employing were gradually developed. Needless to say, he thoroughly disagrees with many of the methods still taught and practised by some of the less well-informed bee-keepers, and he does not hesitate to say so, or to criticize severely some of the equipment still advocated for general use. Indeed this book, besides being of inestimable value to those people who wish to learn what a man who has been successful in earning a living from honey production thinks about various systems of management, apiary equipment, bee-breeding, swarm control, queen introduction, and much else besides, will also be a tonic to those who have wished for so long to see the archaic nonsense still talked about bee-keeping exposed.

This is indeed one of the few books about bee-keeping that one can unreservedly recommend, and one that I hope will find a place in the library of every bee-keeper.

C. G. Butler

Dairy Farming

Theory and Practice. By V. C. Fishwick. (Agricultural and Horticultural Series.) Pp. 237+55 plates. (London: Crosby Lockwood and Son, Ltd., 1947.) 15*s.* net.

A FEATURE of this book is that about half of it is devoted to concise descriptions of the methods and views of twenty dairy farmers. Six of these farmers are said to be men with a national reputation, seven are well known in their own locality and the remainder are representative examples of the ordinary farmers of Great Britain. The accounts, which cover a wide range of current practice in dairy farming, are readable and enlightening; and they are illustrated by a useful selection of photographs.

The other half of the book purports to deal with the scientific principles of dairy farming; but this section is singularly rambling for a scientific work and the principles are diluted with platitudes. The diction is sometimes puzzling; for example, when the author states "A skilful breeder will frequently raise a herd of animals that are very similar to the eye". Many of the definitions are inept, and a new agricultural student might be misled by reading that a starchy food is one that contains a small amount of protein.

The general conception of the book and part of the contents are excellent; the style of the remainder will have a limited appeal, but in any case should be read in conjunction with more authoritative works.

S. B.

Birds of the Southwest Pacific

A Field Guide to the Birds of the Area between Samoa, New Caledonia and Micronesia. By Ernst Mayr. Pp. xx+316+3 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1945.) 18*s.* net.

THE south-west Pacific, that is, the area between Samoa, New Caledonia and Micronesia, is a rich ornithological field, many interesting and varied species of birds being found in it. This little book is a field guide to them, its author, Dr. Mayr, having worked for many years on Pacific ornithology. In his introduction he points out that the difficulties and the interest of the task are enhanced by the many separate archipelagos involved, each with its distinct bird fauna, though certain species are common to many if not all the archipelagos. He therefore divides his book into a general section and a geographical section, dealing with the seabirds, shorebirds, and land and freshwater birds of the area in the first part, and taking the faunas of the different groups of islands separately in the latter section. The coloured plates and the black-and-white sketches are helpful and enhance the value of a very useful book.

FRANCES PITT

Archéologie du Pacifique-Nord

Matériaux pour l'étude des relations entre les peuples riverains d'Asie et d'Amérique. Par Dr. André Leroi-Gourhan. (Université de Paris: Travaux et mémoires de l'Institut d'ethnologie, Tome 47.) Pp. xviii+542. (Paris: Institut d'Ethnologie, 1946.) 700 francs.

THIS volume deals with the archæology of the North Pacific in two parts. The first deals with the area generally and with the inhabitants of different regions severally—Japan, the Ainu, Kamschatka, the Eskimo of four different regions, and the Aleutian Islands and British Columbia. In the second part the author takes some fifteen or sixteen implements of common use and widespread occurrence, analyses the various types, and shows their distribution on sketch maps. The Eskimo in particular afford a remarkable instance of an extremely wide distribution of material types, due in part to their possession of a common language and culture, in part to the extremely small and scattered population using the artefacts in question. Life in the North Pacific is necessarily dependent on a highly specialized material culture in which the nature of every tool is strictly determined by the physical environment.

The author comes to the conclusion that it is possible in a sense to speak of a North Pacific civilization, but he rejects any suggestion of a common focus of culture or of the importation of a formed culture from outside the area dealt with. He points out that the remotest period covered by archæological finds cannot be shown to be more than two thousand years ago; that during all that period the population of the area concerned has possessed a comparatively stable physical type; and that the distribution of various types of artefact indicates lines of communication, not of migration. He infers, in consequence, the general danger in archæology of building up theories of migration on the data of typological distribution. Human movement is much less frequent and very much slower than the movements of material culture.

The volume contains a good bibliography of wide range in date and language, a rather poor index, forty-three good maps mostly of distribution, and 1,148 text figures. The work is an important one not only as a study of North Pacific cultures, but also in reference to archæological method in general.

J. H. HUTTON

The Navaho

By Clyde Kluckhohn and Dorothea Leighton. Pp. xx+258+20 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1946.) 25*s.* net.

THE recent increase in the Navajo population and the reduction in fertility of the land in their reservation, consequent upon soil erosion, has confronted them with a serious material problem. Their contact with the civilization of the white man has aggravated this and introduced an equally grave spiritual problem. The Indian Field Service is doing its best to help them; but the policy of moving the administrators from tribe to tribe on promotion prevents them from really getting to know any of the Indians.

This book is one of a series of tribal monographs published on behalf of an Indian Education Research Project sponsored by the University of Chicago and the U.S. Office of Indian Affairs. It deals primarily with Navajo life at the present time, and is designed chiefly to instruct the administrators and teachers who work among these people. The deep concern of the authors for the welfare of the Navajos is shown by it and other books which they have written, and it is a useful, though necessarily limited, study of culture contact, based on intimate knowledge. How far their audience lags behind them is shown by the fact that they find it necessary to insist, at some length, upon such elementary matters as the importance of acquiring at least a smattering of the Navajo language.

That the Navajo word for themselves can be translated 'people' or 'the people' is by no means an isolated phenomenon, so the frequent reference to them as The People, which recurs throughout the book, is an irritating mannerism. The production of the book is up to the high standard which we expect of the Harvard University Press, and it is illustrated by some admirable photographs.

G. H. S. BUSHNELL

SCIENTIFIC ASPECTS OF THE WORK OF THE NATIONAL COAL BOARD

By JOHN CROSSLAND

Department of Mining, University of Leeds

Introduction

UNDER private ownership, only a few of the larger colliery companies in Britain had laboratories and research departments, and apart from an effort to control the standard of coal preparation, little real scientific investigation was carried out by the colliery companies themselves; at any rate, judged by present-day standards, it was totally inadequate. To some extent, various research organisations—largely sponsored by the Mining Association—compensated partly for this deficiency; but, here again, the scale of attack was not large enough.

When the Miners' Welfare Committee came into being and a levy of 1*d*. per ton of output was arranged, some of this money was used to create the Safety in Mines Research Board. Work carried out by this Board was directed towards increasing the health and safety of those employed in the coal mines of Britain, and much useful work was accomplished. Naturally, the aim was to improve working conditions, study safety appliances and generally to find ways and means of reducing the number of accidents.

There was also the British Coal Owners' Research Association, where some work was done on mine atmospheres, suppression of dust, drilling and spontaneous combustion; but the staff was never large.

Just prior to 1939, the British Coal Utilisation Research Association, to which the Mining Association subscribed most generously, commenced work on a number of programmes connected with the efficient utilization of coal for both domestic and industrial purposes. This organisation was able to assist the various industries in many ways during the war period. It must be remembered that when the National Coal Board took over the vast mining industry of Britain, it did so at comparatively short notice and with almost no preparation for the gigantic task before it. Some of its plans are now being made known, and among them it is not surprising to find that the Coal Board proposes to develop a scientific department in the fullest sense.

Although the organisations mentioned previously were doing useful work before January 1, 1947, it was obvious that considerable expansion would be necessary as deeper, dirtier and more difficult seams were mined. An increase in the amount of mechanization will take place, with a consequent increase in the use of power, both on the surface and underground. Therefore, research should be directed towards obtaining a solution to the many problems that will occur, so that plans for the changes can be formulated well ahead, in order to obtain the highest standard of efficiency in all branches of mining work.

In the various coalfields, there has existed for many years, and usually attached to a university department of mining, a coal survey laboratory. These laboratories were financed by the Department of Scientific and Industrial Research, for the purpose of making chemical analyses and physical examinations of the seams in the area and for providing information of national importance in connexion with the future working of the coal seams. The results of this work have been available to all colliery companies in the past, and the National Coal Board has taken over these laboratories as a going concern, to be placed under the direction of the scientific member of the Board.

Status of Scientific Department

The National Coal Board decided, from the commencement of its existence, quite rightly, that science should be brought into the mining industry in the fullest sense, and that it should be represented at the highest level. It was not surprising, therefore, to find that Sir Charles Ellis had been appointed as the scientific member of the Board. This was decided so that a scientific approach could be made to all problems, whether under the heading of control or research. It is intended that a scientific organisation shall be built up to become an integral part of the industry, and not something quite extraneous to it.

A divisional 'chief scientist' has been appointed in each division, that is, each coalfield approximately, not as a member of the divisional board, but as an adviser to it. The divisions are split up into areas, and in each area there is a 'scientist' and a staff, so that it will be possible to provide a comprehensive scientific service, which will be at the disposal of the area general mines manager. In time, modern laboratories and equipment will be available in all coalfields, and, when the necessary staff can be obtained, much useful work may be accomplished in a field where there is a wide scope for work of this kind. Eventually, at the divisional level, laboratories will be available, with a specialist staff, to tackle problems which are beyond the resources of the area laboratories, and which are of special interest to the particular division. In this connexion, it should be mentioned that each coalfield has its own particular problems; for example, South Wales, production and suppression of dusts which cause pneumoconiosis; Staffordshire, Warwickshire and South Yorkshire, spontaneous heating and gob fires; West Yorkshire, working thin seams; north of England, preparation and cleaning of gas coals.

There are many problems which are found in all coalfields: pit heap fires, treatment of effluents, testing of suggested new analytical methods, the routine examination of the prepared coal and coal preparation problems generally. Routine scientific work includes analysis of coal, mine air, mine dusts, cokes, oil and metals, physical tests on coal, analysis and treatment of water (particularly for boiler plants and in some instances for domestic use).

In an effort to decentralize the scientific control service, it is intended that the day-to-day work of control should be determined by the division, in accordance with standard methods and standards of accuracy laid down by the Board. This is so that laboratories will be similar in status, arrangements and staff. A 'director of scientific control' has been appointed to co-ordinate the work in the various divisions.

As mentioned previously, the national coal survey has been transferred to the Coal Board, and the laboratories will co-operate with the divisional scientific organisations, with the Geological Survey and with the Fuel Research Station at Greenwich.

National Research Directorates

Many of the research problems concern all the coalfields of Britain, and therefore cannot be investigated at divisional level. In order to obtain the maximum of efficiency, the full weight of the headquarters staff will be necessary to deal with these problems. Provisionally, three research directors have been appointed at national level: (*a*) chemical, (*b*) medical, (*c*) physical. Under (*a*), much of the long-term research will be on the 'physics and chemistry' of coal, the carbonization and manufacture of special fuels and the development of chemicals from the by-products of coke and gas. The majority of this work will be carried out at Newcastle and in South Wales, and will be co-related with that of the British Coal Utilisation Research Association, where work is being done on the efficient utilization of coal. Under (*b*) the chief problem will be the health of the miner. The present director is a physician, and in the first place investigation will be made on such occupational diseases as pneumoconiosis, nystagmus, dermatitis, rheumatism, beat-hand and beat-knee. There are in existence organisations which have already carried out some work on these diseases; but much can be done by co-ordinating their efforts, and in the dissemination of knowledge obtained. Very often the latest information never reaches the miner, who, like many men employed in rather rough and tough jobs, tends to be careless about his health. Statistics relating to diseases and accidents will be examined, and special men and collieries will be selected for experimental purposes, as these problems have to be considered from the medical, physiological and operational points of view. An effort is being made to recruit an adequate and properly qualified staff.

General Research

It is important that all questions of a fundamental character which affect underground working conditions should be investigated. In the first place, the 'director of general research' is concentrating on mine dusts and illumination. With regard to the latter, for example, it is necessary to produce lighting of a character which is suitable for different coal faces. Pneumatic fluorescent lamps are being tried, and, generally, mine lights of numerous types are being studied in relation to the various methods of working, which include the use of many classes of machinery. It is obvious this work has considerable bearing on the prevention and alleviation of certain diseases such as pneumoconiosis and miners' nystagmus. The National Coal Board has taken over all the liabilities of the Mining Association with regard to research, and therefore becomes the largest subscribing member of the British Coal Utilisation Research Association. Sir Charles Ellis has been elected president and chairman of the council of the Association. This will allow of the necessary liaison between these large organisations and will ensure that all research work on coal will be co-ordinated, and much overlapping of programmes of research thus avoided. In order to facilitate the interchange of ideas between the Board and the research organisation, the scientific member's deputy—the director-general of research—has been made responsible for the efficient organisation of the scientific aspect of the Coal Board's work, and a small staff will be engaged on routine administration, so that the scientific workers employed will be free from restrictions of this kind.

The ground work has been accomplished, and much of the machinery created for the scientific study of the British coal industry's problems; but it is premature yet to look for major results. There is unlimited scope for the Scientific Department when it is properly equipped and staffed.

THE FUTURE OF THE NEW FOREST

THERE is probably no part of England which is the subject of more general interest than the New Forest. Everyone in the country has become acquainted as a child with at least one historical fact associated with the New Forest, and has since acquired some information—probably inaccurate—as to the real significance of both parts of its name; even if he has never visited it, he feels that it is part of the national heritage which should be preserved as such.

Those who live in or near the Forest, those who know it well as visitors, and those who have some part to play in its use and maintenance, have naturally all been keenly interested in the effect modern developments and ideas are having or may in future have on it; and the result has been a series of official publications on these subjects—as well as numerous unofficial reports and papers—of which the latest is the "Report of the New Forest Committee, 1947"*. The Committee in question was appointed by H.M. Forestry Commission in April 1946, "to investigate the state and condition of the New Forest and, having due regard to existing rights and interests, to recommend such measures as they consider desirable and necessary for adjusting the Forest to modern requirements". The membership of the Committee should be noted, comprising a distinguished representative each of the English National Committee of the Forestry Commission, of the Council for the Preservation of Rural England, and of the Forestry Commission itself, under the chairmanship of the Right Hon. H. T. Baker. From the list of eighty-four witnesses heard, it is evident, despite one or two gaps, that every effort was made to hear all informed and interested points of view—and incidentally the Committee met no fewer than thirty-five times.

The two committees responsible for the previous reports of 1939 (Report of the Committee of Planning Officers, 1938–39, H.M.S.O.) and 1945 (Planning Officers Report; Planning Committees Revision, 1945; New Forest Advisory Planning Committee, Lyndhurst) were primarily composed of representatives of the local government authorities most concerned, and dealt specifically with the protection of the New Forest as related to local and regional planning. The deputy-surveyor, Mr. D. Young, has served on all three committees, and much of the credit is due to him for the very considerable measure of success attained in reconciling rather conflicting views and interests, and the significant improvement of the relations between the major interests which has been brought about in recent years.

This is perhaps not the place to examine the legal aspects of the problem, important and interesting though they are; but it must be noted that the present situation is mainly governed by the New

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* Forestry Commission. Report of the New Forest Committee, 1947. Pp. 104. (Cmd. 7245.) (London: H.M. Stationery Office, 1947.) 3*s*. 6*d*. net.

Forest Act of 1877, many clauses of which are shown to be in need of clarification or revision. It has also to be realized that since 1923, when the management was handed over from the Office of Woods to the newly constituted Forestry Commission, the Forest has ceased to be Crown property. Appreciation of the value of the Forest from the point of view of recreation and enjoyment can be traced back to 1868 at least, and in 1928 it was declared in Parliament that amenity should be the chief object of management, and positive steps were taken to ensure outstanding appropriate treatment of areas of interest, with the help of an advisory committee.

A matter which has long been the subject of the keenest interest and concern is the enclosure of parts of the area for forestry purposes. Out of the total area of 92,365 acres, 64,707 are Crown Lands, and at the time of the Deer Removal Act (1851) it was agreed that the enclosures might total 20,000 acres, this figure being afterwards reduced to 16,000. The actual areas enclosed were not fixed in perpetuity, but only the maximum area that may be enclosed at any one time, so that an area successfully stocked with trees might be thrown open and an equivalent area elsewhere taken in. The present position is that 15,745 acres are enclosed and the balance of 255 may only be taken up within 1,927 acres which, though now unenclosed, have been enclosed in the past. An interesting historical point is that enclosures to protect young coppice were expressly provided for so long ago as an Act of 1483, and 6,000 acres were actually so enclosed in Elizabethan times. It should be noted that there are 5,000 acres of unenclosable forest—the ancient unenclosed woods—and more than sixty square miles or 40,000 acres of open heath; but at the moment no less than 8,700 acres, out of an even larger area occupied during the War for Service and other purposes, have not yet been released. The timber also suffered very heavily during the War, but there has been generally favourable comment on the smallness of the damage to the amenities by these unavoidable fellings.

Turning to the specific recommendations, it is proposed that the framework of the time-honoured administrative organisation should be maintained, authority being in the hands of the Council of Verderers, with the Court of Swainmote exercising its judicial functions, but it should be reorganised to suit it better to modern requirements. A strong case is made out for constituting the whole Forest area into a single rural district committee, which with the Borough Committee of Lymington should be the planning authority for the Forest.

In the 'inclosures', natural regeneration and group planting should be preferred to large-scale plantations, broad-leaved species favoured, and the coniferous blocks duly screened. The Committee thinks it desirable that the verderers should agree with the Forestry Commission for further enclosures of up to 5,000 acres of land valueless for grazing but suitable for planting without harming the amenities. It is recognized that owing to absence of regeneration the ancient unenclosed woods are gradually dwindling; and to remedy this, powers are recommended to enclose and restock small areas not exceeding twenty acres together, throwing them open again as soon as the new trees are out of danger from grazing stock. This is considered an important matter, and the Committee would like to see not less than fifty acres dealt with annually in this way.

Various proposals are made in connexion with the commoners, aiming at clearing up points in doubt under existing legislation and at furthering their interests. A progressive step suggested as advisable and practicable is to make the whole area a 'tuberculin-tested' area.

A recommendation which is supported by various good arguments but which may not be acceptable to all concerned is the acquisition by the Forestry Commission of the adjacent commons, aggregating no less than 6,300 acres, to be controlled and administered by the verderers as part of the 'open forest'.

Scientific men will look with special interest to the recommendation for the preservation of the whole Forest as a nature reserve under the control of the verderers acting through a specially appointed qualified curator. The difficulties involved in making sure of adequate protection of flora and fauna against an unheeding public and the unscrupulous collector of rarities are squarely faced, and proposals are made for meeting them; if adopted, the necessary powers will be there, but only time will show how effectively they can be used. It is good to note that the basic necessity of habitat preservation is recognized and leads to specific warnings against extensive heath burning and against draining certain bogs: the Committee somewhat optimistically finds "nothing irreconcilable in the competing claims made on behalf of nature lovers and holiday makers".

Some further modernization of the roads, notably a modern twin trunk road across the Forest from Cadnam to Ringwood, is inevitable. The Committee has some useful suggestions as to how to do what is necessary with minimum loss of amenity, and there are sound proposals dealing with such matters as advertising.

In this review, much of interest and importance in an excellent and comprehensive report has unavoidably been passed over. It is to be hoped that the report will be widely read and carefully considered, and that helpful criticism will be made so that the new New Forest Act which should be enacted before long will be able to take into account not only the views that have been put before the Committee during its inquiry but also views it did not hear and the reactions to the conclusions it has reached.

H. G. Champion

THE STATUS OF THE PROTOZOA

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I

The purpose of this article is to consider whether the Protozoa are to be regarded as cells and whether the animals so named form a natural group.

The Cell as a Unit

In order to decide whether a given object is or is not a cell, it is necessary to have definite ideas as to the meaning of that word. The cell is often described as a *unit*, without any adequate account being given of what is unitary in its nature. One of the most evident facts about the cell is that its characteristic component is protoplasm, the self-perpetuating and synthesizing substance of organisms. While allowing that this word has no absolutely precise meaning, we must acknowledge that there are many substances of which it can be stated with certainty that they are not protoplasm, and that such substances occur commonly between cells, but never constitute cells; while protoplasm exists in cells (and in transformed cells). These facts are generally agreed, whatever view may be taken of the cell-theory as a whole.

There is, however, nothing unitary about the idea of protoplasm. Two separate or separable masses of this substance correspond qualitatively, in virtue of their chemical composition, but need not correspond in any numerical sense. The idea that a cell is a unit, and that different cells thus correspond numerically, must be based upon the existence of something that can be counted. The most obvious objects that suggest the unitary nature of the cell are the centriole, the nucleus and the nucleolus, all of which usually occur only once in each little mass of protoplasm. The centriole, as is well known, has a tendency to divide long before cell-division, and the nucleolus is not always single; but when all these objects are in fact single, the cell is in its most characteristic unitary form.

The chromosomes provide even better evidence of the unitary state. The cell is most clearly a unit when the nucleus has originated by the telophase transformations of one *set* of chromosomes. The haploid cell is clearly a unit, and all haploid cells correspond with one another and deserve a single name. Owing, however, to the existence of sexual reproduction in organisms, there is a necessary alternation between the haploid and diploid conditions. Haploid and diploid cells are the fundamental components of most organisms; they succeed one another in regular alternation in the germ-plasm of the great majority, generation after generation. The diploid cell, from its possession of a single nucleus and other unitary characters, can indeed be regarded as a unit; but the haploid cell is the most perfectly unitary component of organisms. One could, if one wished, suggest a decreasing order of unity in cells, as one passed from haploid to diploid, triploid, tetraploid and polyploid cells of various degrees of chromosome multiplication. Since, however, no naturally occurring organism has more than two parents, and since cells usually divide when the number of chromosomes has become doubled by division, it is reasonable to make rather a sharp distinction between the haploid and diploid states on one hand, and states in which the number of chromosomes is greater than $2n$ on the other. This distinction may reasonably and conveniently be marked by restricting the word 'cell', when used without qualification, to cases where the haploid or diploid condition is realized. The phrase 'transformed cell' may be used when an object that has possessed the characters of a cell becomes so changed as no longer to possess them—as, for example, when the number of chromosomes is increased beyond the diploid condition. Under this terminology a cell would become a transformed cell if chromosome reduplication occurred within the nucleus, or the nucleus divided mitotically without cytoplasmic division; and a *Vaucheria* could be regarded as an extreme form of transformed cell. It may be remarked that the reverse change occurs when, for example, a tetraploid transformed cell becomes diploid, in the course of evolution, by differentiation of the chromosomes.

The fact that there is usually only one nucleolus in diploid cells is related to the activities of the chromosomes. A nucleolus usually begins to form at one locus only on each of only one pair of homologous chromosomes, and the two nucleoli so formed commonly fuse.

No constantly occurring cell constituent beyond those already mentioned seems to provide evidence of unitary nature. The mitochondria and the components of the Golgi apparatus are too inconstant in number to provide reliable criteria. The unitary concept of a cell has, however, been attacked by those who have laid stress on the existence of various self-perpetuating bodies within a cell and have suggested that these are the real units. These arguments have been answered by Bourne[1], who has argued, with justice, that there are no smaller particles within cells, that are to the cell as the cell is to the multicellular organism. As he says elsewhere[2], "Cells are the ultimate vital units . . . *they* are the Lebensträger, or biophors, and there are no living individuals lower than cells".

It has been suggested that the word 'cell' has practical usefulness but only vague validity, like the word 'species'. Now the invalidity of the word species is evident from the following considerations. If an evolving organism were seen by systematists at two periods of its history, geologically remote, it would necessarily be regarded as belonging to two different species (or genera or larger groups); and if every intermediate stage were known, it would be impossible to get the concurrence of systematists as to the exact stage at which the new species was to be regarded as separate from the old. No difficulty of this kind arises in connexion with the use of the word cell, as applied to many-celled organisms (except in special cases in which, for example, tetraploidy gives place to diploidy in the course of evolution, by chromosome-differentiation). The word cell can be used with a precise and valid meaning. *A mass of protoplasm, largely or completely bounded by a membrane, and containing within it a single nucleus formed by the telophase transformation of a haploid or diploid set of anaphase chromosomes, is a haploid or diploid cell.* The presence of a single nucleolus and (at the moment when the mass of protoplasm first originated by the division of a preceding one) a single centriole would be confirmatory evidence.

Unicellular Protozoa

It follows from this definition that a great number of Mastigophora, Amœbina, Heliozoa, and Sporozoa (*sensu stricto* = Telosporidia of Schaudinn) are single cells, which alternate between the diploid and haploid condition (though nuclear unaccompanied by cytoplasmic division occurs, of course, in some forms at certain stages of the life-history). In many cases the chromosome cycle is accurately known. It has, indeed, been claimed that there are structural differences showing that the supposed cells of Protozoa are not cells, and attention has been directed in particular towards the intranuclear centrosome and spindle. The centrosome is, however, by no means always intra-nuclear in Protozoa. The extra-nuclear basal granule of flagellates is generally regarded as the counterpart of a centriole. Again, the centrosomes of the trophozoite of the gregarine, *Monocystis rostrata*, are extra-nuclear, and an extra-nuclear spindle is formed between them[3]. In the terrestrial amœba, *Hartmanella klitzkei*, the centrosome is extra-nuclear, and the nuclear membrane disappears during mitosis[4]. Arndt gives a list of Protozoa in which extra-nuclear centrosomes have been described.

Many Protozoa display the characters of a cell so well that it is not easy to understand how it can be denied that they are unicellular. The question whether certain Protista may be regarded as unicellular is, indeed, a subject of dispute among zoologists only; botanists are almost unanimous in considering that this is obviously so. Among the algæ, several distinct groups are *each* represented by species that are motile holophytic single cells, by other species that are motile colourless single cells, by others again that are motile, dendroid or palmelloid colonies, and by yet others that are simple or heterotrichous filaments (see especially Fritsch[5]). If the word 'metaphyte' is to be used as the botanical equivalent of 'metazoon', then one can say that metaphytes have unquestionably arisen more than once among the algæ. A metazoon is characteristically an animal in which there is *more than one kind of somatic cell*. This is exactly the condition in heterotrichous filaments among algæ. Now the heterotrichous *Stigeoclonium* is allied to the unicellular *Chlamydomonas*, and the heterotrichous *Dinoclonium* to the unicellular *Gymnodinium*. Conditions are particularly clear in *Dinoclonium*[6]. This is a brown marine alga that spreads as a filament over other algæ, and sends out upright lateral filaments. Single cells of the main thread become modified as swarmers, which escape from their cell-walls and swim freely as typical dinoflagellates resembling *Gymnodinium*. One cannot escape the conclusion that each swarmer is a cell, with the necessary consequence that *Gymnodinium* is a cell—a fact that will be allowed by botanists, though it contradicts those zoologists who altogether deny the cellular nature of Protozoa.

From these facts it follows that the Protozoa cannot be regarded as monophyletic: they include motile representatives of algæ belonging to various groups, many members of which are clearly not Protozoa in the ordinary sense since they are multicellular, non-motile and holophytic. To take a concrete example: *Gymnodinium* is very much more closely related to *Dinoclonium* than to *Amœba*. It is therefore wrong to include *Gymnodinium* and *Amœba* in a single group (Protozoa) which excludes *Dinoclonium*. The word Protozoa is not valid in the evolutionary or true classificatory sense, though it may be used descriptively. No precise definition will cover all organisms that are regarded as Protozoa and exclude all that are not, but the following covers all the typical ones: "Organisms that are motile and/or holozoic, and in which different kinds of somatic cells do not occur"; but it is necessary to add to these such organisms as are obviously related to those that are covered by the definition, but themselves escape it. The strict definition does not cover the Amœbosporidia (= Neosporidia), in which there is a differentiation of more than one kind of somatic cells (pole-capsule cells and envelope cells).

Non-cellular Protozoa

It will be noticed that in the proposed definition, no mention is made of Protozoa being unicellular. This is because there are many Protozoa that are not cells, in the sense in which the term has been defined above (p. 549). The Radiolaria provide some of the best examples. The careful work of Borgert[7,8] on *Aulacantha scolymantha* shows that a huge number of 'chromosomes' (more than 1,600) appear at division of the 'nucleus'. Very large so-called nuclei are usual in the group. There is no question of a meiotic division of these large nuclei, with the production of gametes containing half as many chromosomes. On the contrary, both the gametes and the non-sexual isospores contain only minute fragments of the large nuclei. The process varies in the different forms, but chromatin is often cast out into the cytoplasm and small portions of the cytoplasm are nipped off round these. The process of nuclear break-up has been described in detail by Brandt[9] for *Thalassophysa pelagica*. From the central capsule, with its single, huge 'nucleus', there develop thousands of small individuals, each with many nuclei. Although the number of chromosomes in the gametes and in the nuclei of the small individuals is not known in most cases, yet it is clear that the large 'nucleus' of the feeding stage is enormously polyploid, or 'polyenergid', as Hartmann[10,11] called it. The idea of the polyenergid nucleus occurred to him when he first saw an apparently uninucleate *Thalassophysa* change into a colony of thousands of small individuals, each with several nuclei, as Brandt had previously described. It is obvious that a radiolarian, with its enormously polyploid 'nucleus', does not correspond with a diploid or haploid metazoan cell (though it may correspond with the polyploid protoplasmic masses that occur in certain tissues of certain metazoan species).

Polyploid or polyenergid 'nuclei' occur also among the Foraminifera and in *Wagnerella* among the Heliozoa. It is probable that so-called 'chromidia' are commonly the actual *nuclei* of polyenergid forms. Further, it is among polyenergid Protozoa that amitosis is generally found. Amitosis is very difficult to understand if it ever occurs in a diploid or haploid protozoan, for it would seem likely to play havoc with the gene-complex. If, however, there is in fact a very large number of nuclei in one large 'nucleus', there is no reason why exact division should be necessary. The nuclei of polyploid protoplasmic masses in Metazoa may perhaps sometimes divide amitotically in a similar way.

Wherever new nuclei are formed from chromidia or a large nucleus divides by amitosis, polyploidy is to be suspected, and a direct comparison with a diploid or haploid metazoan cell cannot be made with any confidence. Highly polyploid Protozoa may, however, be less usual than one is inclined to suppose. The largest Protozoa are the easiest to study and much the easiest to demonstrate to elementary students; and the largest Protozoa are the most likely to be polyploid and therefore the least likely to be typical of the group as a whole. It is perhaps significant that when *Amœba proteus* undergoes mitosis, a large number of chromosomes appears[12].

The Ciliophora present a problem of their own. The so-called protociliates, such as *Opalina*, are obviously multinuclear; the other members of the group possess one or more macronuclei, the exact significance of which is still obscure. The micronucleus is unquestionably diploid until meiosis occurs at the beginning of conjugation. Two or more micronuclei are present in various ciliates of different groups; but the majority have only one, and the question is whether such forms can be regarded as diploid cells. The hypothesis that seems to fit the facts best is that the macronucleus, whether obviously multiple or not, represents a polyenergid nucleus. Races of ciliates lacking the micronucleus have been bred in several species; *Oxytricha fallax* has lived through 246 generations in this condition[13]. Amicronucleate specimens present the characteristic complex structure of the species and appear to be able to perform all normal functions except endomixis and conjugation (which they sometimes attempt unsuccessfully). It must be assumed, therefore, that they possess the complete gene-complex. A normal ciliate, therefore, is at the very least triploid. Since, however, the macronucleus divides by 'amitosis', it is probably highly polyploid; otherwise serious changes in the gene-complex would result from such a rough method of division. As is well known, various ciliates may be divided mechanically, and each half or lesser portion will show that it possesses a complete gene-complex by regenerating into a normal individual. In some forms there is no distinct macronucleus, but only a mass of small granules of chromatin; each of these may perhaps represent a nucleus.

If this argument be correct, the Ciliophora must not be compared with the diploid and haploid cells of Metazoa, but rather with the polyenergid Radiolaria and other evidently polyploid Protozoa.

(*To be continued*)

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THE ARTIFICIAL PRODUCTION OF MESONS

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RECENT reports[1] from the United States announce that E. Gardner and C. M. G. Lattes have observed that mesons are generated when α-particles of great energy are allowed to fall on matter. The α-particles were produced by the 184-in. synchro-cyclotron at Berkeley, California, the mesons being detected by the photographic method. Most of the experiments have been made by the bombardment of carbon; but in similar conditions, targets of beryllium, copper and uranium yield mesons in approximately the same numbers.

The experiments show that the production of mesons becomes appreciable when the energy of the α-particles is of the order of 300 MeV., and the yield rises rapidly with increasing energy. By observing the deflexion of the mesons in the field of the cyclotron magnet, it is possible to determine the sign of the electric charge and the value of $H\rho$ of the individual particles. The momentum of a particle can thus be determined; and this quantity, taken in conjunction with its observed range in the emulsion of the photographic plate used for detection, gives a measure of its mass. The mean value so obtained is $(313 \pm 16)\, m_e$, where m_e is the mass of the electron. The authors state that in view of the large number of tracks available for measurement, it will be possible, in the near future, to reduce the errors of the determination to the order of ± 2 per cent. Up to the present, no measurements have been made of the mass of the positive mesons by this method.

A large proportion of the negative mesons which stop in the emulsion produce nuclear disintegrations with the emission of heavy charged particles. On the other hand, the positive particles, at the end of their range, produce no nuclear disintegrations, but a large fraction of them give rise to secondary mesons. These results, taken in conjunction with recent determinations of the mass of cosmic ray mesons, make it certain that at least a large proportion of the artificially produced particles are identical in type with the heavy mesons recently discovered at Bristol[2,3].

In these latter experiments, two types of heavy mesons were distinguished: σ-mesons, which produce nuclear disintegrations at the end of their range; and π-mesons, which decay with the emission of a secondary μ-meson. It was suggested that the π-mesons, and most of the σ-mesons, are respectively positive and negative particles of the same type; and, in view of their observed production during the explosive disintegration of nuclei, that they have a strong interaction with nucleons.

This view has been confirmed by Goldschmidt, King, Muirhead and Ritson[4]. These authors, working at Bristol, have determined the mass of the particles by studying the small-angle scattering which they undergo in passing through the emulsion. The value thus obtained is $(270 \pm 40)\, m_e$, for both π- and σ-mesons. Further, the quantity m_π/m_μ, the ratio of the mass of the π-meson to that of the secondary μ-meson produced by its decay, has been determined by Lattes, Occhialini and Powell[5], using the method of grain-counting. The value thus obtained is $m_\pi/m_\mu = 1{\cdot}65 \pm 0{\cdot}15$. If it is assumed that the μ-mesons are identical in type with the charged penetrating particles of the cosmic radiation, of mass $200\, m_e$, the above result corresponds to a value of $m_\pi = 330 \pm 30\, m_e$. The masses of the heavy mesons observed to be produced artificially, and of those in the cosmic radiation, are therefore equal to within the limits of error of the experiments. In view of the points of similarity in their behaviour when brought to rest in the photographic emulsion, it may be taken as established that the two classes of heavy particles, observed in the two experiments, are identical.

Experiments with heavy cosmic-ray mesons[6] have shown that the half-value period associated with the decay of these particles, τ_π, is greater than $0{\cdot}4 \times 10^{-10}$ sec. Preliminary observations indicate that the time of flight of the particles in the cyclotron experiments, assuming them to originate in the target material and to proceed to the photographic plate without suffering spontaneous decay, allows this limit to be reduced to about 10^{-9} sec. This result is consistent with the value $\tau_\pi < 2 \times 10^{-8}$ sec., deduced by Marshak and Bethe[7] from the absorption curve of the penetrating component of the cosmic radiation at great depths.

In addition to the production of heavy mesons, the Berkeley cyclotron experiments also provide evidence that light mesons, with a mass of about $200\, m_e$, are created in the bombardment of matter by α-particles of great energy. Preliminary observations suggest that some of the negative particles of this type, at the end of their range in the emulsion, also produce disintegrations.

The 184-in. cyclotron was designed and constructed with the view of generating mesons artificially; but until recently it was thought that the fast particles it produces were not sufficiently energetic for this purpose. From the point of view of meson production, an α-particle of energy 400 MeV. was considered to be approximately equivalent to four nucleons, each of energy 100 MeV.; and such a nucleon has not sufficient energy to lead to the creation of a particle of rest-mass 300 m_e. In contradiction with this view, the observations show that the generation of mesons occurs when the kinetic energy per nucleon is about 75 MeV., and indicate that the production process must be considered in relation to the α-particle as a whole.

It is pointed out by Gardner and Lattes[1] that it is possible to reconcile the observed production of mesons with the view that they are created in interactions between individual pairs of nucleons, if, following a suggestion of McMillan and Teller[6], account is taken of the internal motion of the nucleons in the colliding nuclei. Suppose the internal kinetic energy of the nucleons, in an α-particle or in a carbon nucleus, to be 25 MeV. For the production of mesons, it may be assumed that the most favourable collisions will be those in which the relative velocity of pairs of nucleons has the greatest possible value. The maximum kinetic energy available in the centre-of-mass co-ordinate system of a pair of nucleons in such a collision will then be equal to $\frac{1}{2}(\sqrt{100} + \sqrt{25} + \sqrt{25})^2 = 200$ MeV.; a value more than sufficient for the creation of a particle of mass 320 m_e. The same approach suggests that the threshold for the production of mesons by α-particles should occur at an energy of $\sim$ 300 MeV. The observations are thus consistent with the simple assumption that the mesons arise as a result of an interaction between single pairs of nucleons.

These experiments establish the possibility of investigating the properties of mesons in laboratory conditions, with localized sources of particles of high intensity. It is reasonable to suppose that they will lead to a period of rapid advance in nuclear physics, especially in the development of our knowledge of the internal motion of the nucleons, and of the forces between them which give stability to the nuclei. They represent a technical advance of decisive importance, and the progress of the investigations will be followed with great interest.

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[4] Goldschmidt, King, Muirhead and Ritson (in the press).

[5] Lattes, Occhialini and Powell (in the press).

[6] McMillan and Teller, *Phys. Rev.*, **72**, 1 (1947). See also Horning and Weinstein, *Phys. Rev.*, **72**, 251 (1947).

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NEWS and VIEWS

Holweck Prize: Prof. Y. Rocard

THE Holweck Prize and Medal were founded in 1945 as a memorial to Fernand Holweck, director of the Curie Laboratory of the Radium Institute in Paris, and to other French physicists who met their death during the occupation of France in 1940–44. The award, made jointly by the Physical Society and the Société Française de Physique, is conferred alternately upon a French and an English physicist. This year the Prize and Medal are awarded to Prof. Yves Rocard, professor at the Sorbonne, and director of the Physics Laboratory of the École Normale Supérieure, University of Paris. During 1925–39 M. Rocard published many papers on the equation of state of gases, hydrodynamics, diffusion of light by liquids, the optics of the atmosphere, mechanics, acoustics, and the propagation of electromagnetic waves. He introduced molecular hypotheses into the equations of hydrodynamics; he rediscovered the classical equations, determined the state of the liquid in the capillary layer which separates it from the vapour, and developed the theory of surface tension. These detailed studies of the structure of liquids enabled Rocard to determine the mechanism of the diffusion of light by an exact calculation of the intermolecular field, and to give the classical theory of the Raman effect. In connexion with these investigations, he carried out a series of theoretical and experimental studies of the transparency of the atmosphere, the range of projectiles and the visibility of signals.

This period of Rocard's scientific life was followed, from 1930 until the War, by ten years of work on acoustics, the mechanics of oscillating systems, and the mechanics of fluids; he studied the stability of motion of locomotives, the possibility of self-sustained oscillations in a centrifugal pump, and the damping of vibrations in the wings of aircraft. At the beginning of the War, Rocard put his knowledge at the service of his country, especially his work on critical frequencies of self-oscillation in aircraft, and the increase of sensitivity of sound detection apparatus. During the occupation of France, he occupied his enforced leisure in compiling a book on the general dynamics of vibrations; this has been translated into English and published in the United States. At the beginning of 1943 Rocard escaped from France and joined the Free French Forces in England. He adapted British and American radar to French ships, and took part in the liberation of Corsica and the capture of Toulon.

Engineering at the National Physical Laboratory: Mr. D. G. Sopwith

MR. D. G. SOPWITH has been appointed superintendent of the Engineering Division of the National Physical Laboratory in succession to Dr. G. A. Hankins, who recently became director of mechanical engineering research in the Department of Scientific and Industrial Research. Mr. Sopwith has been on the staff of the Engineering Division of the National Physical Laboratory for about twenty years, and his main interest has been in research on engineering materials and in the application of the basic principles of elasticity to engineering design problems. Until 1938 he worked in collaboration with Dr. H. J. Gough on fatigue and corrosion fatigue of metals, and on the design of lifting gear such as crane hooks. The former work showed the effect of the atmosphere on the fatigue resistance of various metals, while the latter resulted in improved practical designs. During the War, Mr. Sopwith carried out important work on the design of gun springs, gun barrels and shells; but his most valuable contribution was on the penetration of shot into armour plate, and his work both analytically and by controlled experiment in a laboratory armour-penetration range has done much to place that hitherto empirical subject on a sounder scientific basis. Mr. Sopwith brings to his new task, not only research experience, but also a marked ability to appreciate and then simplify analytical methods so that they can be readily applied to practical problems of engineering design.

Economics at the University of Sheffield : Dr. G. P. Jones

DR. G. P. JONES, reader in economic history in the University of Sheffield, has been appointed professor of economics in the University, in succession to Prof. D. Knoop, who retires in September. Dr. Jones is no stranger to Sheffield or Sheffield people, for he has been a member of the University staff since 1926 when he was appointed lecturer in economic history, and in recognition of the distinction of his scholarship and research the University conferred upon him in 1946 the title of reader. He has been especially interested in the organisation of the building industry from medieval to early modern times, to which field he has made distinguished contributions. In addition, ever since he has been in Sheffield, Dr. Jones has been closely connected with adult education, and throughout the whole period April 1940–July 1946 he did great service to the cause of education in H.M. Forces as secretary to the Sheffield Regional Committee, under the auspices of which more than twelve thousand lectures and classes were held for members of the Army, the R.A.F. and Women's Auxiliary Forces.

Royal Geographical Society : Awards for 1948

H.M. THE KING has approved the award of the Royal Medals for 1948 of the Royal Geographical Society as follow : *Founder's Medal*, to Mr. Wilfred Thesiger, for his contributions to the geography of southern Arabia and for his recent crossings of the Southern Arabian desert, the Rub al Khali ; *Patron's Medal*, to Mr. Thomas H. Manning, of the Geodetic Survey of Canada, for his explorations and survey work in the Canadian Arctic, including the mapping of Southampton Island and the Foxe Basin shores of Baffin Island, and for his successful adaptation of Eskimo methods of travel. The Council of the Society has made the following awards : *Victoria Medal*, to Prof. Frank Debenham, professor of geography in the University of Cambridge, for his work in geographical education and for his contributions to polar geography and exploration in the Antarctic and as first director of the Scott Polar Research Institute at Cambridge. *Murchison Grant*, to Mr. Robert W. Steel, lecturer in Colonial geography at the University of Oxford, for geographical work on the West African Ashanti Social Survey, 1945–46. *Back Grant*, to Mr. Alan J. Marshall, for exploratory and scientific work as leader of the Oxford University Exploration Club Expedition to Jan Mayen Island, 1947. *Cuthbert Peek Grant*, to Dr. Donald F. Thomson, for his explorations and anthropological studies in Arnhem Land, Northern Territory, Australia. *Gill Memorial*, to Mr. William W. Williams, lecturer in geography at the University of Cambridge, for original research during the War on the determination of underwater beach gradients.

Royal Asiatic Society of Bengal : Medal Awards

THE following medal awards of the Royal Asiatic Society of Bengal were announced at the annual meeting held on February 16 : *Barclay Memorial Medal*, a biennial award for contributions to medical or biological science with reference to India, to Rai Bahadur K. C. Mehta, principal of Agra College, for his contributions to the study of "Cereal Rusts in India" ; *Joy Gobind Law Memorial Medal*, a triennial award for contributions to the study of zoology in Asia, to Dr. Lieven Ferdinand de Beaufort, professor of zoology in the University of Amsterdam and director of the Zoological Museum at Amsterdam, for his contributions to the study of "Fishes of the Indo-Australian Archipelago" ; *Paul Johannes Bruhl Memorial Medal*, a triennial award for contributions to the study of Asiatic botany, to Prof. S. R. Bose, professor of botany, Carmichael Medical College, Calcutta, for his original research on polyporin from fungi ; *Dr. Bimala Churn Law Gold Medal*, an annual award for contributions to Indological studies, to Dr. B. M. Barua, professor of Pali in the University of Calcutta, for his contributions to the study of Buddhism in India ; *Sir Jadunath Sarkar Gold Medal*, a newly instituted biennial award for contributions to Indological researches from the thirteenth century A.D. up to A.D. 1802, to Sir Panduranga S. S. Pissurlencar, for his contributions to the study of the history of the Marathas and the Deccani Muslim Powers down to the time of Tipu Sultan.

Council for 1948

THE members of Council of the Society for 1948 are as follows : *President*, Dr. W. D. West ; *Vice-Presidents*, Dr. B. C. Law, Maharajadhiraja Bahadur Sir U. C. Mahtab, Dr. M. N. Saha, Sir B. L. Mitter ; *General Secretary*, Dr. K. N. Bagchi ; *Treasurer*, K. P. Khaitan ; *Philological Secretary*, Dr. S. K. Chatterji ; *Joint Philological Secretary*, Dr. M. Ishaque ; *Natural History Secretaries*, Dr. K. Biswas (biology) and Dr. S. K. Mitra (physical sciences) ; *Anthropological Secretary*, Dr. Verrier Elwin ; *Historical and Archæological Secretary*, H. Waddington ; *Medical Secretary*, Lieut.-Colonel C. L. Pasricha ; *Library Secretary*, Dr. B. S. Guha ; *Other Members of Council*, C. C. Blagden, H. F. Bensly, Dr. A. H. M. Mohiyuddin, Sir A. H. Ghuznavi and Ramaprasad Mookerjee.

The following were elected fellows of the Society : Rao Bahadur K. V. Rangaswami Aiyangar, director of public instruction, Travancore ; Dr. B. M. Barua, professor of Pali, University of Calcutta ; Dr. F. G. Percival, of the Tata Iron and Steel Co. Prof. D. R. Bhandarkar, formerly of the University of Calcutta, was elected an honorary fellow.

Corrosion Research in Canada

THE National Research Council, Canada, has established a committee to assemble information on all aspects of corrosion and promote its dissemination. In the first instance, a survey is being made of existing Canadian facilities for the study of corrosion and means of combating its effects. It is proposed to assist Canadian universities in making studies of the fundamental chemical and electrochemical reactions that cause deterioration of metals in service, and in the training of students in the techniques of corrosion research and prevention. In the development of a programme of research in this field the committee is seeking the co-operation of all organisations and industries that are concerned in dealing with corrosion problems, and to obtain information a questionnaire has been prepared and given wide distribution.

The chairman of the new committee is Dr. R. R. Rogers, Department of Mines and Resources, and the secretary is D. Wolochow, Division of Building

Research, National Research Council, Ottawa. Other members of the Committee are: H. J. Butterill (International Nickel Co.), N. Cohen (National Research Council), R. Judge (Department of National Defence, representing the Defence Research Board), Frank D. Forward (University of British Columbia), H. P. Godard (Aluminium Laboratories, Ltd.), Lorne Sproule (Imperial Oil Ltd.), Dr. C. Y. Hopkins (National Research Council), E. T. Hurley (Canadian National Railways), H. D. Smith (Nova Scotia Research Foundation), and Frank Twining (Canadian Industries, Ltd.).

'Supermalloy': a New Magnetic Alloy

IRON-nickel alloys, containing 35–90 per cent nickel, have permeabilities very much greater than that of iron. These alloys, called 'permalloys', are especially useful commercially for transformers. The addition of one or more of the elements molybdenum, chromium and copper to permalloys has proved advantageous. 'Mumetal', which contains usually 5 per cent copper, 2 per cent chromium, 75 per cent nickel and 18 per cent iron, is perhaps the best known of the permalloys. It is used in transformers suitable for high frequencies and is notable not only for its high initial permeability (between 10,000 and 30,000) and its high electrical resistivity (60 microhm. cm.) but also for the very simple heat treatment required in its preparation. O. L. Boothby and R. M. Bozorth have described recent developments in these high-nickel alloys for use at low inductions (*J. Appl. Phys.*, **18**, 173; 1947; see also Bozorth, R. M., *Rev. Mod. Phys.*, **19**, 38; 1947). The new material 'Supermalloy' (su-perm′-al-loy), developed during the Second World War and already supplied in considerable quantities to the U.S. Navy, contains 5 per cent molybdenum and 79 per cent nickel, the remainder being mainly iron with a little manganese. The alloy is heat-treated, being maintained at 1,300° C. in pure dry hydrogen and then cooled from 600° C. to 300° C. at a critical rate. Whereas its electrical resistivity is about the same as for 'Mumetal', its initial and maximum permeabilities are many times larger, 50,000–150,000 for the initial, and 600,000–1,200,000 for the maximum, permeabilities. 'Supermalloy' can be produced in the form of very thin insulated tape, suitable for transformer cores, and it is claimed that the use of this new alloy in communication transformers permits a threefold increase in the range of frequencies transmitted, and a pulse duration three times that previously obtained.

Colchicine, its Chemical and Biological Properties

THE sessional inaugural lecture to the Chemical Society of University College, Dublin, was delivered on February 3 by Prof. J. W. Cook, regius professor of chemistry, University of Glasgow, who spoke on colchicine. Colchicum, a drug of great antiquity, is extracted from meadow saffron (*Colchicum autumnale*). It is present in all parts of the plant, especially in the seeds, which contain up to 0·75 per cent of the active principle. The poisonous nature of colchicum was known to Dioscorides; its toxic symptoms and its only therapeutic use, in the treatment of gout, are described in "The Herball", by John Gerarde, published in 1597. Colchicine, the active principle of colchicum, was isolated by Pelletier in 1820, but was not obtained pure and crystalline until 1915. Its composition and its functional groups were investigated by Zeisel, and the main features of its molecular structure were established by Windaus in 1924. Colchicine, $C_{22}H_{25}O_6N$, contains three rings, one them a trimethoxylated benzene ring, an acety amino group, and an inert carbonyl group, and it the methyl ether of an enol. Recent studies hav shown that revision of the Windaus structure necessary, and the molecular formula of a degradatio product, deaminocolchinol methyl ether, has bee established beyond doubt by Barton, Cook an Loudon (1945). The final details of structure colchicine itself still require to be settled. The mol cule probably contains at least one seven-membere carbon ring. The remarkable effect of colchicine i arresting mitosis in nuclei at the metaphase w discovered by Lits, a pupil of Dustin; it is effectiv in a dilution of 1 in 10^8, and has important biologic applications. Thus, it may be used as an index the rate of growth of tissues, and of the activity various classes of growth-stimulating hormones. A effect on plants, first studied by Havas, was show by extensive investigations of Blakeslee to result i the production of polyploidy, leading to new an improved varieties of flowers, fruits and cereals.

Insect Pests of Flour

UNDER the title of "Insect Pests of Food: Th Control of Insects in Flour Mills" (London: H.M Stationery Office. 7*s*. 6*d*. net), the Ministry of Foo has recently issued a useful 84-page practical bulleti by J. A. Freeman and E. E. Turtle. The author are, respectively, chief entomologist and chie chemist of the Infestation Control Division of th Ministry. The bulletin deals with those insects an mites that affect the flour miller: it describes th measures that can be adopted in order to preven infestation and how to control such insects shoul they manage to establish themselves. It is divide into three main sections, namely, methods of pre vention and control; life-histories of insects an mites; and infestation in the mill. The losses whic these creatures inflict on the industry may be assesse as damage to wheat; interference with productiv processes; contamination and spoiling of finishe products and loss of goodwill and trade reputation The methods of control that are described are onl those which have been examined by the Ministr and thoroughly proved in practice. It should no be inferred, however, that these methods are in an sense static. New work is continually going on, and as examples, may be mentioned that which is bein done in assessing the value of D.D.T. and of benzen hexachloride ('Gammexane') in this connexion. Th bulletin is very well illustrated by numerous hal tone plates and text-figures.

The Bird Watcher

THE company of bird watchers grows larger wit succeeding years, its ranks including a diversity o enthusiasts, from the scientific ornithologist to th schoolboy and schoolgirl recruit. It is to help thes latter that the *Daily Mail* has issued a number o booklets on Nature subjects and so on, the latest o its School Aid series being "Bird Watching" by M Stuart Smith (2*s*.). This consists of some thirty-fou pages of excellent advice on how to study birds, wit a number of admirable photographs by Mr. Eri Hosking, supplemented by equally admirable drawings by Mr. Edward Bradbury and eight colou pictures, the latter being reproductions of plates fron Gould's "Birds of Great Britain". It is wonderfu how fresh in spirit and treatment the Gould bir portraits remain, while for accuracy of feather detai they are hard to beat. With regard to the letterpress, Mr. Stuart Smith's advice on bird-watching will be very helpful to young people, especially his hints on identifying birds in the field; in short, his book is not only a good addition to the School Aid series, but is to be recommended for any boy or girl who shows an inclination for bird study.

The Caribbean Commission

THE Caribbean Commission, instituted by the Governments of France, the Netherlands, the United Kingdom and the United States, has published its first annual report (Port of Spain: Caribbean Commission. London: Crown Agents for the Colonies). From the scientific point of view its most important work is that of the Caribbean Research Council. The Commission is a consultative and advisory body fully representative of all the Colonies (islands and mainland) in the Caribbean area. Its Research Council is specially concerned with scientific, technological, social and economic problems. After its war activities, concerned largely with provision and distribution of food to the various Colonies, the Commission and its various committees are now again getting down to work. Problems of forestry, livestock, grain crops and grassland have been investigated or are under investigation. The Commission has also been concerned with the transference of West Indian agricultural labour to the United States.

Ray Society: Annual General Meeting

THE hundred and fourth annual general meeting of the Ray Society was held on March 17. It was announced that Pennant's "Tour on the Continent 1765", edited by Prof. G. R. de Beer, would be published shortly as part of the issue to members for 1947, and other volumes relating to the British fauna and flora are in active preparation, including Prof. Berrill's work on the Tunicates, Mr. Dandy's volume on British vice-counties, Messrs. Locket and Millidge's "British Spiders", the late Prof. W. M. Tattersall's monograph on the Mysidacea, and a second volume of Prof. Balfour-Browne's "British Water Beetles". The greatly increased cost of printing is likely seriously to hamper the activities of the Society, and an urgent appeal is made for new subscribers—both institutions and individuals. Prof. G. R. de Beer, Mr. A. C. Townsend and Dr. Errol White were re-elected president, honorary treasurer and honorary secretary respectively; Capt. C. Diver and Dr. W. S. Bristowe were elected vice-presidents and Dr. Malcolm Smith, Dr. John Hutchinson, Major Maxwell Knight and Dr. Ethelwynn Trewavas new members of council.

Summer School in X-Ray Crystallography

A SUMMER SCHOOL in fundamental and applied X-ray crystallography will be held in the College of Technology, Manchester, during September 6–17. The course will be conducted by Dr. H. Lipson, Dr. H. E. Buckley and other members of the staff of the University and the College of Technology. During the course emphasis will be laid upon fundamentals such as the analysis of the basic types of X-ray photograph, and enough detail will be given to enable the student to deal with more advanced types by himself ; in addition, directions of practical application will be indicated. It is hoped that, by these methods, students will have received a clear outline of the application of X-ray methods in general and that they will thus be able to assess its value to their own researches in particular. Applications to attend the course should be sent to the Director of Extra-Mural Studies, University, Manchester 13, and must be received not later than May 12.

Announcements

WE regret to announce the death of Prof. Alfred Lacroix, For.Mem.R.S., permanent secretary for thirty-four years of the Paris Academy of Sciences, on March 16, aged eighty-five; and of Prof. E. Waymouth Reid, F.R.S., professor of physiology at University College, Dundee, during 1889–1935, on March 10, aged eighty-five.

THE honorary degree of doctor of laws has been conferred by the University of Aberdeen on Sir George Thomson, professor of physics, Imperial College of Science and Technology, London; and on Major-General D. N. Wimberley, principal of University College, Dundee.

ON the occasion of the installation of Lord Halifax as chancellor of the University of Sheffield on July 2, the honorary degree of doctor of laws will be conferred on the following: The Hon. Lewis W. Douglas, Ambassador for the United States of America; Mr. Anthony Eden; Lord Addison; Admiral of the Fleet Lord Cunningham; Sir Frank Stenton, vice-chancellor of the University of Reading; Sir Henry Tizard, chairman of the Advisory Council on Scientific Policy; and Mr. Ernest S. Graham, Lord Mayor of Sheffield, 1946–47.

DR. V. PETROW, lecturer in chemistry at Queen Mary College, University of London, has been appointed chief research chemist to the British Drug Houses, Ltd., London, in succession to Dr. W. Bradley, who has accepted an invitation to the chair of colour chemistry and dyeing in the University of Leeds.

A PRELIMINARY meeting with the view of the establishment of a Scottish Society of the History of Medicine will be held in the Library of the Royal College of Surgeons, Edinburgh, on April 23, at 5 p.m. Dr. Douglas Guthrie will make a statement regarding the constitution and object of the proposed Society, and a paper by Dr. Henry J. C. Gibson on "The Early Days of Dundee Royal Infirmary" will be read. Communications should be sent to Dr. Douglas Guthrie, 21 Clarendon Crescent, Edinburgh.

THE National Research Council of Canada has established post-doctorate fellowships in pure chemistry tenable in its laboratories in Ottawa. The normal stipend will be 2,820 dollars, but may be varied depending on the qualifications of the candidate. A travelling allowance may be made. The awards are tenable for a period of one year but may be renewed for a second year. The subjects for investigation include photochemistry, radiation chemistry, spectroscopy, organic chemistry, radioactivity, ~~low-tem~~perature investigations, surface chemistry, and the properties of gases at high pressures and temperatures. Information and application forms may be obtained from the Chief Scientific Liaison Officer, Canada House, London, S.W.1.

ERRATA. In the note on the Max Planck Society in *Nature* of March 20, p. 427, the president's name should have been Prof. Erich Regener; misprints also appear in the names of Prof. Georg Schreiber and Prof. Heinrich Wieland.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Distribution of Alkaline Phosphatase in the Eggs of a Sea-urchin

IN a paper presented before the Sixth International Congress of Experimental Cytology at Stockholm, 1947, J. Runnström[1] remarked : "I find it reasonable to assume that the activation of the development means the activation of a number of enzyme systems". Starting from this assumption, I have studied the distribution of alkaline phosphatase in oocytes, mature unfertilized and fertilized eggs of the sea-urchin *Paracentrotus lividus* Lm. The material was collected during the summer of 1947 at the Station Biologique, Roscoff, Finistère.

The eggs were treated according to the histochemical methods elaborated by Gomori[2,3] and by Takamatsu[4]. The substrate contained sodium glycerophosphate and calcium chloride together with veronal buffer. The *p*H of this mixture was approximately 9·4. With this method, the sites of phosphatase activity appear black.

The results obtained may be summarized as follows.

(1) *In oocytes.* The phosphatase is localized in the nucleolus and the nuclear membrane (see Fig. 1). The cortical layer is devoid of phosphatase.

(2) *In mature unfertilized eggs.* A uniform layer of granules present in the cortex gives a strong phosphatase reaction (see Fig. 2). In all probability, these are identical with the cortical granules, which contribute to the material of the fertilization membrane (cf. refs. 5, 6). The peripheral part of the nucleus also contains phosphatase.

(3) *In fertilized eggs.* The quantity of alkaline phosphatase is considerably greater than in the mature unfertilized egg. The enzyme is present in numerous granules evenly distributed throughout the cytoplasm (see Fig. 3). There is thus no particular accumulation of the enzyme in the cortical layer. The extensive activation of alkaline phosphatase following the fertilization is accomplished within a few minutes after the attachment of the spermatozoon.

There is thus a pronounced difference with respect to quantity and distribution of alkaline phosphatase in oocytes, unfertilized and fertilized eggs of *Paracentrotus lividus*. The phosphatase activity appearing in the cortex after the maturation may be one of the factors on which the fertilizability of the egg depends. The strong activation of cytoplasmic phosphatase in the fertilized egg is in harmony with the profound modifications which the proteins undergo upon fertilization (cf. ref. 1). It is tempting to suggest that the activation of the phosphatase is in some way correlated to an increased nucleic acid metabolism.

Several aspects of this work are now being continued. A more detailed report will appear elsewhere.

My sincere thanks are due to Prof. John Runnström, who suggested this subject to me, for his help and active interest.

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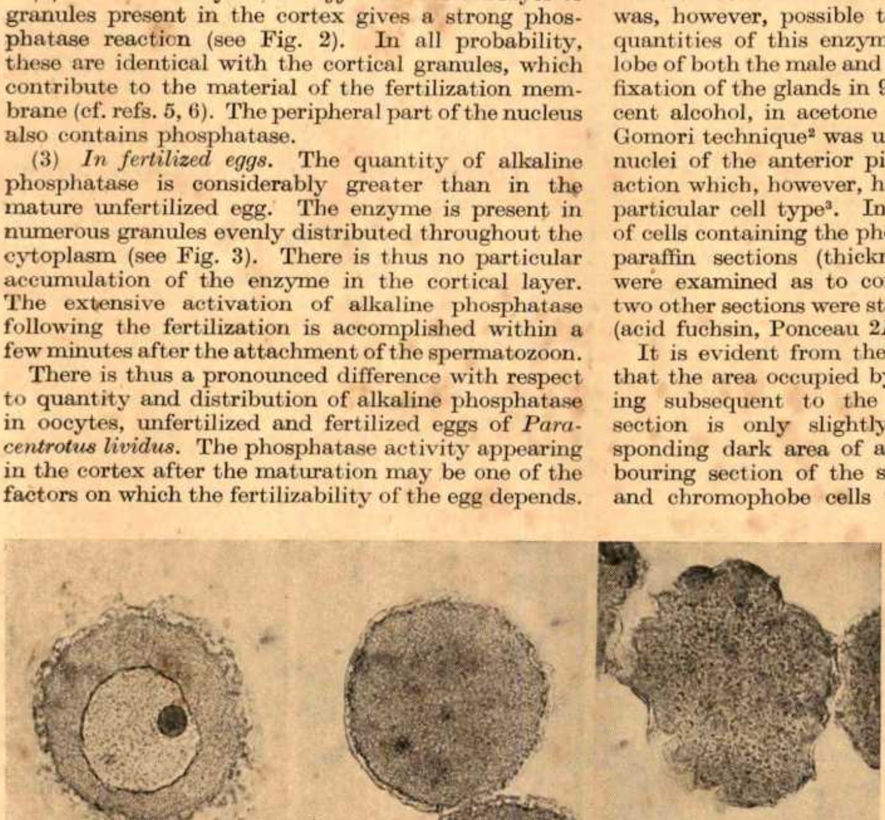

Paracentrotus lividus LM. EGG CELLS FIXED AND STAINED BY THE GOMORI FIXATION TECHNIQUE. (1) OOCYTE, (2) MATURE UNFERTILIZED EGG, (3) FERTILIZED EGG FIXED 45 MINUTES AFTER INSEMINATION

In (1) and (2) the cells are surrounded by a coat of jelly much distorted by fixation and embedding. The cytoplasm of the oocyte and of the mature unfertilized egg is much better preserved by cold alcohol than that of the fertilized egg ; cf. the irregular contour of the latter (3). This gives supplementary evidence of the profound alteration of the cytoplasmic fabric occurring upon fertilization

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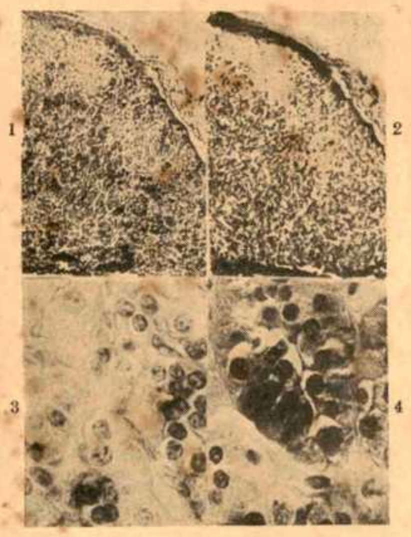
Alkaline Phosphatase in Various Cell Types of the Anterior Pituitary of the Guinea Pig

ONLY small amounts of alkaline phosphatase have hitherto been found in mammalian endocrines. It was, however, possible to demonstrate considerable quantities of this enzyme in the anterior pituitary lobe of both the male and the female guinea pig. After fixation of the glands in 96 per cent alcohol, in 80 per cent alcohol, in acetone or in pyridine-alcohol[1], the Gomori technique[2] was used. As already known, the nuclei of the anterior pituitary show a positive reaction which, however, has not been localized to any particular cell type[3]. In order to identify the type of cells containing the phosphatase, every two of four paraffin sections (thickness : 2–4 μ) of each gland were examined as to content of phosphatase : the two other sections were stained by Masson's trichrome (acid fuchsin, Ponceau 2*R* and aniline blue) method.

It is evident from the photomicrographs (p. 557) that the area occupied by the black product appearing subsequent to the dephosphorylation in the section is only slightly smaller than the corresponding dark area of acidophile cells in the neighbouring section of the same gland. The basophile and chromophobe cells which occupy most of the peripheral area as well as the smaller basophile and chromophobe islets within the interior area exhibit no, or very slight, enzymatic reaction.

In acidophile cells, the strongest reaction is given by nuclei and cell surface ; but in many cells the cytoplasm also shows a high phosphatase content. In such cases the enzyme is either diffusely present within the whole cell, or localized around the nuclei, or mainly concentrated in the centroplasm- (Golgi-)



PHOTOMICROGRAPHS OF FRONTAL SECTIONS OF THE CRANIO-LATERAL REGION OF THE PITUITARY OF PREGNANT FEMALE GUINEA PIG. FILTERS: TRICOLOUR GREEN AND COMPLEMENTARY BLUE

(1) Dark, alkaline phosphatase reaction area. (2) Corresponding dark area of Masson-stained acidophile cells in the neighbouring section; black connective tissue on the surface of the gland (both sections × 30). (3) Peripheral portion of phosphatase-exhibiting section; light basophile cells, dark nuclei of acidophile cells (× 400). (4) A group of acidophile cells with diverse phosphatase contents in the cytoplasm (× 400)

field, a localization found also in the intestinal epithelium[4]. The nuclei of the acidophile cells either contain large black granules or stain diffusely[3]. The highest content of enzyme was observed in the pituitary of the pregnant female. In all the glands examined a smaller number of acidophile cells was found where the phosphatase activity was confined to the nucleolus or the nuclear surface. When a group of acidophile cells in different stages of functional activity was examined, the amount of enzyme was found to vary considerably. I propose to extend the present work by following the changes of enzyme content in the different stages of secretion.

It is already clear, however, that there is no direct correlation between the enzyme content and the quantity of acidophilic granules present. The question is not yet settled whether there is a distinct qualitative (or only a quantitative) difference, so far as phosphatase activity is concerned, between the acidophile cells on one hand and the basophile and chromophobe cells on the other. Possibly the slightly blackened cells present in the light area of sections treated by Gomori's method do not correspond to basophile or chromophobe, but to acidophile cells in a stage of low phosphatase activity. It is of interest that the presence of alkaline phosphatase is correlated with the occurrence of ribose nucleic acid, the presence of which in acidophile cells of the guinea pig pituitary[5] we were able to confirm. In the hypophysis of advanced embryonic stage the phosphatase was mainly found in the nucleolus and in different parts of the nucleus, but rarely in the cytoplasm. This localization may agree with Caspersson's conception of the protein synthesis[6] in the young secretory cell as well as with observations on other secretory organs[7].

From a preliminary investigation of the hypophysis of the rat, it appears that the enzyme and the ribose nucleic acid contents are low. Our observations on operated animals lead us to believe that there is a quantitative difference between the rate of hormone production in guinea pigs and rats.

In the bovine hypophysis the acidophile cell produces the lactogenic hormone and the growth hormone, whereas the basophile cell produces the FSH, the LH and the thyrotropic hormone[8]. The same probably holds true in the case of the guinea pig (at least as regards the gonadotropic, the thyrotropic and the growth hormones)[9]. In the light of the evidence presented above, it may be inferred that the production of pure protein hormones[10] in the acidophile cell of the anterior lobe of the pituitary of the guinea pig is somehow related to high alkaline phosphatase and ribose nucleic acid content, while the production of hormones of the glycoprotein type (as well as of the adrenotropic hormone[8], which is a pure protein) in the basophile cell occur under enzymatic conditions different from those found in the acidophile cells.

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Influence of Vitamin P (Vitamin C_2) upon the Amount of Ascorbic Acid in the Organs of the Guinea Pig

WE have put forward previously the view that vitamin P acts upon vitamin C as a 'sparing factor' by slowing down its oxidation; this factor should be indispensable, for without it the organism would need vitamin C in much larger quantities than can be supplied by a normal diet[1]. This theory led us to carry out two series of experiments. The first showed that various substances capable of raising the mean capillary resistance of a group of guinea pigs decrease *in vitro* oxidation of *l*-ascorbic acid[2]. The other showed that *l*-ascorbic acid, administered to guinea pigs, even in large doses and over a long period, is inefficient if the animals are given at the same time a diet deficient in an ascorbic acid economizing factor. Conversely, if vitamin P is added, *l*-ascorbic acid, even in small doses, becomes fully efficient; vitamin P alone, without ascorbic acid, has no effect. The tests used were the mean capillary resistance of a group of guinea pigs and the histological picture of the thyroid gland and of the cortico-adrenal gland[3].

It then became a question whether vitamin P would be able to increase the amount of ascorbic acid present in the organs, if the quantity of ascorbic acid administered in the diet was kept constant.

Tests were made with twenty male guinea pigs weighing about 300 gm. In a preliminary period of eleven days, the animals were given a diet with

MEAN QUANTITIES OF ASCORBIC ACID IN MGM. PER 100 GM. OF ORGAN

		I	II	III	IV
Liver	*a*	1·9	2·9 (1)	3·4 (3)	20·0
	b	4·0	<4·4	<2·6	12·3
	c	<0·6	0·9	<1·0	5·0
Spleen	*a*	3·4 (3)	3·8	6·2 (2)	18·2 (4)
	b		<2·0		12·9
	c	<3·5 (3)	1·7	<4·1	8·5
Kidney	*a*	3·8	1·4	2·0	20·3
	b	4·2	1·8	<3·4	9·5 (2)
	c	<0·8 (3)	0·6	<2·1	4·8
Adrenals	*a*	6·7 (3)	10·2	<5·3 (3)	33·5
	b				30·9
	c	<3·9	<3·9	<3·4	13·5

Diets: I—Basic diet (4 guinea pigs).
II ,, ,, + catechin*: one mgm. per animal daily, orally (2 guinea pigs).
III ,, ,, + *l*-ascorbic acid; 10 mgm. per animal six days a week, orally (5 guinea pigs).
IV ,, ,, + *l*-ascorbic acid and catechin in the doses given above (5 guinea pigs).

Techniques: *a* Direct measurement with dichlorophenolindophenol following Tillmans.
b Kinetic measurement with dichlorophenolindophenol following Meunier.
c Kinetic measurement with methylene blue following Géro.

When a measurement had not been made on all animals of a set, the number of animals which were submitted to this measurement is indicated in brackets.

* A mixture of epimers of the *d*-catechin (Percapyl Roussel).

plenty of ascorbic acid and vitamin P (cabbages *ad lib.*). Then they were divided into four sets of five animals. The diet of each set is given in the accompanying table.

The basic diet consisted of a mixture of equal weights of oats (var. *grignonnaise*, which proved, during preliminary experiments, to be without obvious effect upon capillary resistance) and bran, autoclaved at 110° C. with ammonium hydroxide for half an hour. In addition, each animal was given daily orally 1 mgm. aneurine, 0·5 mgm. riboflavine, 1 mgm. nicotamide, and twice weekly 1 cm.^{3} cod liver oil.

In groups I and II, the mean weight of the animals decreased from about the eighteenth day. It remained almost stationary in groups III and IV. In group I, one guinea pig died on the eighteenth day and two others were dying on the twenty-third day. In group II, one animal died on the eighteenth day and two others on the twenty-second day. No animals died in groups III and IV. All survivors were killed by bleeding, groups I, II and III on the twenty-third day, group IV on the twenty-sixth day. Measurements were made of the amount of ascorbic acid present in the organs of the animals which had survived until the twenty-third day.

Autopsy and histological examination demonstrated the presence of scorbutic type lesions in all animals, with the exception of those in group IV.

The measurements of ascorbic acid present were made after extraction with a saturated solution of ammonium sulphate, following the technique of Mentzer. The mean figures obtained are given in the table. Three techniques were used: (*a*) direct measurement with dichlorophenolindophenol; (*b*) kinetic measurement with dichlorophenolindophenol, following the technique of Meunier[4]; (*c*) measurement with methylene blue, following the technique of Géro[5]. It will be noted that the three techniques give rather different figures; but two points should be noted: (1) Each technique gives for the same organ amounts four to eight times larger in Group IV than in the other groups. (2) This difference cannot be ascribed to over-estimation of the amount of ascorbic acid due simply to the presence of catechin; for Géro[5] showed, and we have confirmed, that the addition of catechin either to an extract of an organ or to a pure solution of *l*-ascorbic acid does not affect the results given by Meunier's technique and even reduces those given by the methylene blue technique.

It follows from this experiment that (*a*) there is no storage of ascorbic acid when guinea pigs receive ascorbic acid without a 'sparing factor' of this substance; (*b*) catechin, alone, does not appear to alter the amount of ascorbic acid in the organs of guinea pigs which are given, during twenty-three days, a scorbutic diet; (*c*) the simultaneous supply of *l*-ascorbic acid and catechin leads to storage of a certain amount of ascorbic acid. Histochemical detection of ascorbic acid was positive only in the organs of the animals of group IV.

These observations show the manner of action of vitamin P; they explain why a higher level of storage of ascorbic acid is reached in the organs when the animals are supplied with natural sources of vitamin C than when they are supplied with pure synthetic *l*-ascorbic acid. The latter observation is in agreement with the figures published by Giroud, Leblond, Ratsimamanga and Géro[6]. More generally speaking, it seems impossible to study any action of ascorbic acid on the living organism without having determined previously the amount of the 'sparing factors' of ascorbic acid present in the diet.

In general, our work on the physiological role of this factor is in agreement with the hypothesis formerly put forward in France so early as 1926 by L. Randoin and R. Lecoq and by Bezssonoff. Bezssonoff gave the new substance the name 'factor C_2', and we think it would be advisable to return to that term. This would have the advantage of avoiding any confusion with vitamin PP, and, above all, it would recall the physiological role of this factor, which is not restricted to an effect on vascular permeability.

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The Nucleolus of the Apodan Sertoli Cell

THE association of desoxyribose nucleic acid with the nucleolus has been reported in a number of different types of cells. Hydén[1] in nerve cells, Davidson[2] in the rat liver cell and Koller[3] in tumour cells, find that particles or granules giving a positive Feulgen reaction occur on the periphery of the Feulgen-negative nucleolus. Caspersson[4] has identified these granules with what he calls "nucleolus-associated chromatin". He assigns to them the important function of the secretion and deposition of nucleolar substances and a part in protein synthesis in the cytoplasm. Koller and Davidson believe that this nucleolus-associated chromatin forms an integral part of the nucleolar structure and contributes to the formation of the chromocentre and the nucleolar organisers.

Recently, while examining the Sertoli nuclei in the testis of certain Apoda (Amphibia), it was observed that the nucleolus showed Feulgen-positive granules adhering to its periphery. The nucleus of the Sertoli cell in *Siphonops annulatus* has one or more nucleoli and each of them shows a distinctly dual structure. Around the spherical nucleolus (which is Feulgen-negative) there occur a number of Feulgen-positive bodies; two to six bodies could be counted on a single nucleolus. They were larger than the granules figured by Hydén in the spinal ganglion cell of the rabbit and nearly as conspicuous as those found by Koller in the resting tumour cell treated with stilbœstrol.

The possible function of these bodies cannot yet be defined, since the function of the Sertoli cells is itself a matter of doubt in the Apoda. In these Amphibia, the Sertoli cells have undergone a great change in position as well as structure, and there is every reason to believe[5] that the usual function of providing support and nourishment to the growing sperms, assigned to the Sertoli cell of the vertebrate testis, could not hold in the case of these Amphibia. But it is a matter of great significance that unlike the tumour cell which enters on division, the Sertoli cell has no mitotic future and is to be regarded as one which has reached a stage of permanent rest[6]. In this respect the Sertoli cell resembles rather the nerve cell or the liver cell, where also mitoses are rare or wanting. It therefore appears unlikely that these granules could take part in any process associated with mitosis. The other possibility of the synthesis of cytoplasmic proteins, suggested by Caspersson, would also appear to be untenable in the Sertoli cell, where the cytoplasmic equipment is very meagre or often altogether wanting, the nucleus lying naked in the periphery of the testis locule[5]. It would therefore appear that the function of these Feulgen-positive bodies on the nucleolus is linked up with the general function of the Sertoli cell itself, which, in the Apoda, is at the moment obscure. Efforts are being made to determine these functions.

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A Cytochemical Study of the Perinuclear Lipidic Layer in the Liver Cell

THE blackening by osmium tetroxide of the perinuclear layer in various animal cells is well known (see, for example, Hirschler[1]). Recently, with an electron microscope, Gessler and Fullam[2] investigated guinea pig liver fixed with osmium tetroxide and cut with the high-speed microtome; they observed that the 'nuclear membrane' is sharply shown, and that, generally, the fat-containing parts of the tissue appear darker in these electron photomicrographs.

But the blackening with osmium tetroxide is not a sufficient evidence for lipidic constitution of a structure. For this reason, I have undertaken a cytochemical study of the perinuclear layer in the liver cell.

Thin fragments of guinea pig liver are fixed in formalin or Regaud's bichromate-formalin mixture. The frozen sections are treated by different methods for cytochemical characterization of the lipids. With Sudan black, the thin perinuclear layer is stained blue-black, obvious not only on the edge, but also on the surface of the nucleus; so the presence of fats in this layer is shown. The reaction for cholesterol and its esters (Schultze's sulphuric acid–acetic anhydride method) is always negative; nevertheless, it is not possible to affirm the absence of these substances in the thin perinuclear layer, for the coloration is weak, and often not obvious in a very thin layer. The reaction for free cholesterol (Leulier–Revol's method using digitonin) is also negative. In addition, the Smith–Dietrich reaction is clearly positive, and indicates the presence of lipoids (phospholipids) in the perinuclear layer.

With the polarizing microscope, I failed to see in fresh liver cells any birefringence connected with the perinuclear lipoidic layer. In fact, observation is disturbed by the refraction of the cell substance.

The osmiophilic perinuclear layer of the liver cell contains some lipoids, just like those I previously studied in the perinuclear lipidic layer of the histiocyte[3]. Its thickness is irregular; measured on electron photomicrographs, the osmiophilic layer does not exceed 75 millimicrons, and it is much thinner in most segments. It is probably composed of a few sheets of radially ordered lipoidic molecules; each bimolecular film is about 5 millimicrons thick and located between protein layers.

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Staphylokinase: an Activator of Plasma Protease

SEVERAL workers[1] have reported the lysis of fibrin clots by staphylococci, and this has been assumed to be due to a fibrinolysin produced by the bacteria.

In a series of experiments, which will be reported in detail later, twenty-seven strains of staphylococci were examined for fibrinolytic activity. All strains were first tested for coagulase, using human and rabbit plasma in parallel. Fourteen out of twenty-four strains which clotted human plasma afterwards lysed the clots which they produced. Clots were produced in rabbit plasma by twenty-three of these strains; but none of these clots showed subsequent lysis. All tubes were sealed and kept at 37° C. for one week; most of the human fibrin clots were lysed in four or five days.

The twenty-seven strains of staphylococci were then grown in digest broth, centrifuged, and the supernatant fluids dialysed under toluol against tap water for two days in the cold room. Merthiolate was added to the residues after removal from the bags. Sterile residues were shown to contain both coagulase and the fibrinolytic agent. They lysed human thrombin-fibrinogen clots in dilutions ranging as high as 1/3,000. But when either the fibrinogen or fibrin was first heated to 60° C. for half an hour to inactivate plasminogen, or when soya bean trypsin-inhibitor was added to the mixture there was no lysis.

Since soya bean trypsin-inhibitor inhibits plasmin but not bacterial proteases, it appears that the staphylococcus produces an activator of plasminogen and not a true fibrinolysin, and that its action is similar to that of streptokinase. This explains the absence of lysis with rabbit fibrin, since Christensen[2] has shown that rabbit plasma contains an inhibitor, anti-plasmin.

It is unfortunate that there has been so much confusion over terminology in this field of investigation. The plasminogen and plasmin referred to here correspond to the pro-fibrinolysin and fibrinolysin of American workers[3], and anti-plasmin to anti-fibrinolysin.

The action of staphylococci on the fibrin of other species is being investigated.

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Hæmolytic System in the Blood of Malaria-infected Monkeys

THE isolation of a hæmolytic substance from normal human blood plasma has previously been reported[1]. It has so far been characterized as an unsaturated monocarboxylic fatty acid having one double bond and the possible chain-length C18. This substance has been found to be widely distributed and has been isolated in varying amounts from a large number of animal tissues, brain especially giving a high yield.

Antimalarial drugs inhibit specifically the hæmolytic activity of this fatty acid *in vitro*[2]. This fact led to the assumption that "the malaria parasites at some stage of their development produce a metabolite closely related to the naturally occurring hæmolytic substance, and that the effect of antimalarial drugs *in vivo* is bound up with their action on this metabolite". This hypothesis is now supported by further experimental data. Heavily parasitized (*Plasmodium knowlesi*) monkey blood has been examined as to its content of hæmolytic substance and has given a manifold higher yield (25–75 ×) than normal monkey blood, varying with the degree and duration of the infection. The content of hæmolytic substance in parasitized blood is increased both inside the erythrocytes, which normally contain only little, and in the plasma. Microanalysis of the hæmolytic substance isolated in crystalline form from parasitized blood was made by Dr. G. Kenner, of the Chemical Laboratory, Cambridge, and so far has shown no difference from the hæmolytic substance obtained from normal blood and other tissues.

The malaria parasites, therefore, seem to produce or cause to appear inside the erythrocytes a hæmolytic substance, possibly identical with the physiological fatty acid, which destroys the erythrocytes when its concentration is high and is then released into the plasma. The production of a hæmolytic substance by the parasites may be thought of as enabling the metabolic utilization of the constituents of the erythrocyte by the parasite and the release of the merozoites.

This mode of erythrocyte destruction by the parasite is accentuated by another parasitic metabolite, namely, the malaria pigment, which is a hæmatin compound. Hæmatin, which is not a normal breakdown product of hæmoglobin, has itself been found to be hæmolytic *in vitro* in low concentrations down to 1/50,000. In still lower, subhæmolytic concentrations (1/200,000), it strongly potentiates the effect of the hæmolytic substance. In the light of these results, it might be interesting to study the quantitative relations of these two factors in the blood of blackwater fever cases.

I am indebted to Dr. F. Hawking, of the National Institute for Medical Research, London, for providing me with the samples of monkey blood used in these experiments. A detailed report will appear elsewhere.

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Nitrogen Metabolism After Fracture

AFTER a severe injury, such as a fracture, nitrogen balance usually becomes negative and the body loses nitrogen. The extent to which local effects of the injury (damage to tissues and disuse atrophy of muscles) contribute to this outpouring of nitrogen appears to have received little attention. The only direct measurements of loss of tissue from fractured limbs are those of Cuthbertson, McGirr and Robertson[1], who studied rats. These investigators fractured one femur of each rat, and on the tenth day after injury the animals were killed and both hind limbs were weighed. The average difference in weight between the sound limb and the injured limb was 1·03 gm. Assuming the material lost from the injured limb to have been muscle, they calculated that this difference in weight was equivalent to a loss of 32·2 mgm. nitrogen. There was, however, an average excess output of 425 mgm. nitrogen in the urine during the first nine days after fracture. From these observations it would seem that very little of the excess nitrogen excreted after fracture comes from the tissues of the injured limb.

We thought it desirable to repeat these experiments with certain modifications: first, the animals were killed five or six days after fracture, because it was thought that by the tenth day reparative processes may have partly compensated for earlier loss of tissue; secondly, direct determinations were made of the nitrogen lost from the injured limb, rather than indirectly by weighings of tissue. Two groups of rats receiving a 25 per cent casein diet were used, and the urinary collections and fracture technique were similar to those employed in previous experiments[2]. The first group of rats were killed five days after fracture, the second group six days after fracture. By this time the main phase of increased nitrogen excretion was ended in each group. The hind limbs were skinned and dissected from the trunk, using anatomical landmarks in order to achieve symmetrical removal of right and left limbs. After weighing, each limb was digested in concen-

Group of rats	No. in group	Mean body-weight (gm.)	Mean difference between right- and left-hind limbs		Mean excess output of N in urine during post-fracture period (mgm.)
			Weight (gm.)	N (mgm.)	
I	6	346	0·68 (= 21·3 mgm. N*)	60·3	205·7
II	5	166	0·16 (= 5·0 mgm. N*)	11·2	128·4

* Calculated from 1 gm. rat muscle = 31·3 mgm. N (Cuthbertson *et al.*[1]).

trated sulphuric acid, and nitrogen determinations were made on aliquots. As indicated in the accompanying table, the mean differences in weight between the injured and uninjured limbs were smaller than the mean difference found by Cuthbertson *et al.*[1]; but differences in the nitrogen content of the limbs found by actual analysis were greater than nitrogen losses calculated on the basis of differences in weight. The nitrogen lost from the injured limb did not, however, account for more than a small proportion of the extra output of nitrogen in the urine after the injury. These observations accordingly confirm the view put forward by Cuthbertson[3] that the greater part of the nitrogen lost from the body after an injury comes from sources other than the injured limb.

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Effect of Colchicine Treatment on the Alkaloidal Content of *Datura metel*

As a result of the work of Rowson[1], who found that the induced polyploids of various Solanaceous plants possessed higher alkaloidal contents than the normal varieties, we have investigated during the past two years the effect of colchicine treatment on the alkaloidal content of *Datura metel*, a commercial source of hyoscine.

A batch of seeds of *Datura metel* was well mixed and divided into two equal portions, one of which was treated with 0·4 per cent aqueous colchicine solution, as described by Rowson[1]. During March 1946 the seeds were sown in boxes and the plants reared under glass until about six inches high, when they were planted in the open on the materia medica farm at Dartford. The treated and the untreated plants were placed in separate plots but, so far as was practicable, under identical growing conditions. At the beginning of November 1946, the plants were harvested and a representative sample of each type assayed. The experiment was repeated in 1947 and the analytical results for the whole investigation are summarized below.

	1946		1947	
	Untreated	Colchicine-treated	Untreated	Colchicine-treated
Total alkaloidal content (%) expressed as hyoscyamine, calculated with respect to the plant in 60-mesh powder dried at 100° C.	0·422	0·419	0·401	0·438

These figures do not seem to us to support the view that colchicine treatment of the seeds results in a significant increase in the alkaloidal content of the plants; but in so far as we were unable to obtain any evidence of polyploidy by microscopical examination of our treated plants, it appears that in our experiments we were unsuccessful in producing polyploid species of *Datura metel*. We think that our results should be recorded, however, for the benefit of other workers interested in the practical applications of polyploidy.

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Structure of Yeast Ribonucleic Acid

DURING recent years, facts have accumulated about the electrometric titration of samples of yeast ribonucleic acid isolated by various methods. All the titration curves published[1-6] show on analysis the presence of a group titrating in the range *p*H 5·0–8·0; further, the pentose nucleic acid of the larvæ of *Calliphora erythrocephala* exhibits a similar dissociation[7]. The amount of this group present varies slightly with the samples used by different observers, but is generally of the order of 0·7 equiv. per statistical tetranucleotide in the polynucleotide, and it has been shown by Fletcher, Gulland and Jordan[3] that this value approaches close to 1·0 equiv. per four atoms of phosphorus on correction for the phosphorus-deficiency commonly encountered in this nucleic acid. There appears to us to be no reason to suppose that the simplest interpretation of this observation is not the correct one, namely, that the group is a secondary phosphoric acid group; this conclusion was reached by Fletcher, Gulland and Jordan[3] and by Chantrenne[4]. The suggestion put forward by Allen and Eiler[2] that this group is a very weak primary phosphoric acid group could only be accounted for on the basis of a much greater disturbance of the interrelationships of the groups in the polynucleotide than has so far been contemplated.

Any proposed structure for yeast ribonucleic acid must take into account the evidence derived from titration, which demands the presence of three primary and one secondary phosphoric acid groups, three amino-groups and two purine-pyrimidine 'hydroxyl' groups for every four (corrected) atoms of phosphorus in the polynucleotide. The simplest formulæ on this basis are those proposed by Fletcher, Gulland and Jordan[3], which are based also on the assumption that the phospho-ester linkage is the main internucleotide bond. At least one other formula which involves pyrophosphate groups and ether linkages satisfies the titration data, but is not acceptable on stereochemical, and perhaps chemical, grounds.

The experimental results of Zittle[5] on the enzymatic degradation of yeast ribonucleic acid, which are considered by him to invalidate the formulæ of Fletcher, Gulland and Jordan[3], cannot at the moment be explained, particularly in view of the facts that, on our analysis, the electrometric titration curve of his nucleic acid initially showed 0·7 equiv. of a secondary phosphoric acid group per tetranucleotide, and that enzymic degradation liberated 3·45 additional equivalents of a secondary phosphoric acid group, as stated by him. The total number of such groups is thus 4·15, the maximum possible being 4 on the basis of any structure for a polynucleotide with the correct theoretical phosphorus analysis. The sample titrated by Zittle would have had to contain about 28 per cent of its weight of water for its phosphorus content to have agreed with the theoretical value; and since this figure is much greater than that normally found, it follows that the phosphorus content was low and that the maximum possible number of secondary phosphoric acid groups must in this case have been less than 4; thus the total of 4·15 equivalents, found experimentally by titration, must have been even more divergent from that theoretically possible in this instance than is at first apparent. We do not consider that the evidence presented by Zittle is at present sufficient to override the considerable weight of experimental fact which is in favour of the formulæ of Fletcher, Gulland and Jordan.

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Adsorption of Calcium Ions by an Acid-extracted Brown Alga under Continuous Flow Conditions

The interaction of simple ions with plant cells has been frequently studied, and it has been found that in some cases cations and anions are both absorbed in the vacuoles[1], while under different conditions the readjustment of the salt content occurs mainly by ion exchange[2]. The experiments now to be described belong to the latter type; but, so far as I am aware, this is the first time that the ionic adsorption by a plant material has been systematically studied under flow conditions comparable to those prevailing in inorganic chromatographic adsorption analysis.

The measurements were done with the brown alga *Ascophyllum nodosum* and with solutions containing calcium ions. The fully swollen well-washed algal material, in which the majority of the cells appeared to be dead, was prepared from particles varying between 5 and 50 mesh/inch, and had been extracted with 1 N hydrochloric acid, at 20°, for about half an hour, thereby exchanging the various metals in the cell tissue against hydrogen ions[3]. The ionic adsorption is characterized by the break-through capacity, α, the number of equivalents of calcium adsorbed until the calcium can just be detected in the effluent; by the half saturation value, β, the equivalents of calcium adsorbed until the calcium concentration in the effluent is one half of that of the original solution; and by the exchange ratio, γ, the equivalents of acid in the effluent per one equivalent adsorbed calcium. The α- and β-values were not detectably influenced by illumination or by the oxygen content of the solution, but they depend on the history, age and particle size of the adsorbent and on the rate of flow, acidity and concentration of the solution. The exchange ratios, γ, were found to be near unity, which indicates that the uptake of calcium ions depends mainly on a conversion of the water-insoluble acids contained in the cell tissue into the relevant calcium salts, which are also water insoluble. The algal material used for these tests contained 2·8 gm.-equivalents of such acids per kgm. dry weight[3]. In most runs the α- and β-values were much smaller than 2·8; that is, the calcium ions appear in the effluent before the absorbent is fully neutralized. If, however, the *p*H value of the solution is relatively high, the break-through capacity approaches the neutralization equivalent, and under such conditions the adsorption capacity of this alga is similar to that of certain recognized cation-exchange materials.

A detailed account of these experiments is to be published elsewhere.

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Ferromagnetic Structure of Cold-Worked Austenitic Stainless Steels

In magnetic wire recording, the medium most frequently used for the recording of music is chromium-nickel austenitic stainless steel, which has been rendered ferromagnetic by drawing into fine wire. By suitable heat treatment after drawing, it has been found possible to obtain intrinsic coercivities $({}_IH_c)$ as high as 500 oersteds, a value so far in excess of the normal range for steels that some explanation seems required.

From the recording characteristics briefly described below, we have been led towards the idea of a dispersion of ferrite particles, probably long in relation to their cross-section, and of individual volumes of the order of a single domain, in a non-magnetic matrix of austenite. Support to this conception is given by the well-known results of the X-ray study of face-centred cubic structures[1] such as austenite, and the probability that the ferrite is produced along the slip planes of cold work; by the evidence both of magnetic testing and of X-ray examination that hard-drawn wires consist of some 50 per cent ferrite and the best heat-treated wires of only about 10 per cent; by the similarity between the variations of remanence with heat treatment for these wires and those for non-magnetic substances containing ferromagnetic impurities[2]; and by the close resemblance between the recording performance of these wires and that of magnetic tapes in which the medium consists of fine ferromagnetic particles embedded in a non-magnetic adhesive. A series of notes by Néel[3] have put forward an explanation of the high coercivities found in powders of cubic ferromagnetics and certain alloys on the assumption of inclusions of magnetic substances of extremely small dimensions in a non-magnetic matrix, and the recent important communication by Prof E. C. Stoner and E. P. Wohlfarth[4], on the interpretation of high coercivities in ferromagnetics provides a general picture into which our conclusions, developed from quite another starting point, fit very well.

Very briefly, the development is as follows. To produce a sine wave, the changes in magnetization must occur in many small, rather than a few large, steps; the ferrite must therefore be relatively evenly distributed in the wire. The ratio of maximum (undistorted, hence wire not saturated) signal strength to minimum (undistorted, although superposed on the minute variations causing the almost inaudible background noise) is of the order of 1,000 to 1, which represents the ratio of the number of particles undergoing reversals of direction of magnetization; the total number of particles in the cross-section of the wire is probably therefore of the order of 10^5–10^6. For a wire of standard diameter (0·004 in. = 10^{-2} cm.) containing 10 per cent ferrite, the mean diameter of a single particle would therefore be between $3 \cdot 2 \times 10^{-6}$ and 10^{-5} cm., so that a number might well be less than the critical value (300 A. for iron spheres given by Néel, and of the same order by Stoner and Wohlfarth) below which single domain formation is energetically possible. Again, the length of a particle must be of the order of half the wavelength of the highest recordable frequency; at 2 ft./sec. with the high-coercivity wires, frequencies of 70 kc./s. can be recorded, and probably very much higher. Taking 100 kc./s. as the maximum, the length would be $3 \cdot 05 \times 10^{-4}$ cm., but it is quite probable that this frequency is too low and that the mean particle-length is less. These tentative values suggest particles of a cylindrical or prolate ellipsoid shape and of single-domain dimensions.

It is hoped to develop more fully elsewhere the method of approach outlined above.

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Effect of the Electron Beam on the Voltage Distribution of a High-Voltage Multi-Stage Electron Accelerator

During the course of experiments on electrostatic focusing with a multi-stage accelerating tube[1], and afterwards with a multi-stage X-ray tube, it has been observed that the electron beam acts as if it were a potential divider (not necessarily uniform) connected to the accelerating electrodes.

In the early experiments, when attempts were made to control the potentials of the accelerating electrodes by means of corona points, the voltage distribution was found to vary with the beam current. Unless the corona current was equal to, or in excess of, the beam current, the potential distribution was controlled mainly by the beam current. These results were repeated using a potential divider in place of the corona points, and the effect observed at voltages up to 300 kV. D.C. using two, three and four stages of acceleration.

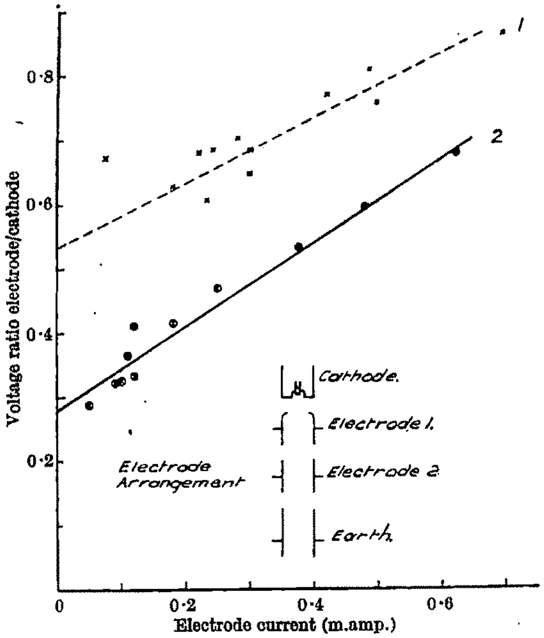

Fig. 1. RATIO OF VOLTAGE ON ELECTRODES (1 and 2) TO VOLTAGE ON CATHODE AS A FUNCTION OF CURRENT FLOWING TO ELECTRODE – CATHODE CURRENT KEPT CONSTANT AT 10 m.amp.

Later experiments were carried out on a three-stage X-ray tube fed from three high-voltage transformers in cascade, and the voltage of each stage in the cascade could be varied independently. The electrode arrangement is shown in the inset in Fig. 1; the currents were measured by milliammeters inserted in the leads to the electrodes, and the voltages by potential dividers.

Experiments were carried out varying the stage voltage ratios, and the corresponding D.C. currents to the electrodes observed. Some of the results are recorded in Fig. 1, from which it will be seen that at some particular ratio of voltages the current to the electrodes approached zero. It is of interest to note that with the particular electrode formation used, the voltage across the upper stage was greater than one third of the total voltage at zero electrode current. The manner in which the gradient varies with the electrode currents is clearly illustrated in Fig. 2, with a beam current of 10 m.amp.

From these results it was concluded that the electrodes would acquire the potential distribution indicated by the voltage ratios at zero electrode current in Figs. 1 and 2 if allowed to float and to

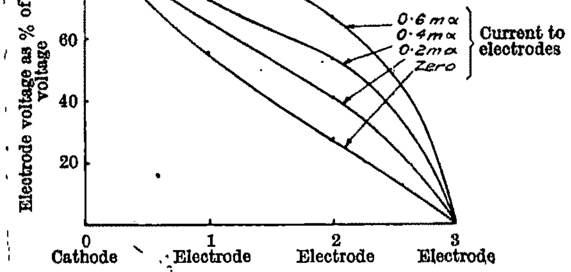

Fig. 2

depend for their source of potential solely on the beam of electrons flowing down the accelerating tube. That this conclusion was correct was confirmed afterwards by running the accelerating tube from a D.C. source and measuring the electrode voltages by means of a spark gap and later by an electrostatic voltmeter. These experiments indicate that a resistance divider will not exercise much control over the potentials of the accelerating electrodes of a multistage tube unless the current flowing in the divider is equal to, but preferably greater than, the beam current. The results are of particular interest in the case of electrostatic generators of low power, where a resistance divider passing only a fraction of the full beam current is used, presumably to obtain uniform voltage grading of the electrodes of the accelerating tube.

The exact mechanism by which the electron beam charges or discharges the accelerating electrodes has not been established; but it would appear that electrons from the main beam strike the electrodes and possibly release secondaries which tend to make the potential of the electrode more positive. This alters the voltage ratio of the stage, and so alters the focusing of the electron beam that fewer electrons strike the electrodes and the potential has a negative tendency. Thus it is conceivable that the electrodes will achieve a stable potential.

From this argument it would appear that the stage potentials are related to the beam focus, and the possibility arises of controlling the voltage distribution by modifying the shapes of the accelerating electrodes. Whether the shape required for satisfactory voltage distribution would also give a suitable focus is a matter for experiment. With multistage tubes, however, the electrode shapes are fortunately of secondary importance compared with the ratio of the voltage across the cathode to first stage to the total voltage, and so some latitude in the electrode shape from the focusing point of view is possible.

The possibility also arises of potential control by suitable choice of metals for the electrode construction, as the number of secondary electrons produced by primary bombardment varies for different materials.

It is suggested that to obtain uniform voltage distribution under all conditions in a multi-stage accelerator the electrodes should be developed on the lines suggested to give uniform voltage distribution with the electrodes floating; and a resistance divider such as is used at present should be incorporated to control the potentials at very small beam currents (that is, with a cold cathode).

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Apparent Emission of Positive Electrons from β-Emitters

SEVERAL investigators have reported finding positive particles emitted from β-emitters[1-8], in numbers very much greater than allowed by the theory of pair production either by γ-rays or β-particles. In some cases positive particles have been found to the extent of 1 per cent of the β-radiations from substances which are not γ-emitters[4,7]; and in others positive particles of surprisingly high energy have been detected[7].

It has been suggested that the theory of pair production is wrong by a considerable factor; but an extensive investigation by Crane and Halpern[9] found no disagreement between theory and experiment. Again, experiments using β-ray spectrographs have failed to confirm the existence of the supposed positive particles in anything like the numbers found in the cloud chamber. Two recent experiments[10,11], one in this Laboratory, have confirmed this result and shown that less than one positron is present in 75,000 β-particles. In addition, a search has been made for the annihilation radiation which positrons might be expected to produce, and none has been found[12].

In an attempt to resolve the discrepancy between results obtained with the cloud chamber and with other methods, a number of photographs of tracks from radium E and radium (D+E) have been taken. Radium E provides a suitable case for test because its γ-radiation has insufficient quantum energy to produce electron pairs. For the first series of photographs, radium E was deposited on a nickel wire which was placed at the centre of the chamber and along its axis. No slit system was used. The chamber had a diameter of 15 in. and was filled with air at 43 cm. mercury initial pressure. A magnetic field of 600 gauss was applied. Photographs of 316 tracks were obtained, and among them were eight which, from their direction of curvature and the increase of curvature along their length, appeared to be positrons.

In other experiments, a strong source of radium (D+E) was placed in a collimated holder with a magnetically operated shutter, so that a narrow beam of particles was obtained. The source was somewhat below the centre of the chamber. With this arrangement, more than two thousand tracks were observed, but to only two of these was it possible to ascribe a positive curvature.

Finally, some photographs were taken with the first arrangement of source but without a magnetic field, in order to observe the effect of multiple scattering on the shape of the β-ray tracks. In the forty-nine tracks which were obtained, the majority were fairly straight, some had an *S*-shape, while sixteen showed a measurable curvature in the same direction similar in appearance to a curvature due to a magnetic field. The results were in general agreement with Bethe's calculations[13] on multiple scattering. Using his formula, it can be shown that β-rays of energy less than 100 keV. will give tracks in air at atmospheric pressure with an average apparent radius of curvature due to multiple scattering of the same order as the curvature due to a magnetic field of 300 gauss; the magnetic fields used in the experiments quoted above varied between 230 and 500 gauss.

In the light of the last two series of photographs and of Bethe's theory, it would appear, therefore, that the apparently positive tracks observed both in the first part of this experiment and in the work of others, cited above, can be explained in either of two ways. In some cases, they would appear to be β-rays which have travelled full circle and the tracks of which show an increase of curvature in the sense to be expected for positive particles because of the effects of multiple scattering; the great majority of the particles which have been observed would fall into this class. In other cases, they would appear to be β-rays, sometimes of low energy, the tracks of which show the curvature of a positive particle because the multiple scattering has counterbalanced the curvature due to the magnetic field; such an effect would explain the observation of apparently positive particles with an anomalously high energy.

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Relation Between Photoconduction and Luminescence in Zinc Sulphide

A LARGE part of the studies on the afterglow or phosphorescence of solids has been made on zinc sulphide activated by copper (ZnS–Cu). Most of the theories of phosphorescence of ZnS–Cu have been based on the assumption that, when light is absorbed by the phosphor, electrons are freed from the luminescence centres and wander about the crystal. These free electrons may then be captured by traps, where they may spend appreciable time before they are freed by thermal energy, and may, then, either be retrapped, or are recaptured directly by empty luminescence centres, thus producing luminescence. The time the electron spends in the trap corresponds to the time delay of emission in phosphorescence.

We wish, however, to direct attention to experimental evidence which indicates that traps and luminescence centres co-exist in one centre, and that each excited electron is raised to a trap-level in this centre and may not be free to travel through the crystal. This evidence is based on two simple experiments. In the first experiment the phosphor is heated to empty all traps, cooled in the dark to 90° K., and then illuminated by exciting light. On warming the phosphor in the dark, electrons escape from traps and produce thermoluminescence and, as the temperature is raised steadily, the resulting thermoluminescence is produced by electrons from traps of progressively greater depth. The curve of thermoluminescence intensity plotted against temperature is the glow curve of Randall and Wilkins[1]. If the phosphor is excited by a sufficiently small amount of light energy, only a small fraction of the traps is filled and, hence, if the electrons escaping from traps wandered through the crystal, the chance of an electron being retrapped would be very great. It may be shown that, as a result, the ratio of the height of the glow curve at high temperatures to that at low temperature would be much greater for the case of partly filled traps than for completely filled traps. The significant fact is that for ZnS–Cu this ratio is only slightly different for the two glow curves (Fig. 1), there being appreciable emission at 200° K. for curve *b* in spite of the fact that only 0·1 per cent of the traps in the phosphor were filled by exciting light.

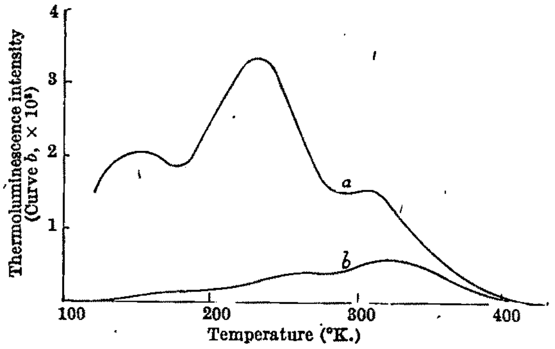

Fig. 1. THERMAL GLOW CURVES FOR A COPPER-ACTIVATED ZINC SULPHIDE PHOSPHOR (WURTZITE) FOR DIFFERENT EXCITATION CONDITIONS

(*a*) Strongly excited at 90° K.; (*b*) weak excitation at 90° K. Area under curve *a* (that is, number of filled traps) is 1,300 times area under curve *b*

This lack of retrapping might be explained in two ways: either the traps are in the luminescence centres, or they are separate and there exists a large number of empty luminescence centres in the unexcited phosphor. The latter explanation is ruled out by the second experiment, which shows that when the phosphor with all traps empty is excited at any temperature from 350° to 90° K. by constant low illumination, the intensity of luminescence increases slowly from zero. If there were empty luminescence centres in the unexcited phosphor, the electrons liberated from luminescence centres would, to some extent, be captured directly by the empty centres, and there would be a sudden initial rise of luminescence. Moreover, when the phosphor has been exposed to previous illumination at high temperature so that some very deep traps are filled, empty luminescence centres must exist in the phosphor. When the phosphor in this condition is exposed to exciting light at room temperature, the luminescence intensity again rises slowly from zero, though more rapidly than if all the traps had been previously emptied. Therefore, it does not appear that an electron from one luminescence centre can pass

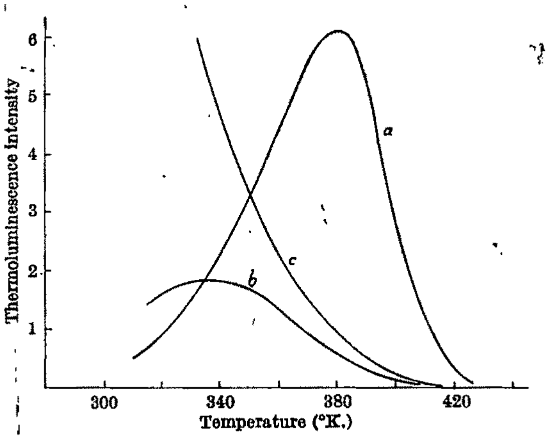

Fig. 2. THERMAL GLOW CURVES FOR A COPPER-ACTIVATED ZINC SULPHIDE PHOSPHOR (WURTZITE) FOR DIFFERENT EXCITATION CONDITIONS

(*a*) Strongly excited at 370° K. and then cooled to 295° K.; (*b*) excited by small amount of light at 295° K.; (*c*) excited by large amount of light at 295° K. (curve reduced in height) directly to another empty luminescence centre, and one is driven to the conclusion that a large part of the luminescence of ZnS–Cu does not involve electrons travelling freely through the crystal. The photoconductivity of ZnS–Cu may be simply due to a limited displacement of the electrons within the trap and luminescence centre.

Finally, we would like to answer a possible criticism of the work of Randall and Wilkins (*loc. cit.*), who maintain that there is continuous distribution of trap-levels in such phosphors as ZnS–Cu. It has been correctly pointed out that some of the glow curves in these papers, quoted as evidence for a continuous trap distribution, could be explained on the basis of a single trap-level if retrapping is taken into account. This theory would require, however, that the shape of the glow curve should be a function only of the number of traps filled. This is not the case, however, and the glow curves in Fig. 2 show the quite different curves obtained if the traps are partly filled by strong excitation at a high temperature (the phosphor being afterwards cooled in the dark) or by feeble excitation at a low temperature. These results seem to show conclusively that the trap-levels are distributed in depth.

We hope to publish shortly further details of this work.

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Ozone and Auroral Spectra

IN 1941, we published a theory[1] which provided, among other things, an explanation of seasonal and latitude variations in the thickness of atmospheric ozone. From this theory we were able to predict ozone thicknesses in latitudes for which, as yet, there are no direct observations—for example, in polar regions. Furthermore, we have shown that near the poles the ozone thickness should be practically zero soon after the winter solstice.

Now routine measurements of ozone thickness, carried out by E. Tönsberg and K. L. Olsen in Tromsö[2], have shown values so low as 0·05 cm. in December. It may be assumed that these occurrences are due to the movement of air masses from higher latitudes, so that the results afford good confirmation of our theoretical predictions.

When so little ozone is present, opportunities are offered for making spectrographic observations, as, for example, by observing the trans-auroral line 2972 A. ($^3P_1 - {}^1S_0$), O I. For this wave-length the optical density of the atmosphere is 0·60 (due to molecular scattering) and 0·365 (due to absorption by ozone), so that the intensity of radiation reaching the ground is about a tenth of that in the upper atmosphere. According to Pasternack's transition probabilities[3] and to the experimental confirmation by L. and R. Herman[4], we must expect a greater intensity for the line 2972 A. than for the line 6300 A. ($^3P_2 - {}^1D_2$), so that even allowing for a reduction of intensity of a tenth, the trans-auroral line should be observable in a zenithal aurora, in Tromsö, during a winter night when the ozone thickness does not exceed 0·05 cm.

Of course, this observation should be easier at a higher latitude, for example, in Spitsbergen, and preferably at some altitude above sea-level, in order to reduce molecular scattering. It is also to be expected that at other stations, at the same or even a lower latitude than Tromsö, the existence of polar air flows might offer still more favourable observing conditions.

It may be added that considerations of atmospheric absorption indicate that, under similar conditions, it might be possible to extend, by at least 200 A., the observed spectra of stars suitably located.

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Mass-Spectrographic Separation of Isotopes of Gaseous Elements

EXPERIMENTS recently carried out in this Institute[1] have shown that, by bombarding silver disks with beams of ions of neon isotopes obtained from a high-intensity mass-spectrograph[2,3], it is possible to prepare targets, containing the separated neon isotopes, that are suitable for certain investigations in nuclear physics. Due to the high energy of 60 keV., the ions penetrate into the silver surface to a depth of about one hundred atomic diameters, and to this depth a high concentration of neon atoms can be obtained. The experimental results (*loc. cit.*) indicate that a maximum concentration is approached when the surface has been hit by about 6×10^{16} ions per cm.^{2}, corresponding to the collection of 2 μgm. of neon per cm.^{2}, if all the neon atoms remain in the surface.

In the meantime, it has been demonstrated that it is possible to release the neon atoms almost completely from the silver by heating the target materia by means of high-frequency induction *in vacuo*. I a sufficiently large target area has been irradiate with neon ions, it is possible in this manner to isolat quantities of neon gas, containing one isotope only sufficient for many experimental purposes. Experiments of this kind have also been carried ou with aluminium, nickel and tungsten as targe materials.

The experiments were carried out in the followin way. The targets, 6·0 cm. × 2·5 cm. in size, wer cleaned by means of a suitable acid, rinsed wit distilled water and then strongly degassed by high frequency induction *in vacuo*. After a target ha been mounted in the mass-spectrograph, its surfac was exposed, a portion at a time, to the bombardment of $^{20}Ne^+$-ions at a current of about 40 μamp. for about one hour altogether, so that maximun concentration of neon atoms in the entire surfac would be ensured. Then the target was remove from the apparatus and rolled around a steel cylinde of 6 mm. diameter, in order to give it a shape appro priate for installation as an electrode in a Geissler tube. Each tube contained one neon-irradiated electrode and one untreated nickel electrode, and had a volume of about 30 cm.[3]. Moreover, each tube was provided with a small trap filled with charcoal for the absorption of small amounts of impurities which could not be entirely avoided when preparing the tubes. After the tube was evacuated, the nickel electrode and the charcoal trap were thoroughly degassed, and when the pressure had been reduced to about 10^{-5} mm. of mercury, the tube was sealed from the pump. Then the irradiated target was heated by high-frequency induction, and at a glowing red temperature the neon atoms were rapidly released from the target surface, raising the pressure in the tube to about 0·5 mm. mercury.

A spectroscopic analysis of the light emitted from the Geissler tubes showed extremely clean neon spectra. In some cases one could observe very small impurities of hydrogen and carbon monoxide which, however, could be greatly reduced by cooling the traps. In order to provide an experimental control on the amount of impurities, Geissler tubes were prepared with aluminium, nickel, silver and tungsten electrodes which had been treated in the same way as described above and installed in the mass-spectrograph, but not exposed to the beam. Immediately after heating these electrodes the tubes were capable of being ignited; but after a few minutes the impurities were absorbed in the traps and the pressure thereby reduced so that the tubes were extinguished, indicating that the pressure was less than 5×10^{-3} mm. mercury. As expected, neon lines were not observed from such tubes.

In order to determine the influence of the ionic mass on the ease of collecting a gas in a metal surface by the method described above, similar experiments were carried out with helium, argon and xenon. By bombarding a silver target with He^+ ions, a Geissler tube was prepared containing extremely pure helium gas at about the same pressure as previously found in the experiments with neon. Similar results were obtained by bombarding aluminium targets with beams of argon and xenon ions. As the experiments with xenon were carried out only to test the possibility of collecting this gas in the target surface, no separation of the xenon isotopes was carried out.

If a mass-spectrograph is to be used in this manner to prepare pure samples of the less abundant isotopes of the rare gases, more favourable experimental conditions will be obtained if substances already subjected to a partial isotopic separation by other methods are used as starting materials. Recently, a method for the separation of the isotopes ^3He and ^4He has been suggested by J. Franck[4], and preliminary experiments based on this suggestion have already been carried out[5,6]. If the application of this method proves to be successful for the separation of strongly enriched samples of ^3He, it may be possible to prepare pure ^3He gas by the mass-spectrographic method described above.

It seems likely that the mass-spectrographic method of separating isotopes of gaseous elements, which has been demonstrated in connexion with the rare gases, may be extended to other gases if suitable target materials are used. The power of metals to absorb gases to some extent, when they are hit by ions of high energy, is well known from the studies of gaseous discharges[7]; but exact measurements of the conditions under which this absorption takes place cannot be carried out by this means, as it is difficult to obtain well-defined experimental conditions. The technique described here, however, offers the possibility of a closer study of the amounts of gases that can be collected in the surface of different target materials at definite energies of the impinging ions. From theoretical arguments[8] it seems likely that the range of the ions in the target material will increase in direct proportion to the ion energy, and the amounts to be collected will presumably increase in the same proportion. It appears that the most practical way of utilizing this effect in mass-spectrographic separation experiments would be to accelerate the ions to higher energies after they have been subjected to the magnetic separation.

I wish to thank Prof. Niels Bohr for his continued interest in the present investigation. Furthermore, I should like to thank Mr. W. Drost-Hansen and Mr. S. Møller-Holst for their assistance in the work on the mass-spectrograph of this Institute.

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Normal Stress Coefficient in Solutions of Macromolecules

In a previous note[1], the most general possible stress versus strain-velocity relations for an incompressible visco-inelastic fluid have been given. They involve two physical parameters for the fluid, Θ and Ψ. Θ is the viscosity and Ψ is a new parameter which we shall term the 'normal stress coefficient'. These relations must also be valid for a visco-elastic fluid in steady-state laminar flow. From a phenomenological point of view, Θ and Ψ may be constants or they may depend on the strain-velocity invariants. If the fluid is in a steady state of laminar flow, parallel to the x-axis, the velocity gradient being parallel to the y-axis, both tangential and normal components of stress, t_{xy} and t_{zz}, exist at any point of the fluid, where

$$t_{xy} = \Theta\varkappa \text{ and } t_{zz} = -\tfrac{1}{2}\Psi\varkappa^2. \tag{1}$$

$\varkappa$ is the velocity gradient in the fluid.

Kramers[2] has calculated the contribution of dissolved high-polymer molecules to the viscosity of a solution, using an idealized 'pearl necklace' model for the high-polymer molecule. The molecule is considered to consist of a number of equal massive points connected by equal rigid links, which are capable of some measure of rotation about the mass-points at their junctions. A number of other simplifying assumptions are made in order to make the problem mathematically tractable. The contribution $\Delta\eta$ of N dissolved high-polymer molecules per c.c., each consisting of N links of length L, is given by

$$\Delta\eta = \frac{1}{36}\,\zeta L^2 N^2 \mathcal{N}, \qquad (2)$$

where $-\zeta\mathbf{v}$ is the force on a mass-point due to the solvent, if $\mathbf{v}$ is the velocity of the mass-point relative to the solvent in its neighbourhood. It is assumed that the solution is sufficiently dilute to make the interaction between the dissolved high-polymer molecules negligible.

Employing a method similar to that of Kramers, we have shown that the contribution to the normal stress coefficient Ψ for high-polymer molecules, in which the links are considered to be freely rotating, is given by

$$\Psi = \frac{1}{405}\,\frac{(\zeta L^2 N^2)^2}{4kT}\,\mathcal{N}, \qquad (3)$$

where k is Boltzmann's constant and T is the absolute temperature of the solution.

If the links in the high-polymer molecules are not capable of any rotation and are collinear, then

$$\Delta\eta = \frac{1}{72}\,\zeta L^2 N^3\, \mathcal{N}, \qquad (4)$$

and

$$\Psi = \frac{1}{1080}\,\frac{(\zeta L^2 N^3)^2}{4kT}\,\mathcal{N}. \qquad (5)$$

From (2) and (3) we obtain, for the case of flexible molecules,

$$\Psi = \frac{4}{5}\,\frac{(\Delta\eta)^2}{kT\mathcal{N}}. \qquad (6)$$

Similarly, from (4) and (5) we obtain, for the case of rigid molecules,

$$\Psi = \frac{6}{5}\,\frac{(\Delta\eta)^2}{kT\mathcal{N}}. \qquad (7)$$

We note that, if N is large, the assumptions of flexibility and rigidity lead to very different values for $\Delta\eta$ and Ψ, but the relations (6) and (7) between $\Delta\eta$ and Ψ differ very little.

It appears from the calculations that, in both the cases considered, the non-vanishing of Ψ arises from the orientation of the dissolved molecules in the flow-field, which—in both Kramers' calculation and ours—is assumed for simplicity to be undisturbed by the presence of the dissolved molecules.

For a 25·7 per cent solution of polystyrene in xylene, Ferry[3] gives the viscosity as about 220 poises at a velocity gradient of 9 sec.$^{-1}$. Taking the intrinsic viscosity as 2·5, we see that if the dissolved polystyrene molecules act independently of each other, the viscosity of the 25·7 per cent solution should be about 0·37 poises. In order to explain the much higher value of viscosity actually measured, we assume that the dissolved molecules interact and that for the purposes of calculation the effectively non-interacting flow units are no longer the $\mathcal{N}$ dissolved molecules but a much smaller number $\mathcal{N}'$ of groups of many molecules. A very rough estimate of this number $\mathcal{N}'$, which has only a limited physical significance, can be obtained from the figures given above, together with the molecular weight of the polystyrene. Introducing this in place of $\mathcal{N}$ in (6) and using the measured viscosity value for $\Delta\eta$, Ψ can be calculated.

From (1) we obtain, when $\varkappa = 9$ sec.$^{-1}$,

$$t_{xy} \approx 2 \text{ gm. wt./cm.}^2 \text{ and } t_{zz} \approx -18 \text{ gm.wt./cm.}^2. \qquad (8)$$

We see that t_{zz} is numerically greater than t_{xy}. In obtaining the formulæ (2) to (7), it is assumed that $t_{zz} \ll t_{xy}$, so that the result (8) has no quantitative significance. However, it shows that a concentrated high-polymer solution, such as that considered, should show quite appreciable values of the normal stress component, at any rate comparable with the value for the tangential stress component, even at such a low velocity gradient as 9 sec.$^{-1}$.

The above discussion is not intended to provide a precise method of calculating the normal stress coefficient, but merely to show qualitatively that a non-zero normal stress coefficient can arise from the orientation of high-polymer molecules in flowing solutions and that for concentrated solutions it may be expected to have a measurable value.

This investigation was carried out at this Institute under the sponsorship of the Reconstruction Finance Corporation, Office of the Rubber Reserve, while I was on leave from the British Rubber Producers' Research Association, Welwyn Garden City, Hertfordshire, England.

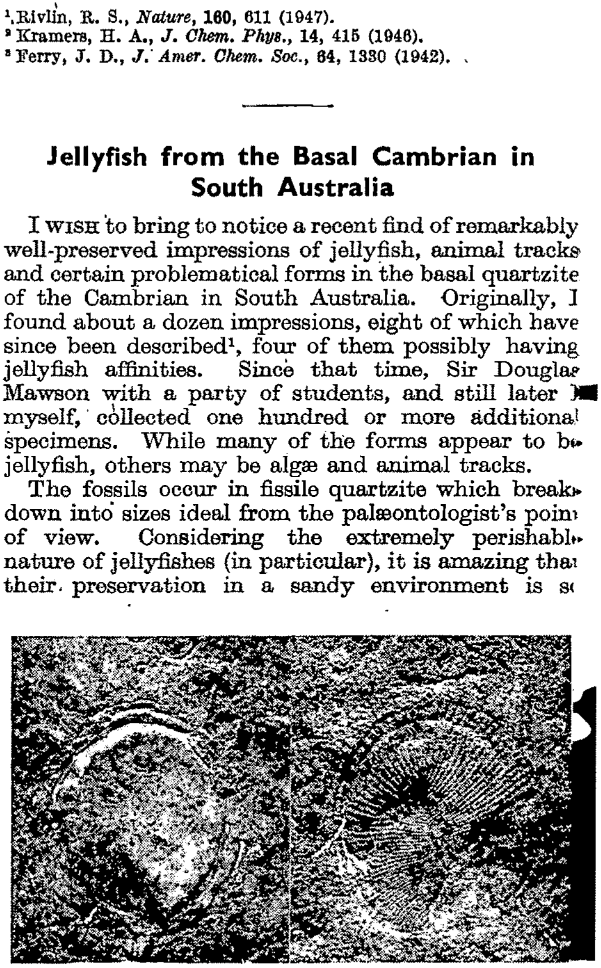
R. S. Rivlin
At the Mellon Institute of Industrial Research,
Pittsburgh, Pa.
Nov. 28.

[1] Rivlin, R. S., *Nature*, **160**, 611 (1947).
[2] Kramers, H. A., *J. Chem. Phys.*, **14**, 415 (1946).
[3] Ferry, J. D., *J. Amer. Chem. Soc.*, **64**, 1330 (1942).

Jellyfish from the Basal Cambrian in South Australia

I wish to bring to notice a recent find of remarkably well-preserved impressions of jellyfish, animal tracks and certain problematical forms in the basal quartzite of the Cambrian in South Australia. Originally, I found about a dozen impressions, eight of which have since been described[1], four of them possibly having jellyfish affinities. Since that time, Sir Douglas Mawson with a party of students, and still later by myself, collected one hundred or more additional specimens. While many of the forms appear to be jellyfish, others may be algæ and animal tracks.

The fossils occur in fissile quartzite which breaks down into sizes ideal from the palæontologist's point of view. Considering the extremely perishable nature of jellyfishes (in particular), it is amazing that their preservation in a sandy environment is so



Beltanella gilesi Sprigg *Dickinsonia costata* Sprigg excellent (see photographs). Canals, (?) gonads and mouth structures are frequently clearly visible, and in one form, *Beltanella*, a velar membrane is present.

Now that a considerable amount of new material is available for description and comparison, it is hoped that a more complete study of these interesting forms will be possible. Criticisms and suggestions would be most helpful in the continuation of this study.

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Dec. 15.

[1] *Trans. Roy. Soc. South Austral.*, 71 (2) (1947).

Cementiferous Paints and their Uses

THE reference by Dr. L. A. Jordan[1] to the possibilities of cementiferous paints as fireproof coverings for the interior of warships makes it advisable to supply an earlier chapter in the history of these paints. The fact that metallic particles interact with certain chlorides to give cement-like masses was noticed by Dr. U. R. Evans, of the University of Cambridge, when working on a Service problem in 1940. He later extended the idea to produce water paints which could be applied to a wet steel surface, and which provided cathodic protection to the steel, even where exposed at discontinuities. Such a paint was put into industrial use in 1942 in a plant where rapid corrosion cracking had caused frequent stoppages in a process of high war priority, and has been in use ever since. Here, the conditions are quite exceptional, and it is unlikely that the paints have any advantage in the average terrestrial situation.

Thornhill and Mayne carried out at Cambridge detailed study of the setting and protective mechanism, working for the Iron and Steel Institute Corrosion Committee (now the British Iron and Steel Research Association Corrosion Committee). Much work was also carried out, first by the Cambridge investigators, later at Caernarvon by J. C. Hudson, and finally at Millport by K. A. Pyefinch, on the possibilities of these paints for protecting steel plates immersed in sea-water; the results have been encouraging.

The Admiralty is represented on the Corrosion Committee, and the idea that the paints might be useful in combating the menace of rapidly spreading fires (such as occurs in ships painted internally with oil paints) appealed to those working on paint in the Admiralty Chemical Department at Portsmouth. Thornhill carried out some experiments late in 1943 on cementiferous fireproof paints, and took samples to Portsmouth in 1944. These were tested by the Admiralty chemists, who reported the coats to be insufficiently resistant to abrasion. Mayne then suggested the use of an overlying silica coat produced by means of ethyl silicate. Apparently this has solved the problem. Meanwhile, the Admiralty chemists appear to have continued researches on the paints, and have evidently achieved notable advances by the addition of industrial spirit, which allows the paints to be kept in a ready-mixed condition.

It is understood that ship trials have been carried out by the Admiralty, with encouraging results, of the possibilities of these paints as underwater protection paints.

Dr. U. R. Evans is anxious to emphasize the fact that these paints are unlikely to be of value except in certain special situations. Unauthorized statements seem to have appeared in the technical Press, and these have evidently led to misunderstanding. It can only lead to disappointment to apply a paint—or anything else—in the wrong situation.

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[1] Jordan, L. A., *Nature*, 160, 216 (1947).

Flint Flaking

WITH reference to the letter from Dr. T. T. Paterson under the title "Earliest Known Prehistoric Industry"[1], I wish to express my indebtedness to him for having brought his new discoveries for my examination at home, so that I could compare them with my collection of natural flakings. I have been familiar with patches of intensive flaking below the Weybourne Crag for many years[2]. On some I have counted 50 per cent of flaking among the stones—a not unusual frequency.

The evidences of localized sites may be misleading. For example, the flaking on such a site may be all of one date; but before drawing a conclusion one must inquire whether on a wider area an identical type of flaking is of miscellaneous dates. Again, an associated group of flaking is not necessarily a human working, it may be a 'Nature's workshop'; in other cases, abraded flakings have been drifted together upon the sub-Crag floor.

Neither this, nor any other disputed group, carries flaking that is superior to that from the sub-Eocene site at Grays. This occurred in the Bullhead Bed, locally modified by the addition of large flints brought in through solution of the underlying Chalk. Some flaking is general in the Bullhead Bed; but this was a localized site of special character, which, in other circumstances, could well have been mistaken for a human industry[3].

My point of view is that while it is not possible to distinguish human from natural flaking upon every separate specimen, I am convinced that mechanical movements under pressure, concussions and the like produce their respective groups of forms which are recognizable[4]. To the best of my judgment, the sub-Crag flakings conform to the distinctive characteristics of movements under pressure.

My tentative suggestion is that the whole of the effects of crushing, striation and flaking observed among the flints of the Crag sea-floor are due to the grounding of floating ice. At least, purely mechanical effects due to that, or some other cause, are conspicuous, and I submit that the problem of this remarkable flaking, with its rostro-carinates, flakes and edge-chipping, should be considered as a whole in association with the physical evidences.

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Essex.

[1] *Nature*, 161, 278 (1948).

[2] Warren, S. H., *Geol. Mag.*, 309 (1924).

[3] Warren, S. H., *Quart. J. Geol. Soc.*, 76, 238 (1920).

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HORMONE-MIMETIC AND OTHER RESPONSES OF THE SILKWORM (*BOMBYX MORI* L.) TO SOME POLYPLOIDOGENIC AGENTS

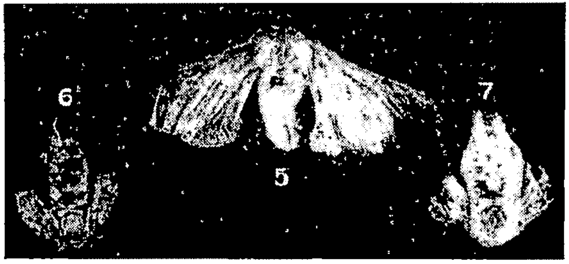
By L. J. HAVAS and J. KAHAN
Hungarian Biological Research Institute, Tihany

ACCOUNTS have been given by the senior author[1,2,3] of a series of 'hormonal' responses of plants and animals to the polyploidogenic agent colchicine. He has also repeatedly pointed out that such effects were, as often as not, independent of the polyploidizing action of the alkaloid. Other authors have come to similar conclusions[4,5,6].

Hirobe[7], using colchicine, has elicited blocked mitoses and polyploidy in the silkworm. Preliminary experiments, carried out according to the plans of the senior author by H. Tangl (unpublished), gave no indication of such effects. We decided in consequence to change the methods of administration of the drug and to repeat the treatments, following the method of Clark, Hanson and Rowntree[8], through several generations, in order to obtain, if possible, cumulative hormonal effects. The role of such effects in eliciting polyploid mutations in plants was shown by Havas[9]. The first stage of this work is described below.

The experiments were carried out partly on 'bivoltinized' and partly on freshly laid eggs or on recently hatched larvæ. In some groups the treatments were repeated after each moult up to, and including, the pupal stage. One thousand six hundred animals were treated in all. The polyploidizing agents used were colchicine, acenaphthene[10], and podophyllin, a resin isolated from *Podophyllum peltatum*. The first two are well known. Dr. I. Cornman has directed our attention to the third, his own and the experiments of other workers[11,12] having demonstrated that it is a powerful agent in inducing blocked mitoses and polyploidy in plant and animal tissues.

The eggs were treated with colchicine or podophyllin in Petri dishes, 40–60 eggs of each group being put into a 1 : 2,000 or 1 : 5,000 solution of the drugs. Water was used for the controls of the colchicine groups, and a 1 : 2,000 solution of acetone for the controls of the podophyllin-treated animals, because the resin was dissolved first in a small quantity of acetone. The methods of treatment of the larvæ with colchicine varied in the different groups. Some groups were placed in Petri dishes on filter paper wetted with solutions of the drug ranging from 1 : 10,000 to 1 : 400,000, or the caterpillars were painted with them. The combined method was also used. In some groups the drug was injected into the caterpillars or the pupæ.



The acenaphthene treatment of eggs and larvæ was also carried out in Petri dishes. 0·05 mgm. of acenaphthene was dissolved in 0·5 ml. of ether, and the solution was poured into the inverted lid, which was put in place when the ether had evaporated. The agent was left to act by sublimation for from 45 minutes up to 16 hours. Only a few examples of the results obtained will be given here, a more detailed account being in preparation.

Colchicine at a concentration of 1 : 2,000 stimulated the hatching out of the eggs but, curiously enough, inhibited it at a concentration of 1 : 5,000. In the same concentrations podophyllin had the opposite effects. The death-rate of both the 'colchicine' and 'podophyllin' animals was in direct relation to the concentrations, 1 : 2,000 being toxic. Acenaphthene either inhibited entirely the emergence of larvæ from bivoltinized eggs, or its effects were practically nil.

The accompanying table shows the effects of colchicine (1 : 100,000) and of acenaphthene (10 hours) on growth and weight of the caterpillars.

Days		Length (mm.)	Weight (gm.)
11	Colchicine	12·19 ± 1·63	0·0276 ± 0·00102
	Control	11·45 ± 1·75	0·0248 ± 0·00391
24	Colchicine	30·90 ± 4·42	0·264 ± 0·03778
	Control	28·60 ± 4·97	0·185 ± 0·03218
32	Colchicine	40·60 ± 7·86	0·880 ± 0·1705
	Control	36·20 ± 6·66	0·573 ± 0·1054
14	Acenaphthene	6·00 ± 1·00	0·0040 ± 0·00068
	Control	15·40 ± 3·16	0·0423 ± 0·00868
28	Acenaphthene	30·00 ± 8·16	0·327 ± 0·0889
	Control	38·60 ± 4·74	0·538 ± 0·0462
41	Acenaphthene	47·70 ± 7·52	0·918 ± 0·0145
	Control	62·50 ± 5·94	2·235 ± 0·2222

It was further observed that larvæ treated with colchicine at a concentration of 1 : 100,000, and still more at concentrations of 1 : 200,000 and 1 : 300,000, began to spin their cocoons earlier than did the controls and reached the chrysalis and imago stages earlier. Acenaphthene—the definite narcotic action of which was also noticed—retarded all these stages of development and metamorphosis. There seemed to be only one sphere of action in which colchicine and acenaphthene produced comparable effects, and this was the induction of morphological anomalies and colour changes. No. 7 of the photograph (kindly taken by Dr. L. Felföldy) shows one of these aberrant imagos with hypertrophied thorax and stunted and partly truncated wings, both bearing yellow maculæ, and No. 6, a stunted variation of coffee-brown colour. No. 5 represents one of the controls. Colour changes were also observed in the larval stage under the influences of colchicine and acenaphthene. Insects with vestigial antennæ or entirely lacking them were frequent in both groups. A rather curious phenomenon was encountered among the 'colchicine animals': an imago, the head, thorax and wings of which were still enclosed in the hard chitinous pupal covering, and which, in spite of this, had laid eggs.

The role of the corpora allata being well known in the above developmental and growth processes, as well as in the colour changes[13,14], the hormone-mimetic effects of the agents may be ascribed, among others, to their influence on the polarity of translocation or on the synthesis of the manifold products of this endocrine organ. However, as regards the inhibitory actions of acenaphthene, the part played by its narcotic effects and the consequent suspension of important vital processes must also be taken into account in interpreting the reactions elicited.

It is not yet known whether the morphological anomalies observed are to be considered as simple variations, as the ephemeral manifestations of hormonal or pharmaco-dynamical actions, as '*Dauer*'-modifications, or as true mutations. The manner of the 'mendelization' of their offsprings will answer these questions next season.

These investigations were partly aided by grants of the Hungarian Department of Agriculture, Bureau of Researches.

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[14] Bounhiol, J. J., *Arch. Zool. Not. et Rev.*, **81**, 54 (1939).

INDUSTRIAL CO-OPERATION

THE delegates to the annual conference of the British Association for Commercial and Industrial Education, which was held at Ashridge in October 1947, were welcomed by the president of the Association, Sir Charles Tennyson, who stated that "the task confronting us to-day will require a range of knowledge in natural science, economics, sociology and psychology of which our grandfathers can never have dreamed, and a degree of perseverance, common sense and mutual consideration which must be a severe tax on human frailty. It is clear that education can make an inestimable contribution to the solution of these difficulties but . . . there seems to be a general consensus of opinion that education has made the mistake of confining itself to 'subjects', dealing with these in isolation and not relating them sufficiently to the needs and circumstances of society and man's everyday life and avocations.

"On the other hand, industry and commerce . . . have failed to realize that they have a responsibility to promote the development of individual capacity and sense of citizenship. They have also failed to realize how much academic training can do to improve the efficiency of the young employee who has been regarded simply as an economic unit to be made as immediately productive as possible at the smallest expense. That is not the way to produce skilled workmen, efficient managers, broadminded and creative technicians or good citizens."* Sir Charles then declared that the motive in calling the delegates together was the belief that unless educationists, industrialists and representatives of the workers come together to deal with this question of education and training in the spirit of research and whole-hearted co-operation Britain has little chance of overcoming its difficulties.

The initial address was given by Mr. F. C. Hooper, formerly director of business training to the Ministry of Labour and National Service, who dealt with the part which management should play in bringing about industrial co-operation. When an administration is faced with the need to change a situation, he said, its first essential task is to change the habit-patterns that have been built up under and by the old situation that is to be changed. The immediate situation we wish to change is one of poor or half-hearted co-operation between management and labour in business and to establish in its place a situation of full and enthusiastic co-operation in which management and labour are a real organic working team. This co-operation can only come if both parties recognize that they possess a single over-riding common interest which wholly justifies them in establishing a common aim and which inspires them in working together to achieve it. Of the forces which stand in the way of establishing full co-operation one of the most important is the actual nature of the trade unions. Formed as fraternities to curb and combat the power of employers, to-day they have become essentially 'antibodies'. When management considers how it can most effectively attain the co-operation of its employees, it must always reckon with the fact that the rank and file of organised labour are extremely suspicious of management and that this suspicion will not be eradicated in any short term. The only way in which antibodyism and suspicion could be abolished would be by the logic of events from without and the efforts of trade union leadership directed to the same end from within. Mr. Hooper then suggested various means by which the climate of work could be made favourable to produce the maximum response by all workers in industry, and suggested that, in his opinion, schemes of education and training are of paramount importance.

Replying for the trade unions, Mr. Harold Clay, assistant general secretary of the Transport and General Workers Union, stated that over a very wide field in industry, especially among the industrial workers, there was considerable suspicion, doubt and hesitation about schemes for education and training. There undoubtedly existed in the minds of the wide body of the working population the idea that some of the 'enlightened' ventures that are now being embarked upon are merely another form of dope or opiate to keep the workers quiet at this particular time. In his opinion, education and training was part of a much wider problem, and until a real sense of social purpose had been built up which was accepted by all sections in industry, any attempt to find a solution to our present difficulties would fail. This sense of social purpose should be quite distinct from individual advantage, firm advantage or industry advantage. Relationships generally between management and workers, and those they represent, should be such that co-operation must be possible over a very wide field. "There must be opportunities for the discussion of all those issues that affect, or appear to affect the interest of the workers, and this includes quite a number of problems that have hitherto been regarded as the sole concern of management."

Other speakers went on to consider how more effective co-operation could be achieved between the planners of education and the planners in industry and commerce, as well as those aspects of education and training which had proved effective in promoting good relationships between the employee and employer. This was followed by a session in which Mr. Noel Hall, principal of the Administrative Staff College at Henley, discussed the further training of higher management and particularly the way in which this training would be given at the Administrative Staff College.

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* "The Short Road to Industrial Co-operation." Published by the British Association for Commercial and Industrial Education, 107 Baker Street, London, W.1. 5*s*.

Finally, the industrialist's point of view was put clearly and forcibly by Sir Ronald Weeks, deputy chairman of Vickers, Ltd., who defined the present obligations of both employer and employee. In his view the employer must regard himself as the trustee, be honest and fair in all his dealings, study the psychology of his employees, do everything possible to ensure good working conditions, know his own job and train his staff accordingly, pay an adequate wage for an honest day's work, endeavour to give his employees a sense of security and reasonable incentives for advancement, and finally, he must provoke a sense of loyalty and a 'sense of belonging'. The employee should observe obedience to rules and a sense of discipline, loyalty to the employer, and an honest day's work.

Sir Ronald emphasized Mr. Clay's belief that spontaneous co-operation cannot come without a sense of social purpose, and indicated that to-day the size of the pay packet on one side and the profit motive on the other are considered to be much more important than the conception of the universal and social purpose in industry. Sir Ronald then put forward various suggestions for the future improvement of industrial relations, indicating ways and means in which schemes of education and training for all grades could be introduced and implemented.

Altogether some 170 delegates attended the conference and, although they represented industries and public services having widely different problems and approached the discussion from widely different points of view, the conference was remarkable for the almost complete unanimity about the solutions that should be applied to Britain's economic crisis. Among the delegates were many representatives of firms who have been world pioneers in schemes of employee education and training and who have proved by experience that such schemes are eminently practical and beneficial. At this time of emergency their experience should not be ignored. T. H. Hawkins

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HISTORY OF SCIENCE IN EDUCATION

A JOINT meeting of the British Society for the History of Science with the Science Masters' Association, the Historical Association and the Association of Women Science Teachers was recently held at the Science Museum to discuss the subject "The Place of the History of Science in Education". The meeting was very well attended, and the chair was occupied by Dr. E. J. Holmyard, who took the opportunity of welcoming Prof. George Sarton as an honorary member of the British Society for the History of Science. The opening speakers were Dr. F. Sherwood Taylor, Mr. G. Fowles (a former chairman of the Science Masters' Association), Mr. S. M. Toyne (chairman of the Council of the Historical Association) and Miss L. E. Higson (secretary, Association of Women Science Teachers).

Dr. Sherwood Taylor said that he believed the principal aim of teaching science in the schools was to enable young people to make wise and sound decisions in their daily life. The teaching should also make clear how far, and in what regions, one may trust science. Instruction in the history of science could obviously provide a valuable means to this end. There was too much tendency at the present day to teach factual rudiments only, and he would like to see more insistence upon scientific method. Where this involved a repetition of famous historical experiments, difficulties were bound to arise, since many of them did not lend themselves to the conditions of school curricula. There seemed to be a great opportunity for historical scientific films in this connexion, but such films must be of high accuracy or they would do more harm than good.

Mr. Fowles said that, in teaching science in schools, the psychological factors were very difficult in that only about 5 per cent of the pupils could ever reach the standard represented by a university scholarship, and that the method of presentation had to be conditioned mainly by the needs of the remaining 95 per cent. So far as the historical method of teaching science was concerned, he thought there were three different aspects which he would describe as anecdotal, recapitulatory and evolutionary. Everybody was agreed that the anecdotal aspect was useful; but he doubted whether it was of value in explaining scientific method. The recapitulatory system was not altogether without defect, since pioneering work did not always provide the most direct or logical solution of the problem involved. General evolutionary consideration of scientific advance had more to recommend it, and this would be particularly valuable in teaching science to classical sixth forms. He agreed that some knowledge of the history of science was of great importance, but felt that it should form part of the general history course rather than of the science course.

Mr. Toyne described the methods he had adopted of teaching the history of science to boys on all sides in a public school. He felt that the history of science should form a part of the history course, but not at the expense of the history normally taught. He emphasized the fact that social history cannot properly be explained without a knowledge of the history of science.

Miss Higson expressed the view that instruction in the history of science would be of advantage to all pupils in schools, especially those of sixth-form age. She had been distressed to find how little mention of men of science and scientific discovery was made in the standard histories used in the schools, and gave some examples. Apparently the only man of science to attract the attention of historians was Darwin. Miss Higson also remarked that she felt that science and its history should form an integral part of the 'current events' periods in schools, and agreed with Dr. Sherwood Taylor's plea for more science films.

Dr. Sarton said that in his opinion the value of the history of science was threefold. In the first place it was essential for science itself. Secondly, it formed an excellent introduction to philosophy. Thirdly, it had inherent cultural advantages, and these he would rate the highest. He gave an account of his own two-year course on the history of science at Harvard, in which he presented his students with a general survey of the developments of science and scientific thought from the earliest times to the present day, in four sessions of thirty-five lectures each.

The discussion then became general, and the consensus of opinion was that a very strong case had been made out for the inclusion of the history of science in the course for both schools and universities, and most speakers agreed that the teaching should form part of general historical study.

THE GOVERNMENT SOCIAL SURVEY

THE Government Social Survey is a social research unit created to provide Government departments with information about the habits, opinions and conditions of the people. It was set up in 1941 in response to specific administrative needs: to obtain information, for example, about war-time shortages of consumer goods and their distribution, and about the effectiveness of the information campaign of the Ministry of Food. The Survey was from the beginning controlled by the Home Intelligence Division of the Ministry of Information; and, at the moment, it is a division of the Central Office of Information. So far no final decision has been made about how the Survey is to be fitted into the Government apparatus.

The Social Survey has made nearly 140 different studies over the last five years, each of which has been individually authorized by the Treasury on the basis of a demonstrated need on the part of a Government department. The public has been interested and willing to co-operate in this work, as is shown by the fact that half a million interviews have been made, and refusals to co-operate have been of the order of half of one per cent on an average.

The wide scope of the Survey's work and its establishment as a permanent Government research organisation have demonstrated that there is a place for the social scientist in the machinery of government, and that scientific method can be applied to the social field to help the administrator to deal with an ever-increasing range of social questions. In Great Britain there is much leeway to make up in this field. We have come a long way from Charles Booth's monumental survey of "London Life and Labour", made at the end of the nineteenth century. The early English sociologists had discussed the way in which the many activities of society were interrelated; and Profs. A. L. Bowley and John Hilton had introduced us to the value of sampling techniques. But British studies were in the main concerned with establishing facts about an under-privileged section of the population, for they dealt with poverty or problems arising out of poverty; and they were, in the main, local studies.

In the United States, on the other hand, the existence of many national minorities, the use of market research—really a special type of social survey—for business purposes in the large home market, and the great stimulus to social inquiry prompted by the New Deal had forced the development of the social science disciplines. The American Institute of Public Opinion (the Gallup Poll) is an example of the kind of organisation that was developed during this period as a result of the interest in the everyday opinions and feelings of ordinary people.

The war-time inquiries of the Social Survey were a response to immediate administrative needs. The Survey collected the data on which those responsible for the organisation of the civilian side of the War based their policies: for example, information about many aspects of the problems arising from the ationing of scarce consumer goods. Thus, soon after he beginning of clothes rationing, study was made of the special clothing needs of workers in occupations where the conditions of work caused extra wear and wear on clothes, to determine how far supplementary allowances of coupons were required. Indeed, from early in 1942 regular studies were made for the Board of Trade to discover the extent of current shortages, and which sections—by population and geographically—were most affected. Man-power policy was of critical importance. The Survey aided in securing the best possible use of the available labour-power. For example, when women were registering for war-work for the first time, studies were made of the extent to which each woman felt satisfied with the kind of interview she had had. Studies were also made of the reasons why women were reluctant to join the A.T.S. and nursing.

These war-time studies were directly utilitarian. Others, of the same kind, included the use of demobilization coupons: for the issue of a demobilization coupon allowance to members of the Forces made available an enormous number of coupons, supplementary to existing civilian coupon stocks, which were capable of completely changing the previous pattern of effective demand. On the basis of studies of coupon disbursement by newly demobilized men and women, the Social Survey was able to produce information which enabled the Board of Trade to estimate the probable effect on total demand of these supplementary coupon issues, and to change its plans accordingly. Other investigations carried out by the Survey included: a survey of the extent to which economies could be made, with the least possible inconvenience to the public, in the use of some kinds of food; credit buying, a study for the Board of Trade of the extent of instalment and hire purchase trading; getting to work, a study for the Ministry of War Transport of workers' transport difficulties; inquiries on the extent to which the technical information provided for farmers by the Ministry of Agriculture was actually being used, the impact of the 'Dig for Victory' campaign on home horticulture, and a survey of garden and allotment food production. In February 1943 an investigation was made into canteen, British Restaurant and café feeding and packed meals. This was carried out for the Ministries of Health and Food, which needed to know in detail something of the feeding habits of the people: what kinds of foods formed the diet of the normal household, how these foods were prepared, and when meals were eaten. The Ministry of Food was providing extra rations for workers in canteens and British Restaurants, but did not know how many and what types of workers made use of these facilities, or what reasons there were for not doing so.

There have also been made a number of intensive, detailed studies which have had implications outside war conditions: for example, Scottish mining communities, an inquiry made for the Department of Health for Scotland, the Clyde Valley Planning Advisory Committee, and the Central and South-east Scottish Planning Advisory Committee in the autumn of 1946, had reference to the need for building new mining communities in the expanding coalfields of Fifeshire. Answers were given to the four following vital questions: (1) To what extent are existing mining communities satisfactory? (2) What is the possibility of transferring miners from areas where coalmining is declining to areas where mining is expanding? (3) What are miners' attitudes to the future of the mining industry, as they affect their attitude to alternative employment, and the attitude of their children to entering this, or other, industries? (4) What are the main social needs of a number of entirely new mining townships to be built in Fife?

During the War there were fears of a large increase of minor illnesses. It became urgent for the Ministry of Health to have some measure of the amount of illness in Britain and of the proportion of minor ailments. Successful experiments were carried out by the Social Survey to test the possibility of regular surveys of illness. From the beginning of 1945 the Survey has shown that morbidity statistics could be systematically produced, for the first time in history, covering all illnesses of the whole population, and not merely notifiable diseases. These statistics are published by the Registrar General. They are of obvious use in the preparations for the full operation of the National Health Act. This survey of sickness permits a precise estimate of the amount of working-time lost through all illness, or through the various types of illness, and also which are the major illnesses in particular regions or groups in the population.

Other intensive studies have dealt with: domestic heating and lighting, to help the Building Research Station and committees of the Ministry of Works prepare building standards; old people's occupation and family responsibilities, in connexion with a long-term investigation to be made by the Industrial Health Research Board; and water heating, an inquiry carried out in March 1947 for the Ministry of Works. The last-named report gives the distribution of water-heating appliances in Great Britain. It examines their distribution by type of district and region, type and age of dwelling and economic group; the extent to which they are used, their relative popularity, and the complaints they give rise to. There is also information about the use of laundries, and bathing habits. Studies are now being planned of consumer expenditures. These budgetary inquiries are designed to provide detailed information about expenditure among all sections of the population. The continuous flow of data to be supplied by these studies will help to provide the basis for a long-term employment policy, and they may be of use in helping to analyse the effects of taxation.

Thus, the Social Survey is now producing social data in a very wide field, and by its work is demonstrating that social scientists can develop observational techniques which provide adequate factual material from which to draw socially valid conclusions. An essential technique developed by the Social Survey is that of population sampling. Trained field-workers interview samples of the general public, or of particular sections, with a recording schedule devised so that the results of the inquiries made can be expressed statistically. Two hundred local investigators are so distributed throughout the country that they can reach the whole population. There is a research staff of twenty, and a technical staff of sixty (dealing with machine tabulation, computation and coding). The research officers include anthropologists, psychologists, sociologists, economists and statisticians. The Survey budget for the past year amounted to £60,000.

The main conclusions from war-time experiences, as stated by Mr. Louis Moss, director of the Government Social Survey, in a paper read to the Institute of Public Administration, in April 1946, are: first, the general utility of the information obtained; second, the importance of public co-operation; third, the general feasibility of sampling as a technique capable of producing information in many different fields; fourth, the value of the personal interview as a method of collecting detailed information on factual matters, and matter of opinion; fifth, the knowledge of the kind of organisation necessary to carry out such surveys systematically on a national scale; and sixth, the value of the mixed team—not only of social scientists, but including also natural scientists. For example, the co-operation of technicians and physical scientists with the social scientists on the Survey's staff has made it possible to devise methods of work which for the first time are capable of providing a picture of the complex housing situation of Britain.

The techniques employed by the Survey are helping to lay the basis for an empirical social science. They have produced basic data suitable for the studies of the research worker in economics. They have shown the way in which changes in demand could be studied in a quantitative manner. In addition, the study of attitudes is a field for the social psychologist and the sociologist. For example, in mining, not only are the social and industrial conditions of importance, but also the attitudes of potential recruits. Similarly, in the field of behaviour there is much for the social psychologist to do. The social scientist has still a great deal to learn, and the work of the Social Survey is providing a detailed experience of methods and an accumulation of social data which will be of great help.

What of the future? The statement of the Lord President of the Council in the House of Commons, when announcing the panels of his Industrial Productivity Committee, that the social sciences had a part to play, is a recognition that adequate administrative and executive action in the complicated social and economic fields demands a scientific approach. Thus, survey techniques will surely have a part to play in studying consumer needs in austerity Britain, where limited resources are available for consumer goods production.

War-time experience demonstrated that the Social Survey reports were of value when implemented at administrative level. Therefore, in arriving at a final decision about the place of the Survey in the Government machine it would be necessary to ensure the closest contacts with those responsible for making decisions on social and economic policy.

The correct employment of the Social Survey will help to make more valid Graham Wallas' early comment that "the Government has come to be engaged not merely in preventing wrong things from being done, but in bringing it about that the right things shall be done".

Maurice Goldsmith

INSECTICIDAL SMOKES

APPLYING insecticides in the form of a smoke is a long-established practice. Pyrethrum has been used in this way by the Chinese for centuries, and burning nicotine shreds in glasshouses has been a common practice in Great Britain and elsewhere for a long time. These practices were empirical and there were little or no quantitative data on their effect.

The smoke may be produced by dropping the insecticide on to a hot plate, by indirect heating in a specially designed generator, or by intimate mixing with a combustible powder which is then ignited.

During the Second World War, the use of insecticidal smokes propagated by mixing the insecticide with a pyrotechnic powder was considered for use in the campaign against the Japanese. Some work was done on the subject at the Chemical

Defence Experimental Station at Porton by E. W. Bateman and G. D. Heath (*J. Soc. Chem. Ind.*, **66**, 325; 1947). In this paper the main technical principles involved in the generation of insecticidal smokes are set out and the development of a pyrotechnic insecticidal smoke generator is described.

When this method is employed, one of the crucial problems is to obtain a suitable pyrotechnic powder. The requirements of this powder as listed by Bateman and Heath are that it should be capable of burning slowly and smoothly when mixed with at least an equal weight of insecticide; that the ignition temperature should be as low as possible, in order to avoid excessive heating before combustion occurs; that it must give rise only to products which will not react with the insecticide, and these products should so far as possible be gaseous, since the presence of a hot residue assists the decomposition of the vapour of the insecticide which is forced to pass through it; it must not be unduly sensitive to friction or to heat and should not be hygroscopic, since it must be capable of being handled with safety and of withstanding storage for long periods under tropical conditions. Experiments are described using potassium chlorate and sucrose as the pyrotechnic mixture, and D.D.T. or benzene hexachloride as the insecticide. With these two insecticides there is the complication that hydrochloric acid may be liberated on storage, and a stabilizer should be added. Magnesium oxide was added for this purpose.

Since the War considerable interest has been taken in the use of this method for the control of the pests occurring in glasshouses, warehouses, farm buildings, etc., and they are now being marketed commercially. The generators consist essentially of a thin-walled metal cylinder containing the insecticide mixed with the pyrotechnic powder, an igniter composition and a fuse. The fuse is ignited, and this in turn ignites the starting mixture which sets off the pyrotechnic mixture. The smoke issues through a cooling baffle on top of the cylinder. The baffle prevents ignition of the cloud.

Smoke generators with D.D.T. and azobenzene as lethal agents are being sold by the Murphy Chemical Co., Ltd., and Plant Protection, Ltd., are selling azobenzene smoke generators and 'Agrocide' smoke generators. The 'Agrocide' generator contains the gamma isomer of benzene hexachloride as lethal agent. The smokes containing azobenzene are intended primarily for the control of glasshouse red spider mite, and the D.D.T. and 'Gammexane' smokes for the control of a number of insect pests.

The Murphy Chemical Co. at a recent demonstration held at Ryder's Nurseries showed how easy it is to fill a glasshouse with insecticidal smoke by this method. The advantages claimed for this procedure are that it is cheap and quick to apply, and labour costs are reduced to a minimum; that it gives a far more uniform distribution of the insecticide than spray application, coating both sides of the foliage and penetrating to every part of the glasshouse. The generators are self-contained, needing no apparatus for distribution. They are simple and clean to use and storage space is considerably reduced. It seems quite possible that the method may form a useful and certainly convenient addition to the existing techniques for the application of insecticides; but more information, both physico-chemical and biological, is required before its value can be accurately assessed.

In addition to the practice of gaseous fumigation and spraying in an aqueous medium, the use of aerosols produced from solutions of the toxic chemicals in propellant gases liquified under pressure, and of concentrated solutions of insecticides atomized by means of compressed air, are now being studied, and smoke generation must stand comparison with all these methods.

At first sight it would seem that smoke generators will give a better distribution and penetration than any method short of fumigation, but will have less residual effect than the aerosols, compressed air atomization and spraying. It also seems likely that the method can be used in situations where successful fumigation would not be possible.

It would therefore appear that insecticide smoke generators are most likely to be used where good distribution and penetration are required and where residual effects are of secondary importance, in situations where successful fumigation would be difficult. Although at present they are marketed for indoor use, it appears that in certain circumstances they may be useful outdoors. One limiting factor in the use of this method is likely to be the amount of destruction of the active chemical occurring during the production of the smoke.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, April 12

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5.30 p.m.—"Aerial Mountaineering" (Technicolour Film with Commentary by Colonel Walter A. Wood).

Tuesday, April 13

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Future Trends in the Design of Receiving Aerials" (to be opened by Mr. E. M. Lee).

Sheffield Metallurgical Association (joint meeting with the Sheffield Society of Engineers and Metallurgists, at the Royal Victoria Hotel, Sheffield), at 6.15 p.m.—Dr. Ulick R. Evans: "Thin Films on Metals".

Manchester Geographical Society (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Brigadier R. A. Bagnold: "Desert Sand Dunes".

Women's Engineering Society (at 35 Grosvenor Place, London, S.W.1), at 7 p.m.—Miss L. Chitty: "Structural Engineering".

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.15 p.m.—Mr. H. Schmitt: "Automatic Control Applications in the Chemical Industry".

Royal Anthropological Institute (at University College, Gower Street, London, W.C.1), at 8 p.m.—Prof. Percival R. Kirby: "The Trumpets of Tut-Ankh-Amen and their Successors".

Tuesday, April 13—Thursday, April 15

Institute of Physics, Stress Analysis Group (in the English Theatre, The University, Edmund Street, Birmingham).—Conference on "Stress Analysis".

Wednesday, April 14

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Henry S. Horsman: "District Heating".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Major H. C. Gunton: "Phenological Report".

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. S. T. Minchin: "An Account of some Solid State Properties of Petroleum Waxes in Terms of their Composition".

Institution of Electrical Engineers, Transmission Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. W. Wanger: "Technical and Economic Aspects of the Transmission of Electrical Energy over Long Distances".

British Institution of Radio Engineers, North-Eastern Section (at Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p.m.—Prof. M. G. Say: "The Pulse Signal".

British Institution of Radio Engineers, Merseyside Section (in the Lecture Room, Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool), at 6.45 p.m.—Mr. M. P. Johnson: "Some Aspects of Moderate Precision Temperature Control in Communication Engineering".

Television Society (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. K. C. Macleod: "Radio Frequency E.H.T. Supplies".

Wednesday, April 14—Friday, April 16

Electrical Association for Women (at Southport).—Twenty-third Annual Conference.

Thursday, April 15

Chadwick Public Lecture (in the Architectural Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. Thomas Ritchie: "The Sanitation of Buildings" (Bossom Gift Lecture)*.

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Frank Dixey: Talk; Dr. W. B. Pollard: "The Detection, Separation and Microtitration of Iridium"; Mr. P. H. Kitto: "A New Form of Thermal Precipitator".

Institution of Electrical Engineers, Installations Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. J. N. Aldington and Mr. A. J. Meadowcroft: "The Flash Tube and its Applications".

Illuminating Engineering Society, Manchester Centre (in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. H. C. Ruff: "New Lamps—New Uses, and New Lighting Techniques".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. W. E. W. Petter: "The Aerodynamic Problems of High Altitude Design".

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Mr. H. S. Tasker: "Speed and Contrast in X-Ray Work".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. R. E. Rewell: "Diseases of Tropical Origin as seen in Captive Wild Animals".

Pharmaceutical Society, Manchester, Salford and District Branch (in the Council Chamber, Houldsworth Hall, Manchester), at 7.45 p.m.—Annual General Meeting.

British Institute of Radiology (at 32 Welbeck Street, London, W.1), at 8 p.m.—Sir Ernest Rock Carling: Mackenzie Davidson Memorial Lecture.

Thursday, April 15—Saturday, April 17

Royal Institute of Chemistry (at Birmingham).—Annual General Meeting.

Thursday, April 15

At 3 p.m. (at the Central Technical College).—Exhibition, "The Chemist in the Midlands", to be opened by Mr. Roche Lynche; at 6 p.m. (at the University, Edmund Street).—Prof. R. P. Linstead, F.R.S.: "The Chemical Research Laboratory, Teddington".

Friday, April 16

At 11 a.m. (at the Botanical Gardens, Edgbaston).—Prof. Maurice Stacey: "The New Fluorocarbon Chemistry".

Saturday, April 17

Visits to the University and the Barber Institute of Fine Arts, Chance Bros. glassworks at Smethwick, and Marston, Thompson and Evershed's brewery at Burton-on-Trent.

Friday, April 16

Institution of Chemical Engineers (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 11.45 a.m.—Twenty-sixth Annual Corporate Meeting; at 2.30 p.m.—Mr. H. W. Cremer: "The Chemical Engineer and Civilisation" (Presidential Address).

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. W. Wild: "The Electrical Measurement of Pressure and Strain, with particular reference to the Testing of Circuit-Breakers".

Institute of Navigation (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.50 p.m.—Commander W. E. May: "The Future of the Magnetic Compass".

British Institute of Radiology (at 32 Welbeck Street, London, W.1), at 8 p.m.—Prof. W. T. Astbury, F.R.S.: Silvanus Thompson Memorial Lecture.

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. E. V. Evans: "The Gas Industry".

Institute of Welding, North London Branch (at Manson House, 26 Portland Place, London, W.1).—Annual General Meeting.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Physical Chemist or Physicist in the Physics Department—The Secretary, Royal Cancer Hospital (Free), Fulham Road, London, S.W.3 (April 15).

Lecturer (Grade II or Grade III) in Physics, and an Assistant Lecturer (Grade III) in Physics—The Secretary and Registrar, The University, Bristol 8 (April 20).

Assistant Lecturer in Chemistry—The Secretary, The University, Edmund Street, Birmingham 3 (April 24).

Research Assistant (Grade II) in the Science Museum Library—The Director and Secretary, Science Museum, South Kensington, London, S.W.7 (April 30).

Headships of the Departments of Botany, Zoology, Chemistry, Physics, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (May 1).

Assistant Lecturer (Grade III) in the Department of Geology—The Registrar, The University, Liverpool (May 1).

Lecturer in Zoology (with special qualifications in Genetics or Marine Zoology)—The Secretary, The University, Aberdeen (May 1).

Applied Mathematician in the Department of Electrical Engineering—The Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7 (May 1).

Professor of Chemistry—The Secretary and Registrar, University College of North Wales, Bangor (May 1).

Senior Cyclotron Engineer—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, Ducane Road, London, W.12 (May 10).

Assistant Lecturer and Demonstrator in the Biology Department, an Assistant Lecturer and Demonstrator in the Chemistry Department, an Assistant Lecturer and Demonstrator in the Physics Department, a Lecturer (with qualifications in Dietetics) and Assistant Lecturers and Demonstrators in the Physiology Department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (May 10).

Lecturer (man or woman) in Biochemistry—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (May 14).

Lecturer in Meteorology—The Secretary of Faculties, University Registry, Oxford (June 1).

Plant Pathologist in the East African Groundnuts Scheme—The Personnel Department, Overseas Food Corporation, Unilever House, Blackfriars, London, E.C.4.

Chemist (with Honours Degree) for research work on problems of Chemical Microbiology—The Secretary, Wright-Fleming Institute of Microbiology, St. Mary's Hospital, Paddington, London, W.2.

Forestry Expert for the Directorate-General of Agriculture, to act as a Deputy to the Head of the Iraqi Forestry Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18183 (3C).

Lecturer in the Department of Chemistry—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

Organic Chemist for research work on problems connected with the bleaching, dyeing and finishing of flax yarns and fabrics—The Director, Linen Industry Research Association, Linen Research Institute, Lambeg, Lisburn, Co. Antrim.

Lecturers in (a) Chemistry to B.Sc. standard, and (b) Physics to B.Sc. special degree standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Lecturer in Biology—The Clerk to the Governors, Battersea Polytechnic, Battersea, London, S.W.11.

Biochemist (non-medical)—The Secretary-Superintendent, County Hospital, Lincoln.

Assistant Experimental Officers (2, Chemists, male) in the Plant and Animal Products Department, for laboratory work in connexion with investigations of Empire raw materials of plant and animal origin—The Establishment Officer, Imperial Institute, London, S.W.7.

Metallurgist—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

International Office for the Protection of Nature. Report for the Years 1940–1946 and Review of Bibliography on the International Protection of Nature, No. 1. Pp. 40. (Amsterdam: International Office for the Protection of Nature, 1947.) [56

Memoires du Musée Royal d'Histoire Naturelle de Belgique. No. 103: Faune malacologique du miocène de la Belgique. 1: Pélécypodes. Par Maxime Glibert. Pp. 266+12 plates. No. 104: La faune ichthyologique du l'yprésien de la Belgique. Par Dr. Edgard Caiser. Pp. 267+6 plates. No. 105: Végétaux de l'assise des sables d'Aix-la-Chapelle récoltés en Belgique (Sénonien inférieur). Par Dr. François Stockmans. Pp. 51+4 plates. (Bruxelles: Musée Roya d'Histoire Naturelle, 1945–1946.) [96

Polska Akademia Umiejetności. Nr. 1: The Species of the Genus *Arrhopalites* occurring in European Caves. By Jan Stach. Pp. 47+10 plates. 100 zł. Nr. 2: The Species of the Genus *Isotomurus* Born. (Collembola) occurring in European Caves. By Jan Stach. Pp. 14+3 plates. 33 zł. Nr. 3: *Lepidoatelura montana* n.g., n.sp., the Myrmecophilous Lepismid from the Balkan. By Jan Stach. Pp. 10+2 plates. n.p. (Kraków: Polska Akademia, 1945–1946.) [10

Catalogues

Hiduminium Technical Data. Pp. 62. (Slough: High Duty Alloys, Ltd., 1947.)

The 'Agrocide' Range of Insecticides based on 'Gammexane' fo Agricultural and Horticultural Crops. Pp. 32. (London: Plan Protection, Ltd., 1947.)

Diodone B.D.H. Pp. 2. (London: British Drug Houses, Ltd., 1947.)

Information on High Vacuum Distillation. Pp. 16. (Rochester, N.Y.: Distillation Products, Inc., 1947.)

NATURE

No. 4094 SATURDAY, APRIL 17, 1948 Vol. 161

CONTENTS

Page
Freedom in the Good Society 577
Story of Human Evolution 579
Mathematics in India. By Prof. E. H. Neville 580
'Plasthetics'. By Dr. S. R. Carter 581
Textile Fibres. By Dr. C. S. Whewell 582
Electronics in Industry. By Prof. J. Hollingworth 582
Atoms for the Layman. By Prof. P. B. Moon, F.R.S. 582
Operational Research in the Research Associations. By C. F. G. . 584
Food Production from Hill Grazing Land. By Dr. George Dunlop . 585
The Status of the Protozoa. By Dr. John R. Baker . . . 587
The Borderline of Psychology, Physics and Music. By Dr. R.W. Pickford 589

Obituaries :

Prof. M. C. Potter. By Prof. M. Thomas 590
Prof. E. Waymouth Reid, F.R.S. By Prof. P. T. Herring . 591
News and Views 592

Letters to the Editors:

Velocity of Meteors Measured by Diffraction of Radio Waves from Trails during Formation.—C. D. Ellyett and J. G. Davies . 596
Triple Splitting of Ionospheric Rays.—J. H. Meek; T. L. Eckersley, F.R.S. 597
Blackett's Hypothesis of the Magnetic Field of Rotating Bodies.—Dr. Niels Arley; Dr. J. Fuchs. 598
Spontaneous Waves in Discharge Tubes and in the Solar Atmosphere.—Prof. V. A. Bailey 599
Method of Steepest Descents: Improved Formula for X-Ray Analysis.—Dr. V. Vand 600
Surface Resistance of Metal Films at a Frequency of 24,000 Mc./s.—Dr. L. Speirs 601
A Large Field Compensator for Measurement of Birefringence.—A. A. Wells 602
The Swimming of Dolphins.—Alfred H. Woodcock . . . 602
Control of Cattle Trypanosomiasis.—R. N. T.-W.-Fiennes . 602
Cinnoline Derivatives as Chemotherapeutic Agents for *Trypanosoma congolense* Infections.—J. R. Keneford, Dr. E. M. Lourie, J. S. Morley, J. C. E. Simpson, J. Williamson and P. H. Wright 603
Effect of Under-nutrition in Man on Hepatic Structure and Function.—Sheila Sherlock and Veryan Walshe . . . 604
Isolation of Stilbœstrol Monoglucuronide from Human Urine.—K. S. Dodgson and Dr. R. Tecwyn Williams . . . 604
Preparation of Œstrogens from Urine by Application of High Temperatures.—Dr. Felix Sulman 605
A Rapid Method for the Estimation of Pregnanediol.—J. Rabinovitch 605
Higher Fatty Acid Dehydrogenase of Mammalian Liver.—K. Burton 606
Enzymic Action of Viruses and Bacterial Products on Human Red Cells.—C. M. Chu 606
Choleglobin Formation in the Erythrocyte.—C. Gardikas, Dr. J. E. Kench and Prof. J. F. Wilkinson 607
Origin of Noble Sugar-Canes (*Saccharum officinarum* L.)—Dr. N. Parthasarathy 608
Occurrence of the Amphipod *Orchestia bottae* and Other Organisms in Britain.—D. M. Reid 609
Discovery of Radioactivity.—Prof. Jean Becquerel; Prof. J. A. Crowther 609
Operational Research.—Dr. F. Yates, F.R.S.; Sir Charles Goodeve, O.B.E., F.R.S. 609
Formation and Breakdown of Serpulid Tubes. By Jean Hanson . . 610
Plant Virus Proteins and Antibody–Antigen Reactions. By R. E. F. Matthews 611
The Disordering of β-Brass by Cold Work. By R. W. K. Honeycombe and Dr. W. Boas 612
Roofs Supported by Air Pressure. By Herbert H. Stevens, Jun. . 613
Production of an Antibiotic Substance on Wheat Straw and Other Organic Materials and in the Soil. By Erna Grossbard . . . 614
Seismological Research in Great Britain 615
United Nations Conference on the Conservation and Utilization of Resources 617

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FREEDOM IN THE GOOD SOCIETY

WHATEVER may be the outcome of the proceedings of the Commission on Human Rights of the Economic and Social Council of the United Nations meeting at Geneva, the very existence of that Commission is a reminder of the many threats to human freedom which beset the world to-day. Mr. Bevin's recent speech, focusing sharply the rift between the U.S.S.R. and Western Europe, indicated that to some extent it is due to the different views of human rights arising from the different emphasis placed on the community and the individual. Again and again the events he surveyed testified to the truth that tolerance and respect for human personality are not only the essence of democracy but also the essence of civilization itself.

The issue of freedom in political affairs is closely related to the issue of freedom in science. Even on this question of tolerance, it has been emphasized in recent discussions on operational research how important are the contributions which minority groups or individuals have made in developing views opposed to the accepted or orthodox opinions of the majority; and the dangers which secrecy in research offers to the advance of science have been made abundantly plain in the debate on the control of atomic energy.

Nor is this all. As the debate in the House of Commons on the Atomic Energy Act of 1946 revealed, the fundamental problem is the extent to which powers of control shall be entrusted to the Government, and the way in which those powers are exercised. It is a problem in government, above all a problem in democracy; and it is a disturbing reflexion that, in one sphere after another, even in democratic Britain, controls have been imposed and administered in ways likely to impair respect for human personality and to arouse the opposition rather than to secure the consent of the governed. In its handling of the fuel crisis, the petrol situation, the new health service and the question of a wages policy, the Government has used too often the methods of the totalitarian State rather than those of a democracy; and under the forms of parliamentary government has shown a spirit of intransigence which, as Sir Ernest Barker points out, is fundamentally opposed to the spirit and temper of accommodation which is the touchstone of democracy.

In his recent book, "Science and Freedom"*, Dr. Lyman Bryson says that when a decision he could make for himself is taken out of the hands of a citizen, his government has failed in democratic operation. That observation is highly significant in regard to the threats to freedom just indicated, and especially in regard to the question of the structure of the public corporations which the programme of nationalization in Britain has brought into prominence and made so urgent and vital. Equally pertinent reading to-day are those general principles and recommendations based on experience at a Japanese re-location camp which Lieut.-Commander A. H.

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* Science and Freedom. By Lyman Bryson. Pp. xi+191. (New York: Columbia University Press; London: Oxford University Press, 1947.) 15s. net.

Leighton has embodied in his book "The Governing of Men"*. In both books there is much to be pondered by all who are concerned in any way with problems of human freedom, and with the urgent question of developing institutions in which those needs can best be served both in the field of science and in those of social, economic and international affairs.

Dr. Leighton places his first emphasis on the need for great understanding on the part of an administration faced with a community under stress. That, rather than great remedial change, is the important factor; and there could scarcely be a more severe indictment of both the great political parties of Britain during the past three years. Then he suggests that an administration should select means that are readily workable, not only in terms of the causes of the stress but also in terms of the way people are reacting, in terms of their habitual attitudes and beliefs, and in terms of their customary forms for dealing with each other. The channels of assent can never be dug too deep, whether we are concerned with legislative or administrative action. Here Dr. Leighton emphasizes the difference between human or social engineering and engineering in the mechanical or physical sense. Not merely does he point out that no alteration of policy should be arbitrary, and that what alterations are chosen should be carefully explained so that those concerned recognize their advisability, but equally he reminds us that administrators should not be too afraid of admitting they have been in error.

Dr. Leighton's fourth conclusion that, wherever possible, plans for social change should be tried out first on a small scale in a segment of the community, and also his fifth, that the administration must identify and deal with the basic social units of the communities, are in line with the results of the researches which Dr. Elton Mayo expounds as the basis of his work "The Human Problems of an Industrial Civilization". Nor can it be charged against Dr. Leighton that he is too conservative; for in his sixth conclusion he recognizes the opportunities which a time of stress affords a skilful administration for guiding constructive developments and even securing extensive changes which might be impossible or extremely difficult in normal times.

What pervades the remaining four of his conclusions most strikingly is the emphasis placed on the need, already indicated, for securing the consent of the governed. The great promise he holds for men and their government is in a fusion of administration and science to form a common body of thought and action, realistic both in dealing with everyday needs and in discovery and improved practice.

Dr. Bryson's book is essentially an essay on the theme that the scientific method can be used to understand human behaviour, and that scientific knowledge can be applied to the management of human affairs. He would use social engineering to solve the problem of setting up the conditions of freedom, but not to determine what men shall do with freedom when they get it. His thesis is that science can be used as one of the tools by which to establish the conditions in which human powers may realize human values. He believes that the conditions of freedom are the conditions in which the creative powers of man, and all the other creative factors of Nature to which man has access, can work best; and he suggests that if we can inspire the behaviour of man with a real desire for freedom and creative change, we can build social structures that will make creative change not violent and costly but peaceful.

Dr. Bryson recognizes that the social structures of a free society are complex, and he insists that our primary concern should be with the condition and techniques of freedom—the content of freedom rather than the use men make of freedom. Once again we find the emphasis laid on the educational aspect of the process of government, on the dangers of centralization of power and the revolutionary character in this context of the conception of economic democracy as it applies to the trade unions and to the employer or manager. Dr. Bryson insists, however, that economic democracy must have political democracy as its counterpart, and he suggests further that this conception of freedom will only be served when to these we have added what may be termed a democracy of culture, where creative genius will have its fullest scope to serve mankind. Just as he defines the conditions of freedom for the person as those that give full use to his creative powers, so he defines the free society as the creative society.

It is important to remember social science has external limits, as well as its internal imperfections. If we are to persuade men to make the effort involved in the scientific solution of human problems, we must, as Dr. Bryson rightly points out, not only meet the criticism that objective thinking has thus far done little to make human behaviour better by any rational standard, but also combat the widespread belief that science is wholly materialistic, deterministic and inhumane. In his succeeding chapters, and notably in that on education, Dr. Bryson gives some indication of his ideas as to how that is to be achieved.

The deeper habits of thought of the philosopher might well, as Dr. Bryson implies, have helped governments to avoid some of the disastrous mistakes of recent years if only by emphasizing the way in which, as each action is taken, the whole situation is more or less changed at the same time. He gives us a glimpse of the dangers of propaganda and of the possibilities in the right use of persuasion where freedom and personality are respected. In his final view of the good society, he once again insists on the necessity for the greatest possible diversity of institutions and chances for loyal attachment; and for the opportunity for the members of the good society to change their own individual patterns of loyalties, shifting from one institutional group to another not only at a time when the whole culture is changing but even with the idiosyncrasy of personal experience.

Whether or not we accept the whole of Dr. Bryson's argument, he has given as suggestive and stimulating a contribution to the whole question of freedom and order, of the relations between science and power, government and the individual, as Dr. Leighton has done in analysing his experiences in the re-location camp. They do not, it is true, take us a great deal further than Sir Ernest Barker did in his "Reflections on Government", though Dr. Leighton at least can quote evidence of the way in which a scientific approach has made a real contribution to the problem of governing men, and with the same success as attended the investigation at the Hawthorne Works of the Western Electric Company described by Dr. Elton Mayo and Dr. T. N. Whitehead. Dr. Bryson goes further towards providing the philosophical basis which Dr. Leighton equally recognizes as essential.

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* The Governing of Men. By A. H. Leighton. Pp. xvi+404. (Princeton: Princeton University Press, 1945.)

Most impressive of all, both books largely corroborate the truths which Sir Ernest Barker brought out and which more recently have been so brilliantly stated by Prof. R. M. MacIver in "The Web of Government"*. There is, indeed, grave peril when government usurps control over the myths of the community, especially since government is now armed with powers more formidable than it ever possessed before, against which democracy is the only safeguard; though, as MacIver points out, not an infallible safeguard, because people can be beguiled by propaganda along specious paths that lead to the end of democracy.

MacIver's lucid study displays two broad principles the full acceptance of which is essential if democracy is to endure. "One is that government should never be suffered to impose its controls on the cultural life of the community, to curtail the freedom of men to differ in their faiths and opinions, in their ways of thought and their ways of life, save when in the pursuit of these ways they inflict overt and objective demonstrable hurt on their fellow men. The second is a corollary of the first. It is that government should not be entrusted with so exclusive a monopoly over the economic utilitarian system that the implantation of these functions conveys with it the effective indirect domination of the cultural life. For if the life-chances, the very livelihood of individuals and groups are at the disposition of government, then the particular values and ideologies of the particular government will inevitably become absolute and will inflexibly impose themselves on the whole community, crushing its free spirit."

Some apprehension of this second precept may well be subconsciously behind the present concern of the medical profession in Britain over the National Health Service; but Prof. MacIver is right to hold that only by vigilant adherence to both these precepts can the peoples remain free and still breathe the life-giving air that comes beyond the realm of government. The relation between the advancement of science and political climate could scarcely be expressed better.

A recent forthright series of articles, "The Middle Class", appearing in *The Economist*, is also worthy of careful consideration. Under that title the position of the professional man is subjected to acute analysis, and there are many sound comments which the scientific worker in particular will appreciate. It was time that it was emphasized so bluntly that essential conditions of freedom for creative work in professional life are leisure, privacy, and the opportunity of external contacts: for high intellectual activity they are as essential as extra rations are to heavy manual labour. Sacrifice of such conditions is from the national point of view much the most serious consequence of the salaried classes losing ground out of all proportion to the general fall in national wealth, as compared with the wage-earner and the profit-maker; but it is a long way from being understood either by the Government or by many of the electorate. Neither is the civic, cultural or social *raison d'être* for the survival of the professional core of the middle class any more widely appreciated; and there are plain words indeed on the subject of experts without power in the third of these articles, which should be marked and heeded by every thoughtful and independent citizen.

It matters greatly how freedom and order are combined, and *The Economist* in this article points out that under present conditions the party system is giving us the worst of both worlds and that persistence in present tendencies in this era of social and economic engineering may have disastrous consequences. Both major political parties in Britain are hopelessly handicapped, and can be relied upon to paralyse their skilled administrators with political directives which frustrate purpose or nullify freedom. "So long as the professional class are merely instrumental in putting badly conceived plans into practice, their specific qualities will be wasted. And waste will continue until they are given a role in the framing as well as in the application of policy."

That is a challenge as well as a warning. National recovery and the large schemes of nationalization now being pressed forward in Britain will only succeed if we eliminate political bias and utilize to the full the principles and techniques of good management and sound administration. Self-interest, as well as his responsibilities as citizen, summon the scientific worker to play his part in establishing those conditions. For him this issue of freedom and order, on which the survival, not only of Britain but also of Western Europe, depends, is inseparable from the conditions for scientific advance; and the cultivation of intellectual freedom is itself a condition of the right and wise use of power.

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* The Web of Government. By Prof. R. M. MacIver. Pp. 498. New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 947.) 21s. net.

STORY OF HUMAN EVOLUTION

Mankind So Far

By Asst. Prof. William Howells. (American Museum of Natural History Science Series.) Pp. xii+319+7 plates. (London: Sigma Books, Ltd., 1947.) 16s. net.

THE ignorance of otherwise well-educated people concerning the origin of their own species is not a little astonishing, considering the personal nature of this problem and its intimate relation to philosophical concepts of human existence. One of the reasons for this apparent apathy, no doubt, is the meagreness (until quite recently) of the direct evidence of the fossil record. Another is the difficulty which anthropologists so often seem to experience in making their field of study intelligible to the general public.

The first reason scarcely obtains any longer, for the discoveries of the last few years have filled in some of the gaps in the palæontological sequence in a most remarkable way. Now the second difficulty has been shown to be surmountable, for Dr. Howells, in his popular book "Mankind So Far", has not only adopted a style which is eminently readable (not to say entertaining), but has also managed to provide a great deal of important information without assuming any specialized knowledge on the part of the reader. His style is the conversational style of the accomplished popular lecturer, transferred directly into writing without any re-casting or re-phrasing to make it conform to the traditional method of presentation which is so commonly associated with the 'science manual'. The result is extraordinarily successful. For one thing, it makes the subject appear to the ordinary reader as exciting as it really is to the specialist. For another, it serves to emphasize that the science of human evolution (like other sciences) is nothing more than organised common sense and, as such, can be readily comprehended by the non-specialist. But it has yet another advantage. By reducing arguments which have from time to time been advanced for this or that partisan theory of human evolution from 'academic' phraseology to ordinary conversational style, the author has at the same time reduced them to their proper proportions, and sometimes, it must be confessed, has even shown them to be slightly ridiculous.

Dr. Howells' exposition of the study of human evolution is permeated by a robust common sense and by a welcome sense of humour which seems by no means out of place when he deals with controversies which, in more academic circles, have been conducted with unnecessary acrimony. We would particularly commend his illustrations, which are simple and direct and yet have obviously been carefully planned to clarify and emphasize his arguments with the maximum effect. They certainly achieve their purpose. The student who aspires to a mastery of human palæontology may be well advised to use this book as an introductory study.

MATHEMATICS IN INDIA

Ancient Indian Mathematics and Vedha

By Prof. L. V. Gurjar. Pp. vi+202. (Poona: Ideal Book Service, 1947.) 6.4 rupees; 10*s*.

FOR too long the history of mathematics in India was studied only by scholars suffering under the almost insuperable handicap of belonging to an alien civilization; but recently a number of Indian mathematicians have made a welcome appearance in this appropriate field. Prof. Gurjar's little book on mathematics up to the twelfth century and on pre-telescopic astronomical instruments is full of interesting material, but its tone is altogether deplorable.

European scholars began to study the mathematical classics of India a long time ago—Colebrooke's translation of the "Lilavati" was published in 1817—and no help from Indians was forthcoming; the language was dead as well as foreign, the background had to be inferred, the idiom was enigmatical, and these pioneers made some of the mistakes which Prof. Gurjar would make if he attempted to translate "The Crafte of Nombrynge" or Chaucer's "Astrolabe" from imperfect contemporary manuscripts and was unable to find one Englishman competent to discuss his difficulties with him. Nor did the Europeans approach their task without taking for granted that the history of mathematics in India would fit into the story of mankind as they knew it: there was a road from Athens to Bologna and Paris and Oxford through Alexandria and Baghdad, and if mathematics was found to have been cultivated in medieval India, there must be another road from Greece to be traced.

Prof. Gurjar has still to learn to correct what he believes to be a mistake without jeering at it, and to challenge an assumption without resenting it as a deliberate insult to his people. To traduce scholars no less honest than himself is no way to impart a sense of confidence in his own interpretations of ancient texts. At the end of his account of Bhâskarâcârya's work on indeterminate equations, he writes: "To deny the due credit and the honour to the Hindus, is a sheer obstinacy which only the prejudiced Western scholars are capable of having". But what, in fact, did Cajori, of whom Prof. Gurjar complains again and again, write in 1894? "The perversity of fate has willed it, that the equation . . . should now be called *Pell's* problem, while in recognition of Brahmin scholarship it ought to be called the 'Hindoo problem'. It is a problem that has exercised the highest faculties of some of our greatest modern analysts. By them the work of the Hindoos was done over again." And on another page: "It is remarkable to what extent Indian mathematics enters into the science of our time. Both the form and the spirit of the arithmetic and algebra of modern times are essentially Indian and not Grecian." This is the very language that Prof. Gurjar wants us to use. Cajori, it is pertinent to observe, is not an orientalist drawing conclusions from his own discoveries; he is a historian reducing to the scale required for a comprehensive work the cumulative judgment of the actual investigators. Nevertheless, Prof. Gurjar roundly accuses the Western scholars, with the explicit exception of Hankel, of "hesitatin to record the credit to the Indians simply becaus they are Indians".

A protest must be made. Burton was warnin the British a century ago to be under no illusion as to the feelings of Indians towards them. Th mathematicians of Britain bear as citizens their shar of responsibility for their country's failures, but the can claim that as mathematicians they have consistently offered not patronage and generosit but appreciation and partnership; the names o Mukhopadhyay and Paranjpye and Rajan, o Naraniengar and Prasad and Vaidianathaswami an a score of others, as well as the great name o Ramanujan, have been honoured equally at Cambridge and in their own land. Surely we have earne the right to expect from Indian mathematicians a this critical moment that whoever else prepares fc the future in terms of hatred, they at least will prc claim the reality of interdependence, and the poss bility of mutual respect and ultimate friendship. Th nursing of grievances has perhaps caused more miser than any other uncivilized habit of mankind; to ad one untrue word to the tragic tale of past wrongs i wanton mischief, and to create a legend of injustic is an infamy.

E. H. NEVILLE

'PLASTHETICS'

The British International Plastics Annual, 1947

Pp. 274 + 183. (London: Croome Hill International, Ltd., 1947.) 63*s*.

THIS work is designed for that large body of users of plastics who require a central source of information on the varied aspects of the industry. It provides technical data on the materials available commercially, and practical advice on the machinery and technique in their treatment. For the present, the authors are only concerned with developments in the British Commonwealth and the United States, so that this volume bears the title "British International Plastics Annual". Later they visualize a true international plastics annual published in many countries and in many languages but identical in matter. A system of standardization is thus essential, and this is one of the objects the Annual sets out to achieve.

The book deals with all modern plastic materials, and these are laboratory-synthesized resins and plastic products from 'Acrylic to Zein'. The authors introduce the descriptive word '*Plasthetics*' (derived from *plas*tics, syn*thetics*) to cover these products.

An introduction to organic chemistry, colloids and analysis is followed by a general description of the main groups of plasthetics, which number about thirty types. The properties of synthetic plastics are treated under general, physical, mechanical, optical and electrical properties, the effect of chemicals and finally the standards of the American Society for Testing Materials. In the section on fabrication processes we find compression, transfer, jet and injection moulding, as well as the manufacture of laminates, foil and sheet. There is also a useful section on diathermic and infra-red heating. The miscellaneous applications of plastics are very varied, and include varnishes, lacquers, yarns, safety glass, printing and adhesives, also medical and biological uses.

A comprehensive directory section gives technical data on upwards of eight hundred British and American commercial grades of plastics, machinery and equipment, together with the characteristics of two hundred solvents and plasticizers. This section includes the societies, trade associations and educational facilities in the plastics industries.

A work of this kind in its first issue can scarcely hope to be free from blemishes, and the publishers provide a questionnaire asking for comments and constructive criticism. Certain criticisms are noted by the reviewer. The index is not adequate for finding the extensive information provided. Some organic formulæ require correction, for example, the breakdown of naphthalene (p. 20). The COOH and other groups are sometimes built into the aromatic ring (for example, in the phthalic acids, p. 114) when they are only substituents. The sensitization of colloidal gold by gelatine (p. 29) is rather out of place, and emphasis on its protective action would have been more to the point. Some of the formulæ for mechanical properties (pp. 144–153) require revision and correction, and the symbols should be those used in current practice by engineers.

Such criticisms, however, are of a minor character compared with the major qualities of this work. This Annual should be of great value to the members of the industrial world for whom it is intended. It is probable, however, that a wider range of readers will be eager to possess copies so far as the limited supplies will allow. The production of the book is of a high standard. Its useful contents, added to clear printing, good binding, and general appearance, will make it a worthy ambassador for British enterprise in the countries which it may ultimately reach.

S. R. CARTER

TEXTILE FIBRES

Matthews' Textile Fibers: their Physical, Microscopical and Chemical Properties

Fifth edition, prepared by a Staff of Specialists under the editorship of Herbert R. Mauersberger. Pp. xvi + 1133. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 75*s*. net.

THE conversion of fibrous materials into cloth or felt has commanded the attention of civilized man from earliest times, and over the years a great deal of skill in the manipulation of a wide variety of naturally occurring fibres has been acquired. The existence of subtle differences between the various grades of fibres is well established, and the selection and blending of raw materials plays an important part in successful commercial processing. Prior to 1904, when the first edition of "Matthews" was published, most of the information on textile fibres was an accumulation of the observations of inquiring growers and industrialists; but in more recent times scientifically trained chemists, physicists and biologists have been attracted by the many problems involved in elucidating the structure of fibres and in investigating their physical and chemical properties. Great advances in our knowledge of the basic characteristics of textile fibres have resulted from work of this type, and there are now sufficient data available to justify a chemical interpretation of the fine structure of most fibrous materials. Probably the greatest contribution of the scientific worker to textiles has been, however, the development of the rayon industry to a size comparable with that of industries concerned with the natural fibres. New rayons with extremely interesting manufacturing possibilities have been introduced, and the day is not far distant when fibres will be made to precise specifications laid down by users.

This great expansion of activity in the field of textiles, and the consequent spate of original contributions, created a need for an authoritative publication collecting together most of the existing knowledge, and this has been met by the new and fifth edition of "Matthews"—the result of a united effort by some forty-seven experts. The work has been carried out under the general direction of H. R. Mauersberger, who is a well-known editor of textile publications, and his collaborators include eminent specialists such as K. R. Fox, F. C. Atwood, P. Larose, R. F. Nickerson, E. R. Schwarz, W. A. Sisson, H. DeWitt Smith, and W. von Bergen.

Detailed accounts of the production and properties of both natural and man-made fibres are given, together with descriptions of lesser-known brush, cordage and fur fibres, and there are chapters on fibre testing and fibre identification. Although due emphasis is given to microscopical characteristics, physical and chemical properties, and research concerned with the study of fibre structure, the results of more technical investigations are not neglected. Thus data on the statistics of fibre production and details of the characteristics of the many commercial grades of each type of fibre are included. It is perhaps inevitable that stress is laid on American research and practice, although reference is made to many British papers.

The book is extremely well written and presented; the illustrations are good, the printing very clear, and the binding and quality of paper are such as to make most English authors envious. All who are interested in textiles, whether they are research workers, manufacturers, salesmen, directors, teachers or students should find this volume particularly valuable, for it is probably the most important publication on textiles which has appeared in the last twenty years. The authors are to be congratulated on their achievement. C. S. Whewell

ELECTRONICS IN INDUSTRY

Electronics for Industry

By W. I. Bendz, with the assistance of C. A. Scarlott. Pp. x+501. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 5 dollars.

THE purpose of this book is to introduce the engineer who has had no special training in electronics to the fundamental principles involved in them, and the means of their practical application. The latter include a very wide range: photo-electric devices, high-power rectifiers, high-frequency heating, and various types of control circuits. The diagrams are mostly basic circuits illustrating the methods used, and so are not confused by minor details, though some actual circuits are given.

On the theoretical side, the book opens with a very clear introduction to as much of modern atomic physics as is necessary for the understanding of the action of practical electronic devices; this is material on which the average engineer is often sadly deficient.

The characteristics of the various types of valves are then dealt with, particular attention being given to the form of discharge in gas-filled valves, and there are many illustrations of actual electrode systems. The nomenclature throughout is the American standard, which differs from that in use in Britain; but the meaning of each expression is fully defined. Attention is then given to rectifiers of all types, from the small power pack for ordinary valve circuits up to the high-power three-phase mercury vapour type, with constructional details of the latter. Considerable attention is given to various types of firing circuits; but distortion of wave form is only slightly dealt with. In the chapter on amplification the basic principles are clearly dealt with, the work being entirely confined to medium-frequency working, no reference being made to the special difficulties which arise with high- and ultra-high-frequency working. A chapter on oscillators follows, all the normal circuits including dynatron and beat-frequency circuits being given, as well as a short description of the piezo-electric crystal.

After a short chapter on modulated signals, the rest of the book is given up to the description (including circuit diagrams) of all types of commercial electronic applications, classified under various headings: and this part contains much information which, up to the present, has been difficult to get in collected form without reference to specialized papers.

Taken as a whole, the book should be of great value to the user of electronic devices; it is not intended for those who have to design them, though throughout there are many references to more detailed information, including a bibliography at the end of each chapter. J. Hollingworth

ATOMS FOR THE LAYMAN

The Atom and its Energy

By Prof. E. N. da C. Andrade. Pp. xii+196+12 plates. (London: G. Bell and Sons, Ltd., 1947.) 10*s*. net.

Meet the Atoms

A Popular Guide to Modern Physics. By O. R. Frisch. Pp. xiv+226. (London: Sigma Books, Ltd., 1947.) 12*s*. 6*d*. net.

PROF. ANDRADE is an old hand at explaining the mysteries of atomic structure; his "Structure of the Atom" was the standard text in the days when electrons circulated on nicely calculable orbits around the nuclei that Nature provided for our study. The electrons have long since abandoned their tram-way-like orbits and, like buses in a fog, have a mere probability of being somewhere near a given route; new kinds of nuclei can be manufactured at will in great variety; and we have learned how to use, or misuse, the immense energy of nuclear forces.

In "The Atom and its Energy", Prof. Andrade marshals the modern array of atomic facts and theories with his usual skill, illuminates them by ingenious analogies, and spices the dish with a literary flavour; though the reviewer's metaphors may be mixed, the author's are not, and they magnify the atoms to visible size with amazingly little distortion.

Prof. Frisch, in "Meet the Atoms", follows the more informal plan of taking the reader into the laboratory and explaining how experiments in nuclear physics are devised, performed and interpreted. The apparatus is there, real and life-sized, and there is no need to magnify it; but when an analogy can help in interpreting the observations, Prof. Frisch does not hesitate. For example, he compares the dual wave and particle aspects of light to the appearance of an animal that everyone's right eye sees as a dog and everyone's left eye sees as a cat; he remarks that in time we would get used to this and would cease to worry about which it 'really was'. Such analogies, crude though they may be, are in harmony with the atmosphere of a real laboratory, where the apparatus and the conversation are not always highly polished. Prof. Andrade's book belongs rather more to the study, and has both gained and lost by its slight detachment from laboratory details.

The cat-and-dog analogy does not apply to this pair of books; each author sees the atoms clearly with both eyes, and explains them to the reader in his own way. The books are not, of course, written for the expert, but they will hold the interest of physicists as well as of the less-specialized public for whom they are intended. They are books about atoms and not primarily about atomic energy; Prof. Frisch deliberately says very little about that subject, and Prof. Andrade is not at his best when dealing with its technical and scientific aspects, though his comments on the moral and political issues show the clear thinking and fine writing that we expect from him. P. B. Moon

Microdiffusion Analysis and Volumetric Error

By Prof. Edward J. Conway. Revised edition. Pp. xix+357. (London: Crosby Lockwood and Son, Ltd., 1947.) 21*s*. net.

MICRO-DIFFUSION analysis represents a real advance in modern analytical technique. It seems strange, in fact, that the underlying principle of allowing the gaseous product of a reaction to diffuse, in a closed chamber, into a suitable absorbent or reactant should not have been used more extensively in analytical procedures at a much earlier date. Absorption of gases into appropriate reactants by distillation and aeration methods is, of course, the basis of many well-known, and important, chemical and biochemical methods of analysis, but the methods are usually tedious and extravagant in apparatus and material. Conway's technique involves the use of a simple and inexpensive glass apparatus (termed the 'Unit') consisting of an inner and outer chamber. The gaseous product of a reaction (for example, ammonia, volatile amines, carbon dioxide, acetaldehyde) passes from one chamber, where the gas exerts a certain tension, into an absorbent in the second chamber, where the tension approaches zero. Analyses are made of the contents of the second chamber, and the accuracy is limited only by the accuracy of delivering and titrating fluid volumes of the order of 1 ml. Conway claims that the method appears to be the "simplest possible consistent with the maximum attainable accuracy in the handling of micro-volumes". The technique has been adopted for analyses of ammonia, amides and amines, adenosine and adenosine derivatives, halogens, alcohol, acetone, lactic acid and glucose, carbon monoxide and carbon dioxide. It may be used also in the estimations of enzyme activities.

Conway's book describes his 'Unit', the various physico-chemical factors involved in diffusion techniques, the micro-pipettes and burettes required and the errors involved in their use. It gives details of the analytical methods involving the micro-diffusion technique which have now been adopted in many laboratories, and it has a most valuable section on the errors encountered in volumetric titrations. It has a good bibliography, and is well illustrated and produced. It is a book which should be in the hands of most biochemists and clinicians.

Archæology and Society

By Grahame Clark. Second edition, revised. Pp. xv+222+24 plates. (London: Methuen and Co., Ltd., 1947.) 10*s*. 6*d*. net.

THIS is a welcome new edition of a book which in October 1939 found a rapid sale, and should certainly do so now. It is one of the best and most readable short introductions to archæology in general, and though much in it has needed no revision, Dr. Clark has related his themes to their present-day setting with sound judgment. Archæology studies how men lived in the past: in partnership with documentary history if available, but in any event with confidence that it can do much that its partner cannot, in particular, of course, in the study of prehistoric times. This does not make it in itself altogether a science; yet it owes its modern precision largely to its growing capacity to collaborate with natural sciences, in the application of their techniques to the study of man's past doings. In that matter Dr. Clark at Cambridge has himself long been a leader, and this gives especial value here to his chapters on archæological discovery, preservation, excavation and chronology. Finally, too, he gives us some excellent plain speaking on the all-important 'social relations' of his subject: research must be kept free of perversion by nationalism, and devoted to the honest pursuit of historical truth.

C. F. C. HAWKES

Faraday's Encyclopedia of Hydrocarbon Compounds

(Covering the Literature up to January 1st, 1947). Compiled by Dr. Joseph Escott Faraday. Vol. 4: C_9 Pp. lxxxviii+448. (Manchester: Chemindex, Ltd., 1947.) £5 10*s*.

DR. FARADAY, in accord with his promise, now presents us with volume 4 of his encyclopædia of hydrocarbons; the author and his publishers are to be heartily commended on being able to keep such a promise in these difficult times. The present volume deals with the C_9 compounds up to January 1, 1947, and follows closely the lines of the previous parts, now so well known to organic chemists.

It is stated in the foreword that future volumes will contain the Dyson cipher of the compounds described: this will greatly increase the value of the work if and when the Dyson cipher becomes widely used.

It came as a slight surprise to the reviewer to find indane called 1 : 2-trimethylane-benzene, and indene, 1 : 2-trimethylene-(7)-benzene; on reflexion, this possibly appears logical, but it will surely be some time before 1 : 3-tribromopropane is called trimethylane dibromide, and surely the group $>CH_2$ is methylene, although perhaps this term should be reserved for $=CH_2$. Hydrindane, which might be expected to be 1 : 2-trimethylane-*cyclo*hexane, is bicyclo-hexane-(1,2)-pentane.

The reviewer is, of course, well aware of the difficulties of systematic nomenclature, and the above remarks cannot be taken as adverse criticism.

The Yearbook of the Universities of the Empire, 1947

Published for the Universities Bureau of the British Empire. Pp. xxxi+1098. (London: G. Bell and Sons, Ltd., 1947.) 21*s*. net.

THE usefulness of this valuable reference book is attested by the sorry condition to which the last issue, that dated 1940, must have been reduced in any institution or department in touch with university affairs. The war-time Supplement issued in 1941 carried on the information for but a short space, and it has been necessary to wait six years before the complete data relating to the staffs of the universities of the British Empire could be made available once more. Even now, due to the rapid expansion taking place in the universities themselves, and also to the longer time now required for printing such a book, it is not claimed that the information is up to date in the sense it used to be. The new volume contains about a hundred pages more than that for 1940—an indication of the growth of the universities that has taken place.

As before, the information under each university includes a directory of the officers and staff, general information and reports of events of outstanding interest during the previous year. There are appendixes on the qualifications for admission to a first degree, statistics of foreign students in British universities, general conditions in American universities, and Anglo-American professorships.

OPERATIONAL RESEARCH IN THE RESEARCH ASSOCIATIONS

WHAT is 'operational research' ? Is it an activity of major importance to industry ? Can it be carried out effectively by co-operative organisations such as research associations ? How does one set about organising operational research ? These questions were examined at a conference on January 13 and 14 attended by representatives of most of the research associations and of a number of establishments of the Department of Scientific and Industrial Research. The conference was organised by the Committee of Directors of Research Associations under the chairmanship of Mr. B. H. Wilsdon, and was held at Ashorne Hill, through the courtesy of the British Iron and Steel Federation. The conference showed that it was possible to make a reasonably clear definition of the subject, and that operational research in one form or another had proceeded with growing emphasis in certain of the research associations very successfully for a considerable number of years. The research associations generally find themselves very suitably placed for an extension of this type of activity, in view of the wideness of the fields they survey and the close contacts they have with the executives in the industries they serve.

It was desirable to obtain first a general form of words and then to follow this by a consideration of the various factors that make up what might be called 'Operational Research'. The discussion was opened by Sir Charles Goodeve, who proposed a definition based on that put forward originally by Dr. Charles Kittel[1]. After some discussion, the following amended form was considered accurate enough for most purposes :

Operational Research is the use of the *scientific method* in providing executive departments with a *quantitative basis for decisions* regarding the *operations* under their control.

The most problematical part of the definition was in the scope associated with the word 'operations'. In general, it was considered desirable to keep this scope as wide as possible, ranging from the operations in ordinary production engineering to policy matters associated with consumer needs, national economic positions, etc. The chief difficulty appeared to be in drawing a line between process or equipment research and operational research, and it was clear that any attempt to draw a sharp line would be artificial and probably harmful. The difference between 'process' and 'operational' research comes down largely to one of direction of approach. The operational research worker starts with the overall picture and may study individual processes in relation to the whole picture, whereas the process research worker is more concerned with developing certain processes to the highest pitch of efficiency in relation to other parallel or following processes. In addition, there is a difference in degree in that the operational research worker more often has to rely on observations of happenings over which he has no control, whereas the process research worker can generally carry out deliberate experiments with at least a substantial degree of physical control. The operational research worker much more frequently has to deal with human factors, market conditions and the many other factors troubling men in executive positions.

Dr. F. C. Toy, director of the British Cotton Industry Research Association, which organisation has undoubtedly been among the pioneers in this type of work, opened the second session of the conference. He said that, judging by his own experience, operational research should form an integral part of the activities of a research association. It can obtain a comprehensive picture for the whole industry by a collection of data from individual firms, which can be summarized by a statistical digest and a general report. By feeding back this digest to all firms, together with a special confidential report to each individual firm, the executives concerned can see their own position in the light of a complete and accurate background. These reports often act simply by stimulating managers to look again at problems or deficiencies already known to exist. This method has proved to be a much quicker way of improving efficiency than the old one of waiting for economic factors to bring into successful prominence the more efficient plants. These studies can also bring out quantitative information on the factors affecting an industry as a whole, and thus aid in determining the right policies for the industry. This is an especially important point in these days when the Government has to deal with many contending issues.

Dr. Toy discussed the prospects of operational research being carried out by organisations other than research associations. Individual firms and professional industrial consultants are limited to studies inside the confine of a particular works ; but they can obviously be helped by the wider picture provided by the research associations. The universities and technical colleges are unsuitable for this type of work, but they play a major part in training personnel. The trade federations have a wide picture of the commercial side of each industry; but their lack of technical knowledge and of scientific atmosphere puts a severe limitation on their activities. However, research associations should work in closely with the trade federations, since many of the executive decisions have to be made by such bodies. There may be special instances where operational research should be carried out in industry by Government teams; but if this is done widely in industries served by research associations, it means duplication of effort. In addition, managements are more ready to co-operate with people in an organisation belonging to their own industry than with those who may be looked upon as Government investigators.

All these arguments supported Dr. Toy's contention that, because of the scientific atmosphere, complete impartiality, close contact with industry, with other research organisations and with Government departments, and because of the confidence placed in them by management and operatives, the research associations are the most suitable bodies to carry out operational research in industry.

Mr. A. T. Green, director of the British Ceramics Research Association, pointed out that operational research methods are of particular value in the older industries where the processes are based on traditional methods developed by subsequent experience. He referred to the detailed works surveys carried out for the National Brick Advisory Council. These give valuable indications of the labour used and of the minimum requirements under a wide variety of manufacturing conditions.

Dr. S. Whitehead, director of the British Electrica and Allied Industries Research Association, spoke about operational research in fields ranging from high-power transmission to radio interference, and emphasized that operational studies frequently pro vide certain links in a chain of deduction of which the remainder are supplied by science and engineering.

Mr. H. Bradley, director of the British Boot, Shoe and Allied Trades Research Association, described the extensive surveys made into the fittings of shoes, based on analyses of measurements of some thousands of feet. For example, most factory-made women's shoes are produced in what are known as single-fitting ranges, that is, each size or half-size of length is made in only one girth. It has always been the practice in the industry to add ¼ in. in girth for each successive size. How this interval was arrived at nobody knows, and the analyses of foot measurements showed the correct interval to be 3/20 in.; or 40 per cent less. The practical effect of this on the fitting properties of shoes, particularly the extreme sizes, is considerable, and the Research Association's 'precision grading' based on the new girth interval is having great commercial success.

Mr. D. J. Bishop, of the British Iron and Steel Research Association, showed how a large part of the research programme of that Research Association is continually under study by the operational research team with the object of providing those concerned with the framing of that programme with adequate information, so that research can be focused on problems the solution of which is likely to produce the greatest economic advantage to the steel industry. This is a case where operational research is used at a 'strategic level' to guide research policy.

It was clear from the points raised by numerous speakers that, despite the large volume of operational research already proceeding in industry in Great Britain, many obstacles would have to be overcome before the desired wide application could be attained. In some industries, the firms' problems are so diverse that wide approaches or comparisons are of little value. Also, some industries have been built up and owe their strength to keen competition between firms. Mr. Wilsdon pointed out that, in operational research *within* an industry, it is essential to take into account variation in the quality of the product, which must be associated in some way with the expenditure of energy in the operations studied in order to provide a comparable basis for executive decisions. Thus criteria such as operations per man-hour or the like might be positively dangerous unless there are good grounds for assuming that the quality of the product is the same throughout. It is clear, therefore, that different industries are likely to adopt operational research to different extents.

On the other hand, as was pointed out by various speakers, there never has been a more favourable opportunity for an extension of operational research. With the present 'sellers' market', competition is at a minimum and co-operation at a maximum. Organised labour, which has always had to look first for security of employment, is able now to take a broader view and consider efficiency of employment.

The discussion on organisation and staff was opened by Mr. Tippett, of the British Cotton Industry Research Association. He considered that a separate operational research team is desirable if the subject is to be treated with the seriousness and comprehensiveness its importance requires. The separate team requires close contact with the management side of ndustry, with the trade associations, Government departments, etc., and also should have close conact with the field observational work. The team should be staffed with men chosen first of all for their ability to view things widely. They should have good scientific ability, and need to acquire technical knowledge of the industry they serve; but they need not have any particular specialized qualifications. The knowledge of statistics required for most of the work is not very great, although it is desirable to have at least one first-class statistician in a team. It is very important that members of the operational research team should be able to talk to managers, foremen and operators, and to get on well with everyone in the factory.

The objects of operational research which have been or could be carried out by the research associations can be summarized as follows: (1) to increase production per man hour, per unit of equipment, or per unit of fuel; (2) to improve quality and suitability of products; (3) to improve the basis for decisions regarding the application of science ('bridging the gap'); (4) to make accurate studies of consumer or market problems, that is, scientific studies in market research; (5) to aid in finding the optimum degree of standardization for any particular field of production; (6) to aid in the planning of research programmes.

The proceedings concluded by short talks by Dr. W. L. Francis, of the Department of Scientific and Industrial Research, and Dr. Alexander King, director of the scientific secretariat, Lord President's Office, on operational research activity and interest in Government departments.

C. F. G.

[1] Kittel, C., *Science*, 105 (Feb. 7, 1947). See also Goodeve, C. F., *Nature*, March 13, 1948, p. 377, for general article on operational research.

FOOD PRODUCTION FROM HILL GRAZING LAND

By Dr. GEORGE DUNLOP
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THE Minister of Agriculture has pointed out that while before the War, for Great Britain as a whole, less than 40 per cent of our food, on a calorie basis, was produced at home, this figure in 1946 had increased to almost 70 per cent.

The land of Scotland may be classified under the headings of:

(1) Farm land: arable and grass land.
(2) Hill pasture.
(3) Other land: deer forests, woodlands, etc.

Sir John Russell has estimated that one acre of farmland produces sufficient food for one person. The population of Scotland is about five million and the arable and grassland acreage about the same figure. This indicates that Scotland is self-supporting in food. It is true that tropical foods, such as grapefruit, bananas, etc., are imported; but on the other hand a good proportion of the arable acreage is devoted to the production of seed potatoes which are transported to England and abroad. Similarly, surplus milk on occasion has found a market south of the border.

The agricultural returns show that there are approximately ten million acres of hill land in Scotland devoted to hill sheep farming. The agricultural production of this type of land will be discussed later. The remaining four million acres may be classed, so far as agricultural production is concerned, as 'waste', and consists mostly of deer forests and woodlands, from which the agricultural productivity is practically nil.

The hill sheep grazings, which are found on more than half of the land of Scotland, produce, according to the Hill Sheep Farming Report[1], 1·4 million draft ewes and lambs which are sold in the autumn of each year. Most of these animals have to be fattened on arable pasture. Responsible livestock graders of the Ministry of Food estimate that the overall average carcase weight of these animals when drafted from the hill grazings is 30 lb. It is clear, therefore, that the hill grazings of Scotland produce 42 million lb. of mutton and 10 million lb. of wool on the average per year. For the five million people in the country, that half of Scotland devoted to sheep farming on hill grazings provides the equivalent of only four days supply of calories and protein yearly.

With the increasing urge for greater home production the question arises as to how the productivity of the hill grazings may be increased. At present given over to hill sheep farming, they are stocked almost solely by hill sheep. The basis of this system is the reduction of the stocking of the hills to the number of animals which the grazings can support during the winter months. The Hill Sheep Farming Report gives the number of ewes carried under these conditions as only 2¼ million on the 10 million acres of hill grazing.

The secretary of the National Sheep Breeders' Association has stated that seventy years ago there was a total of 30 million sheep in Great Britain as a whole, which number decreased continuously until 1920. In 1920 after the First World War there were only 20 million sheep in Britain. This figure increased up to 1940, when the number reached about 26 million, but after 1945–46 only 19 million remained. In 1947, largely as a result of the severe winter, the figure has dropped to a record low level of 16 million. "At no time in our history have we ever needed an increase in the supply of good British meat as we do now."

It appears unlikely that the 2¼ million breeding ewes at present carried on the hill grazings could be greatly increased under the hill sheep farming system even if the stocking was stepped up to what it was seventy years ago. It would scarcely double itself and it would appear, therefore, that any great increase of food production from grazings devoted to hill sheep farming should not be looked for.

The truth is that the productivity of the hill grazings is not reflected by the number of sheep sold each autumn. The sheep consume only a small part of the herbage produced on the grazings. Most of it is consumed by a fire which sweeps over the grazing every other spring-time. The herbage should be eaten off by animals and not burned off if productivity is to increase.

Research work has shown the inadvisability of grazing herbage constantly with one species of livestock. The internal and external parasites of the host animals increase in numbers until they become a serious menace. Many of the stock may actually die after years of decreased productivity on the grazing.

Furthermore, the amount of herbage produced per annum is greatly reduced owing to the constant grazing of the animals. Stocked as they have been for centuries to their full carrying capacity during the winter months, the spring flush of herbage, although still marked, has been greatly checked by the hard grazing in winter. Cattle are the species of livestock of choice which must return to the hills in much greater numbers than ever before. It is suggested that the hill land of Scotland be devoted principally to beef production or to dairying.

With the increase of home food production since the outbreak of the War, five herds of beef cattle of about a hundred breeding cows each have now been maintained throughout the year on grazings in West Perthshire since 1939. Although the acreage of grazing allotted to these animals is more than might be desired if maximum food production is the aim, it is interesting to note that the sheep stock has not decreased as many farmers appeared to expect, but has actually increased since the cattle were introduced. The animals remain on the hill all the year round but receive some fodder—straw or hay—from January until April. During this period the amount of herbage which is available on the grazing is very limited and the animals would probably fare much better if fed indoors. Their loss of condition during the early months of the year does not, however, appear to affect the calving percentage of the herd, which is the chief consideration. The progeny are taken off the hills in the autumn for fattening off on low ground.

The hill sheep farming system as practised at present on some of the grazings has been traced back to medieval times, when the chief consideration of the monks was wool production per abbey[2] and not maximum food production per acre. The whole object of 'hill farming' has changed in the interval.

After the 1947 experiences on hill grazings, it would appear that even the sheep stocks should be removed to lower ground from January and fed from the flush of herbage of the previous summer preserved either as hay, silage or dried grass. *All* grazings on hill land would benefit by at least two months rest in late February, March and April. It has been shown by Edinburgh parasitologists that large numbers of worm larvæ are picked up on the hill at this time and the mature worm burden rises to its maximum during June. It would appear that the food for the hill stock during the early months of the year should consist mainly of silage, hay or dried grass gathered from the previous summer flush of herbage on enclosed hill land. Recent experiences in Argyllshire and West Perthshire show that dairying can be conducted successfully on hill grazings, while the outdoor bail system has also proved successful in Morayshire and Fife. Ernest attempts should be made to extend the milk production of the country to hill land. A price incentive would be required and it is suggested that, after industry can supply all the equipment such as milking bails, material for covered courts, fencing, etc., dairying on arable land in Scotland should be discouraged and hill dairying encouraged by price regulation, say, 1*s*. 6*d*. per gallon for milk produced on arable land and 2*s*. 6*d*. per gallon for milk produced on hill land.

Such an enterprise, largely on hill land in West Perthshire, not only provided for the requirements of four local village communities but also exported milk to the industrial areas. On the other hand, Highland communities in proximity to which no dairying is practised obtain their milk supply from the arable and dairying areas of the Lowlands or from Ireland during the winter months. 'Milk from the Mountains' —the motto on the milk bottles of the Perthshire pioneers—would appear to be the policy for the hill grazings.

It was recommended by the Departmental Committee, appointed by the Secretary for Scotland in 1909, in its report on livestock and agriculture in the congested districts of the Highlands[3] that, where considered advisable, assistance be given in changing the cattle to a dairy breed. "Some districts appeared suitable for dairying—and dairying would pay infinitely better than their present system." "In many districts there was a dearth of milk during the winter and the children suffered therefrom."

Instead of the 4 lb. of mutton per acre which at present the hill grazings produce, we could have 50 lb. of beef or 50 gallons of milk; these latter standards are at present being attained on hill land. It is suggested that *in addition* 10 lb. of mutton per acre might be produced if hill grazings of Scotland were properly farmed instead of being ranched as they are at present.

[1] Report of the Committee on Hill Sheep Farming in Scotland (H.M. Stationery Office, 1944).

[2] Fraser, Allan H. H., "Economic Aspects of the Scottish Sheep Industry", *Trans. Highland and Agric. Soc. Scotland* (5th Series), 51, 39 (1939).

[3] Report of the Departmental Committee on Livestock and Agriculture in the Congested Districts in Scotland (Cmd. 5457) (H.M. Stationery Office, 1910).

THE STATUS OF THE PROTOZOA[*]

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II

Death in Protozoa and Metazoa

It has been said by opponents of the cell-theory that since a single protozoon corresponds with a whole metazoon and not with a single cell, one might expect to find in Protozoa something corresponding to somatic death; and this is supposed to be represented by the degeneration of the macronucleus in Ciliophora and by comparable processes in certain Sporozoa[14]. It is necessary to consider the significance of this degeneration. The macronucleus of Ciliophora, as we have seen, must be assumed to contain the same gene-complex as the micronucleus, in polyploid form. But the degeneration of the macronucleus is particularly prone to occur precisely when the gene-complex of the micronucleus is changed, whether by conjugation or endomixis. The macronucleus is then replaced by a new one, containing the new gene-complex, presumably in highly polyploid form. Now it is supposed that the significance of conjugation and of endomixis is the origin of a new gene-complex. The necessary result of the degeneration is that the individual ciliate does not possess both the old and the new gene-complex, but *only the new*. If the old macronucleus were retained, it would swamp the effects of the new gene-complex, possessed by the reconstituted micronucleus. This, then, is surely the significance of the degeneration of the old macronucleus.

There is nothing that corresponds exactly to this process in Metazoa; but the degeneration of the chromatin in polar bodies is functionally similar, for if the genes contained in these bodies were retained in the egg, the old (diploid) gene-complex of the mother would co-exist, after fertilization, with the new (haploid) one brought in by the spermatozoon. One may, if one chooses, draw a rough comparison between the degeneration of the macronucleus and that of the chromatin of polar bodies; but there is neither homology nor functional correspondence with the death of a metazoon. In death there is decay of the whole of the protoplasm, not of the chromatin only; and in the ciliates the chromatin of the macronucleus does not appear even to be excreted. Roskin[15] has shown that the macronucleus of *Paramecium* may contain a considerable amount of ribose-nucleic acid, and it seems that at 'degeneration' there is a distribution of this substance throughout the organism. The most likely hypothesis is that 'degeneration' involves conversion of desoxyribose-nucleic acid into ribose-nucleic acid, with break-up of the chains of genes. There is evidence from Metazoa that desoxyribose- and ribose-nucleic acids are interconvertible, and it is likely that the ribose-nucleic acid dispersed through the body after degeneration may be built up into the 'chromatin' of the new macronucleus. This matter urgently requires investigation. There is nothing resembling death in the changes that are known to occur in the degeneration and reformation of the macronucleus. Death is a familiar process in the Protozoa, despite their potential immortality; and when it occurs, it shows no resemblance to degeneration of the macronucleus.

A Comparison between the Cleavage of Eggs and the Division of Protozoa

Those who deny that a protozoon can ever be regarded as a cell lay stress on a supposed difference between cleavage of an egg on one hand and the multiplication of a protozoon by division on the other. It is suggested that while the cleavage furrows are dividing the egg, the latter is being passively partitioned and the blastomeres are not increasing in volume, while in the Protozoa there is no mere partitioning by furrows, but a regular alternation between phases of division and phases of growth and differentiation. Actually it is doubtful whether any hard and fast distinction can be drawn between the two processes. When a protozoon is multiplying rapidly, the size becomes reduced. When division occurs within a cyst or firm cell-wall, for example, in *Chlamydomonas*, the size of the products of division is reduced just as in cleavage. To speak teleologically, the cleaving egg has generally no reason to grow, because sufficient food-substances have already been stored up inside it to last until a multicellular food-gathering apparatus has been formed. In some cases, however, the reserve food to be used by the embryo is external to the egg, and in such cases the blastomeres do grow, and may separate from one another in so doing and become irregular in form. This has been known for a long time. Growth of blastomeres was remarked by van Beneden[16] in the cleavage of *Tænia serrata*. The phenomenon is particularly clearly exhibited by some of the Turbellaria. For example, Hallez[17] found that if the volume of the egg of *Paravortex cardii* be taken as unity, that of the two-cell stage must be represented by 1·33 and that of the blastomeres of the four-cell stage by 5. In other words, each blastomere is now larger than the egg was: there has been even more growth than would have been characteristic of a protozoon. A similar state of affairs, though with less growth, is seen in the cleavage of the summer eggs of another rhabdocœl, *Bothromesostomum personatum*[18]. The most striking example of all is provided by the triclad, *Dendrocœlum lacteum*, for here the blastomeres are irregular in shape and lie quite

[*] Continued from p. 551.

separately from one another in a fluid derived from the yolk-syncytium; and they grow between one division and the next, so that the total volume is greater at the later stages of cleavage[19]. Since the blastomeres increase in size, are separate, and do not maintain a spherical shape, their resemblance to Protozoa is striking. There are, in fact, all gradations between *cleavage by partitioning* on one hand and an *alternation between phases of growth and of division* on the other; and all these gradations occur *both in Protozoa and in Metazoa.* No valid distinction between cells and not-cells can be drawn on the basis of differences of this sort.

Evolution of Metazoa from Protozoa

These considerations may be applied also to the evolution of Metazoa from simpler forms. There are those who consider that Metazoa originated by the failure of Protozoa to separate after division, while others insist that the many-celled condition arose by the appearance of partitions in a protozoon, and that until these partitions were formed, there was no such thing as a cell. Since there is no palæontological evidence and no one has ever seen a metazoon originate in evolution, this is not a matter on which certainty can be reached; but, as we have just seen, some Metazoa certainly originate in ontogeny in one way and some in the other, while others show an intermediate condition; and this shows that the two extremes are not alternatives, but the end-points of a series.

Dobell[20] has written, "The succession of individuals formed from one conjugation to the next is not comparable with a metazoan body any more than a swarm of bees is comparable with an elephant", and again, ". . . it is clear that a protist is no more homologous with one cell in a metazoon than it is homologous with one organ (for example, the brain or liver) of the latter". One must agree that a single elephant does not correspond with a swarm of bees: only a herd of elephants would be at all comparable. But the argument suggests that it is unthinkable that individuals should associate together to form an organism exhibiting a new grade of individuality. It is clear that bees could not do so, because their firm, chitinous external surface does not lend itself to the adhesion of one individual to another, and their organisation is such that they would be seriously incommoded in their activities by such adhesion; this kind of association is only to be expected in more plastic forms and in groups that possess the faculty of asexual reproduction. In such groups the association of individuals of one grade to form an individual of a higher does, of course, occur. Integration of this kind probably reaches its climax in *Pennatula.* No one who is familiar with the anatomy of this animal can doubt that each constituent polyp is comparable to a single *Haimea* or *Hartea* (or, to take a more familiar but less closely related form, *Hydra*). Yet the polyps of *Pennatula* are differentiated in structure in relation to their separate functions, their activities are integrated together, and the whole compound organism has even taken on a marked bilateral symmetry.

Now it would clearly be wrong to compare a single *Haimea* with a whole pinna of *Pennatula,* which consists of many polyps. This would be like comparing a single protist with the brain or liver of a metazoon. But there is no more absurdity in comparing a unicellular protist with a single cell of a metazoon than in comparing a single *Haimea* with a single polyp of *Pennatula.* Error could only arise if one were to choose a non-cellular protist, such as a radiolarian or ciliate, when making the comparison.

There has been some tendency for two separate questions to be confused. One may ask: 'Did Metazoa originate by the adherence of Protozoa after division?' To this no certain answer can be given, because no observations bearing directly on the point have ever been made. One may also ask: 'Is it logically conceivable that Metazoa originated by the adherence of Protozoa after division?' There can be only one valid answer to the second question, and that answer is 'Yes'. The suggestions to the contrary that may be found in the literature are not backed by evidence.

It may be remarked that while such forms as *Volvox* raise a storm of controversy among zoologists, they are not regarded as unusual by botanists, who are familiar with such colonial forms in groups other than the phytomonads. Botanists regard them as composed of cells, which are comparable on one hand with the individuals of what they call unicellular species, and on the other with the cells of higher but related forms, in which there is somatic differentiation (heterotrichous forms and other algal metaphytes).

If we seek the reason why zoologists are more divided in this controversy than botanists, we shall surely find it in a fundamental difference between plants and animals. In the lower plants *each group* tends to present both unicellular and metaphytic representatives, and botanists are repeatedly confronted with the intermediate forms. Metaphytes, in fact, have obviously originated independently many times, so that no one would propose the word 'Metaphyta' in any classification that was supposed to be based on evolutionary principles. With animals it is far different. Zoologists have not got intermediates again and again before their eyes. In the great group of Rhizopods, for example, there is no example of a multicellular form (the word 'cell' being here used as defined on p. 549). It would not appear that anyone has discussed the reason for this striking difference between plants and animals. The following suggestion may be made. The unicellular plant absorbs nutriment from all sides equally, and when, in the course of ontogeny or phylogeny, it becomes a metaphyte, there is no fundamental change in this respect: a cell divides without separation and the two products continue to absorb nutriment over most of their surfaces. The passage from the unicellular form to the metaphyte is therefore easy. In the case of animals, however, there is an important change when a unicellular form becomes a metazoon: a *new method* of feeding must be adopted. We see this particularly clearly in the ontogeny of *Dendrocœlum.* The blastomeres feed at first saprozoically, but at last a profound change occurs: a set of digestive organs originates, and a new method of nutrition begins. Most animals overcome this difficulty in ontogeny by placing enough reserve foodstuffs within the single-celled stage to make feeding unnecessary. It is easy to see what evolutionary difficulties must be presented when a *new system* of nutrition must be acquired before advance can occur. The difficulties would be greatest when a protozoon had a localized mouth. If the products of division of such an animal were to adhere together and each were to acquire its own mouth, no advance would be made towards the evolution of a metazoan alimentary canal. This suggests that the Metazoa may have arisen from primitive Protozoa, unprovided with localized organs of assimilation. These considerations seem to make it clear why intermediates between unicellular animals and Metazoa are rare, while intermediates between unicellular plants and metaphytes are common. (The colonial phytomonads are, of course, only regarded as animals by zoologists on account of their motility: their nutrition, it need scarcely be said, is holophytic or saprophytic.)

I acknowledge the help given by many friends in the course of conversation. In particular, I must thank Prof. A. C. Hardy, Dr. S. M. Manton and Dr. C. F. A. Pantin for valuable advice (though they must not be regarded as responsible for any opinion here expressed).

Summary

(1) A cell is defined as a mass of protoplasm, largely or completely bounded by a membrane, and containing within it a single nucleus formed by the telophase transformation of a haploid or diploid set of anaphase chromosomes.

(2) It is argued that many algæ and Protozoa are properly regarded as unicellular organisms.

(3) Certain Protozoa, notably the Radiolaria and Ciliophora, are not cells in the sense of the definition given above.

(4) It is argued that there is no fundamental difference between the cleavage of an egg and the multiplication of a unicellular protozoan by division.

(5) It is not unlikely that Metazoa may have arisen by the failure of unicellular Protozoa to separate after division.

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THE BORDERLINE OF PSYCHOLOGY, PHYSICS AND MUSIC

At a meeting of the Acoustics Group of the Physical Society, held in the Science Museum, South Kensington, on February 12, three speakers contributed to a symposium on "The Borderline of Psychology, Physics and Music". The chairman was Mr. H. L. Kirke, head of the Research Department of the B.B.C. and chairman of the Acoustics Group.

Prof. Balth. van der Pol was the first speaker and he dealt with three problems: (*a*) the mathematical theory of consonance; (*b*) intonation from a purely musical point of view; and (*c*) absolute pitch.

In his discussion of the mathematical theory of consonance, Prof. van der Pol directed attention to the work of Leonhard Euler, who, in 1739, gave in his "Tentamen novæ theoriæ musicæ" a rigorous numerical measure for the "gradus suavitatis" or euphonic value of consonances and dissonances. This measure was the ratio of the least common multiple to the greatest common divisor of the frequencies of the component notes. Prof. van der Pol showed a table of the euphonic values of twenty-four 2-note, six 3-note and two 4-note combinations. It was clear that these euphonic values corresponded with the purely musical impressions of the relative consonances of the intervals and chords in question. The euphonic values of several familiar intervals are: unison, 1; octave, 2; twelfth and fifteenth, 3; fifth, 4; fourth, 5; tenth and eleventh, 6; greater sixth, 7; lesser and greater major second and lesser sixth, 8; lesser and greater seventh, 9; lesser major second and augmented seventh, 10.

Both Euler and Huygens suggested the introduction into music of the prime number 7, as all musical intervals used before could be represented by $2^l 3^m 5^n$, which led Leibnitz to state that musicians could count up to five only. Both suggested the dominant seventh chord: $g\ b\ d'\ f' = 4, 5, 6, 7$. The seventh of this chord, however, is too flat for musical purposes, as Prof. van der Pol demonstrated with an oscillator, with which he sounded the notes both separately and together. He showed that the chord 36, 45, 54, 64, the diatonic dominant seventh, is musically satisfying. The euphonic values of these two chords are 15 and 17, and it is clear that musicians would prefer the more dissonant of the two for æsthetic reasons.

On the matter of intonation from a purely musical point of view, Prof. van der Pol put forward the idea that the pitch of a note played is legitimately variable to a certain extent at the performer's discretion, just as the executant has some freedom in the matter of rhythmic interpretation. The intonation of *E* in the chord of *C* major may depend on its function as the third of the chord. In brilliant music, a sharp (Pythagorean) third will accentuate the typical and unmistakable quality of a major chord. Probably Beethoven was aware of this, though without knowledge of the underlying mathematical theory, when he indicated in the last movement of his Fifth Symphony, that the second note of the first bar should be an open *E* string. Similarly, in the main theme of Wagner's Meistersinger overture, also in *C* major, a sharp third should be played. The pitch of a note and its effect will, in fact, depend on the musical context.

A low third (the diatonic 5 : 4) will be appropriate in soft and floating music such as a lullaby. The leading note of the dominant seventh, thrusting towards the tonic, is not seldom sung too high, and often, indeed, the composer anticipates the tonic in his closing harmony. A Neapolitan sixth (*D*♭ in the chord *F*, *A*♭, *D*♭, in *C* major or minor) can, with advantage, be sounded low, because it leads down to the tonic.

Prof. van der Pol concluded with an account of experiments on the measurement of changes in absolute pitch, carried out on himself in 1939, with an oscillator by means of which a note of any desired pitch could be produced. During a fortnight, eighteen independent measurements of an *A* were made, as most closely conforming to his absolute pitch for that note. The estimates had a mean value of 435·2 c./s., with a mean deviation of 3·3 c./s. The greatest 'error' was 6·2 c./s., or a quarter tone. He explained that absolute pitch sometimes tends to vary in the course of years. The absolute pitch of a physicist friend of his had fallen 1·5 tones when he was about eighty years of age. Prof. Klein of Utrecht had communicated to him that the absolute pitch of the Dutch composer Wagenaar had remained unchanged up to his death at the age of seventy-nine.

The second contribution to the symposium was made by Dr. R. W. Pickford, who described three experiments on the relation of the impression of dissonance to the context of a chord. All the experiments were done by rating the critical chords on a 7-point scale running from −3 (very dissonant) to +3 (very consonant). Liking and disliking were kept apart, and in the third experiment these qualities were also rated in the same way. In the first experiment, forty women and eight men took part, and twelve chords were rated, each in six different settings and by itself. In the second, forty-three women and seven men rated fourteen chords in all of which the actual notes were identical. They were in settings mostly taken from familiar pieces of music. In the third, forty women and ten men rated fourteen chords in all of which the notes were identical, and which were in settings specially constructed for the experiment. The piano was the instrument used throughout. In the first experiment 'clang' effects were exploited, and in the other two interest was concentrated upon the musical preparation and resolution of dissonances.

It was found that familiar dissonances were given all kinds of ratings from very consonant to very dissonant, but most often they were classed as moderately dissonant, a seventh being classed on the average as less dissonant than a ninth, so that the average results were appropriate to musical expectation. There was a strong tendency for the consonance-dissonance level of chords to vary (*a*) with the context and (*b*) with the individual subjects' peculiarities of musical attitude and experience. Nevertheless, the chords had a strong tendency to retain their relative dissonance-levels in spite of these variations. There was a moderate tendency for liking to go with the impression of consonance, and disliking with that of dissonance. Smooth musical handling of dissonances tended to lead to the impression of consonance and also to liking, but departure from smooth handling led to various other combinations of liking, disliking, consonance and dissonance. The subjects were always astonished when told that they had rated the same note-combinations in different settings.

Helmholtz's theory of fusion appeared to provide the most satisfactory explanation of consonance and dissonance, apart from the effects of musical setting and individual attitudes of listeners. A Gestalt or 'form' theory of the effect upon the dissonance-consonance level of individual chords owing to their integral membership of whole passages or contexts should be added, together with a theory of personal schemata due to differences in musical ability and experience of individual listeners. Further experiments should be carried out on the relative effects of various musical techniques in handling dissonances and of 'clang' effects upon dissonance-consonance levels, and to compare these effects for pure tones and notes of complex timbre.

The third contribution to the symposium was made by Mr. J. Steuart Wilson. He pointed out that there are unfortunate tendencies at present to exploit the performer's capacity to vary the intonation of the intervals he sang or played. This is particularly noticeable in 'jazz' and 'swing', in which it has become an objectionable form of virtuosity. Even among serious musicians, some teachers trained their pupils to vary the intonation in playing classical music to produce special effects. Sometimes this had unfortunate results, because of the variety of thirds, for example, which might be included in a major common chord played by an orchestra. In addition, the liberties taken in 'jazz' and 'swing' had taught the public to like some effects which classical musicians eschewed, with the result that they thought that serious music was intolerably dull when it was really well played.

In the discussion the main speakers agreed that slight adaptations of pitch to suit the musical needs of a passage might be justified, provided that this did not lead to intolerably slovenly performance or to a form of senseless virtuosity. They also agreed that the impression of harshness of a dissonance might be expected to vary according to the way in which it was used. Mr. Steuart Wilson thought it most unfortunate that so many peoples' ideas of musical intervals came from listening to the pianoforte, which was often badly tuned either because nobody looked after it or because there was none to criticize the work of the tuner.

Dr. Dennis Fry pointed out that many people with absolute pitch are able to assign pitch to a sound which, for the majority, seems to be a noise without definite pitch. He asked whether people with absolute pitch might have two abilities, possibly separate in some cases: first, the permanent memory for pitch enabling them to compare pitches without reference to an external standard; and second, the ability to assign pitch to a frequency complex containing strong inharmonic components. In reply, Prof. van der Pol said that it is easier for most persons who have absolute pitch to assign pitches to notes which have many overtones than to pure single tones.

Dr. Fry asked whether the pitch of a given tone of fairly low frequency, say Middle *C*, 261 c./s., is recognized by a person with absolute pitch regardless of its intensity. If not, then at what intensity-level would it become Middle *C*? Also he thought it would be interesting to know what loudness-level of a pure tone of 261 c./s. gives rise to a pitch sensation exactly equal to that of a frequency complex containing a number of terms with a constant difference of 261 c./s. between them. Prof. van der Pol demonstrated the effect of varying the intensity of a given tone with his oscillator, but did not think data were available for answering the questions asked by Dr. Fry. It was suggested by Dr. Pickford that a valuable piece of research could be carried out in which adequate psychological experiments were performed with a large group of persons having various degrees of absolute pitch, in order to find out more about its variations among individuals, which might be very great. He also suggested that the euphonic value of an interval or chord, as defined by Euler, did not in itself determine the dissonance level of that chord. The only way to determine the euphonic value which would correspond to dissonance rather than to consonance would be to study the average of individual judgments and their variability. Most people would think that a euphonic value of 8 was dissonant; but the only way to determine this would be that of experimenting with large numbers of subjects.

R. W. Pickford

OBITUARIES

Prof. M. C. Potter

At the age of eighty-nine, Emeritus Professor the Rev. Michael Cressé Potter died on March 9 at New Milton, Hampshire, where he had lived since his retirement in 1925 from the chair of botany at Armstrong College (now King's College), Newcastle upon Tyne.

In 1877, Potter left the Perse School, Cambridge, and entered Peterhouse, where his father, who was rector of Corley, had preceded him and his uncle, the Rev. Canon Potter, had been a fellow. As, in addition, another uncle, Prof. Richard Potter, was a fellow of Queens', Potter rightly regarded himself as a well-established Cambridge man. He was ardent in support of his University on all public occasions. As an undergraduate he read natural science and graduated in 1881. He then read for the Mathematical Tripos, and in 1883 was classed senior optime. Shortly afterwards he was appointed to the post of assistant curator of the Herbarium under Prof. C. C. Babington, which became vacant through the tragic death by drowning of T. H. Corry. He assisted Dr. Walter Gardiner in re-establishing the University Botanical Museum, which had been founded by Prof. Henslow, and in commencing the preservation of botanical specimens in spirit.

Potter began his academic work when what was then known as the 'new' botany', introduced by McNab at Dublin and by Huxley and Dyer at South Kensington, was coming to the fore, and when practical laboratory investigation was being developed at Cambridge under the direction of the reader, S. H. Vines. He stressed the new ideas, and the economic importance of plants, in the long-vacation course of lectures he gave on systematic botany, and he arranged excursions and laboratory work. He delivered the first course of lectures given at Cambridge on the geographical distribution of plants. On two occasions he was awarded a Wort's travelling scholarship. In 1886 he went to Portugal and made observations on an alga which lived parasitically on the carapace of the water tortoise. In 1888–89 he studied the tropical flora in Ceylon.

In addition to these travels, Potter went to Heidelberg and attended Prof. Pfitzer's lectures there. He thus became familiar with the Continental system of classification, and used it in his lectures on systematic botany. In 1894 he translated and edited Dr. E. Warming's "Handbog i den Systematiske Botanik" in order to introduce this system to English-speaking botanists.

In 1889, after six years of rich experience, Potter took up a lectureship in botany and biology at Newcastle upon Tyne. In his first term there were only five students in natural history, none reading for a degree. In 1892 a chair was instituted, and Potter was its first occupant. Potter, who could be a determined man, eventually won his uphill fight to secure the recognition of botany as an independent subject at the intermediate and final pass and honours degree examinations. A measure of the success with which he built is the fact that on his retirement from the chair in 1925 he had four lecturers on his staff, and his department, which was fairly well equipped, could accommodate in reasonable comfort the 167 students of pure science, agriculture and medicine who were then attending courses in it.

The link between the Departments of Botany and Agriculture has always been strong. Potter did much in establishing it. The content of his course for agricultural students is indicated by that of his elementary "Text-book of Agricultural Botany", which was published in 1893. He also took evening classes for farmers and gardeners. He became interested in problems of plant pathology, and his researches culminated in the major discovery in 1899 that white-rot of turnips is caused by a bacterium, which he named *Pseudomonas destructans*. In his presidential address to the British Mycological Society in 1909 he gave the evidence that led to the recognition of bacterial diseases of plants, and placed his contribution in its historical setting. His interest in plant pathology and economic mycology was maintained throughout his life, and the subject received much attention in the curriculum he devised for students in science and in agriculture at Newcastle.

As a teacher and examiner, Potter laid great emphasis on experimental physiology. From 1895 (the date of publication of Darwin and Acton's book) onwards, students carried out experiments, even in the elementary agricultural and medical classes and examinations. Potter believed that, in those early days, the University of Durham's schools examination was unique in requiring a practical examination in botany in which each candidate was required to set up and explain a simple experiment and to determine a plant by means of a flora.

Some may regret that after 1910 his main research interest was transferred from plant pathology to electrophysiology, through his reading Dr. A. D. Waller's "Signs of Life". Physicists who knew about his work thought that such effects as he obtained were open to interpretations other than those he put on them. He held tenaciously to the idea that electrical effects accompany metabolism and are of primary importance in determining cellular activity. He may have been right. Who knows ?

During the First World War Potter showed his ardour by acting for a period as a volunteer in a Newcastle signalling unit raised for home defence, and later by taking Holy orders to relieve younger clergymen required by the Forces. Among his hobbies were campanology and dowsing.

M. THOMAS

Prof. E. Waymouth Reid, F.R.S.

THE death of Prof. E. Waymouth Reid in Edinburgh on March 10 has taken from us one of the pioneers of British physiology. Born in 1863 in Canterbury, the son of a surgeon, he was educated in Sutton Valence Grammar School, and went as a classical scholar to the University of Cambridge. After taking a first-class in anatomy and physiology in the Natural Sciences Tripos in 1883, Waymouth Reid worked in St. Bartholomew's Hospital, and graduated M.B. Thereafter he was for a time assistant electrician in St. Bartholomew's, but soon began his life's work as a physiologist, first as demonstrator and then as lecturer in St. Mary's Hospital Medical School. At the early age of twenty-seven he was appointed to the newly established chair of physiology in University College, Dundee, where he joined a body of highly gifted men who held teaching posts in the recently formed College affiliated to the University of St. Andrews. Waymouth Reid served the University for forty-six years, and after his retirement in 1935 the University of St. Andrews conferred upon him an honorary degree of LL.D.

Waymouth Reid showed his ability in the number and versatility of the published records of his research work. He contributed in 1898 noteworthy articles to Schäfer's "Text-book of Physiology" on diffusion, osmosis and filtration, and on secretion and absorption by the skin ; and papers in journals on a diversity of topics. He was made a fellow of the Royal Society in 1889, and later on received the honorary degree of Sc.D. from the University of Cambridge.

Waymouth Reid was especially interested in the physical mechanisms of living processes and kept in touch with modern developments. He was an early worker with X-rays, and investigated their effects on the animal organism, using his own body to its detriment. He was an expert photographer, and his laboratory was at one time richly equipped with apparatus for experimental purposes. At another time he occupied his spare time in the making of elaborate sweetmeats. He was always busy, and everything he did was done thoroughly.

He was largely instrumental in the development of what is now a very big and important concern, namely, the examination and reporting upon pathological material sent in to the College by medical practitioners in Angus, Fife and Perthshire. Much of the early work was done by Waymouth Reid himself, but it became so big that the University Court had to take it over and make special provision for it in the Department of Bacteriology.

Waymouth Reid was a good teacher and did not neglect that side of his Department's work. He was concise, humorous on occasions, and was liked and respected by his students. For some time he acted as dean of the Medical Faculty of the University, and took his share of administrative work. He was for a period one of the editors of the *Journal of Physiology*, a vice-president of the Section of Physiology at the annual meeting of the British Medical Association in 1898, and president of the Dundee Branch during 1903–4. He also acted as external examiner in physiology for the Royal College of Surgeons, the University of Cambridge, and the Royal College of Veterinary Surgeons.

On his retirement Waymouth Reid went to live in Edinburgh, but failing health lessened his activities, though he retained his mental acuity.

P. T. HERRING

WE regret to announce the following deaths:

Prof. F. O. Bower, F.R.S., professor of botany in the University of Glasgow for more than forty years, on April 11, aged ninety-two years.

Prof. Alexander Ogg, formerly professor of physics in the University of Cape Town, and a past-president of the Royal Society of South Africa, on February 23.

NEWS and VIEWS

Institution of Civil Engineers: James Alfred Ewing Medal

ON the joint recommendation of the presidents of the Royal Society and the Institution of Civil Engineers, the Council of the Institution of Civil Engineers has awarded the James Alfred Ewing Medal for 1947 to Sir John Cockcroft, for specially meritorious contributions to the science of engineering in the field of research. The medal is awarded annually and was founded in 1936 in memory of Sir Alfred Ewing. Sir John Cockcroft succeeded Sir Edward Appleton in May 1939 as Jacksonian professor of natural philosophy in the University of Cambridge. During the War he became director of the Air Defence Research and Experimental Establishment of the Ministry of Supply and a member of the Ministry's Advisory Council on Scientific Research and Technical Development. Later he became director of the Montreal Laboratory of the National Research Council of Canada, and of the Canadian Experimental Atomic Research Plant until early in 1946, when he was appointed director of the Atomic Energy Research and Development Establishment, Harwell, Didcot, formed under the Ministry of Supply to deal with all aspects of the use of atomic energy. He has published various papers on nuclear physics and also on technical subjects. In 1936 he delivered the thirty-seventh Kelvin Lecture before the Institution of Electrical Engineers, taking as his subject "The Transmutation of Matter by High-Energy Particles and Radiators". In 1946 he received the Hopkins Prize from the Cambridge Philosophical Society for researches carried out during the period 1933–39 on the artificial transmutation of elements. Sir John Cockcroft has been concerned with most of the major achievements of the Cavendish Laboratory during the past sixteen years, his advice having been sought on the design of much of its special equipment; he took a leading part in the construction of the cyclotron at Cambridge.

Hatfield Memorial Lecture of the Iron and Steel Institute: Prof. Robert E. Mehl

THE third Hatfield Memorial Lecture of the Iron and Steel Institute will be delivered in London on May 5, in connexion with the annual general meeting of this Institute, by Prof. Robert E. Mehl, of the Carnegie Institute of Pittsburgh. Prof. Mehl, who was born in Lancaster, Pa., on March 30, 1898, received his early training at Franklin and Marshall College, Lancaster, Pa., proceeding eventually to Princeton University, and, as a national research fellow, to Harvard University. He then became superintendent of the Division of Physical Metallurgy at the Naval Research Laboratory, Washington, D.C. (1927–31), inaugurating this division. In 1932 he became director of the Metals Research Laboratory and professor of metallurgy at the Carnegie Institute of Technology, Pittsburgh, Pa., and in 1935 head of the Department of Metallurgical Engineering in the Institute. Prof. Mehl has published many papers on the constitution of alloys, crystal structure, radiography, the electron microscope, the properties of forging steels, general metallurgy, theory of age-hardening, heat-treatment of steel, etc. He translated Gustav Tammann's book on "The States of Aggregation" (1925) and published his own book on the "Metallurgy of Iron and Steel" (in Portuguese) in Sao Paulo in 1944. His "History of Physical Metallurgy" was issued this year by the American Institute of Mining and Metallurgical Engineers.

Royal Zoological Society of Scotland

THE President and Council of the Zoological Society of Scotland have been informed by the Secretary of State for Scotland that the King has been graciously pleased to grant to the Society the privilege of prefixing the title "Royal" to its name, so that the proper title of the Society is now the Royal Zoological Society of Scotland. The Society, which is of national status, was formed in 1909 and was incorporated by Royal Charter in 1913, when the Scottish National Zoological Park, which it owns and controls, was founded. The Park has had the honour of several Royal visits and has been the recipient of a number of Royal gifts of animals.

August Gärtner (1848–1934)

Nestor of German hygiene, August Anton Hieronymus Gärtner, whose name is familiar to every medical student in Gärtner's Bacillus (*Salmonella enteritidis*), was born on April 18, 1848, at Ochtrub, Westphalia. He served in the Franco-Prussian War of 1870–71, and in 1884 became assistant to Robert Koch at the Kaiserliche Gesundheitsamt, Berlin. Two years later he was appointed to the chair of hygiene at the University of Jena, which he held until his retirement in 1914. As a teacher he was immensely popular, his genial personality endearing him to students and colleagues alike. It was in 1888, during an outbreak of meat poisoning in Frankenhausen on the Kyffhäuser, that he succeeded in growing the bacillus ever since known by his name. To the literature of hygiene he contributed his classic "Die Hygiene des Trinkwassers (1897), "Die Hygiene des Wassers" (1915), and, in co-operation with Ferdinand Tiemann, "Handbuch der Untersuchung und Beurteilung des Wassers" (1889–95). His "Leitfaden der Hygiene" was first published in 1892; a tenth edition was issued in 1923, and a French translation in 1895. In the First World War Gärtner served as 'Kriegssanitätsinspekteur' of prisoner-of-war camps. Preserving excellent health into advanced age, he died at Jena on December 21, 1934, in his eighty-seventh year. His autobiography appeared in *Centralblatt für Bakteriologie*, 107, 1, ii (1928).

Royal Aeronautical Society: Awards

The following medals and awards have been made by the Council of the Royal Aeronautical Society: *Society's Gold Medal*: Sir Bennett Melvill Jones, for his outstanding work in aerodynamics; *Society's Silver Medal*: I. I. Sikorsky, for his work on the development of the helicopter; *Society's Bronze Medal*: Miss F. B. Bradfield, for her work on aeronautical research; *Simms Gold Medal*: Sir William T. Griffith, for his paper "The Problem of High Temperature Alloys for Gas Turbines"; *George Taylor (of Australia) Gold Medal*: Dr. J. W. Drinkwater and W. G. Glendinning, for their paper on "The Risk of Fire and Fire Prevention Methods"; *Edward Busk Memorial Prize*: Air Marshal the Hon. Sir Ralph Cochrane, for his paper on "The Development of Air Transport During the War"; *R.38 Memorial Prize*: W. M. Widgery, for his paper on "Pressurisation of Aircraft"; *Branch Prize*, awarded for the best paper on an aeronautical subject read before the branches of the Society: A. N. Clifton, for his paper on "Naval Aircraft" read before the Southampton Branch, and J. A. Kirk, for his paper on "Wind Tunnels" read before the Belfast Branch.

Courtaulds' Scientific and Educational Trust Fund

Messrs. Courtaulds, Ltd., have announced the formation of the Courtaulds' Scientific and Educational Trust Fund, which has been formed with the object of encouraging study and research in those branches of natural science likely to assist the textile, plastics or other allied industries. The Fund provides for the establishment and maintenance of scholarships, and the provision of laboratory apparatus and equipment for education and research institutions. The Company will pay to the trustees the sum of £105,000, less tax, over a period of seven years. The trustees are Sir Edward Appleton, Sir Charles Tennyson, and, representing Courtaulds, Ltd., Mr. J. C. Hanbury-Williams (chairman), Mr. R. A. Butler, M.P., and Mr. R. A. Kinnes. The Trust will be administered by a management committee of representatives from the Company, together with Prof. C. N. Hinshelwood (University of Oxford), Prof. D. M. Newitt (University of London), and Prof. J. B. Speakman (University of Leeds).

Atomic Energy Commission Fellowships

The U.S. National Research Council has announced a new programme of fellowships supported by funds provided by the Atomic Energy Commission as a part of the Commission's responsibility for future atomic energy research. These fellowships will be awarded in the many fields of science related to research in atomic energy and the products of atomic energy processes. Some of the fellowships are available to those who wish to continue in graduate training or research for the doctorate in an appropriate field of science; others will provide training in biophysics applied to the control of radiation hazards. Further fellowships will be awarded to candidates less than thirty-five years old who have already obtained a doctorate and who wish to secure advanced research training and experience in aspects of the physical, biological and medical sciences related to atomic energy. The programme provides for two groups of fellows in the pre-doctoral field. One group will work in the biological and basic medical sciences, including applied biophysics, relating to the measurement and control of radiation hazards and the effect of radiation upon health; another group will be selected for study and research in the general field of the physical sciences. Awards will be made for the academic year 1948–49. Further information can be obtained from the Fellowship Office, National Research Council, 2101 Constitution Avenue, Washington 25, D.C.

American Summer Scholarships for European Students

The Massachusetts Institute of Technology, in co-operation with the students at the Institute, is offering approximately eighty scholarships to European students for study there for the period June 14–September 17. A certain proportion of these scholarships have been reserved for students in Great Britain. Any science or engineering student, male or female, who has completed approximately four years of university study, or any person who has recently graduated in the fields of science or engineering, is eligible; applicants must be more than thirty-five. All expenses will be paid by the Institute, with the exception of the cost of the trans-Atlantic passage, which may cost approximately £70 for the round trip. The summer seminar offers advanced courses in civilian and sanitary engineering, mechanical engineering, metallurgy, aeronautical engineering, architecture and planning, building engineering and construction, chemistry, electrical engineering, physics and chemical engineering. Further information concerning the subjects of instruction can be obtained from the Chief Scientific Officer in the United States Embassy, 5 Grosvenor Square, London, W.1. The last date for submission of applications is April 30.

Discovery of a Living *Metasequoia* in China

UNDOUBTEDLY one of the most interesting recent additions to our knowledge of the Chinese flora is the discovery of a 'new' conifer thought to be congeneric with Mesozoic fossil forms originally ascribed to *Sequoia* but now placed in a separate genus *Metasequoia*, as *M. Heerii*, *M. japonica*, *M. disticha* and *M. chinensis*. The living species of *Metasequoia* was discovered in north-eastern Szechwan in 1945, but is now known to occur more abundantly in Hupeh province. It occupies, however, only a limited area, and there is a grave danger that felling of the trees may lead to its extinction. Thanks, however, to the enterprise of the Arnold Arboretum of Harvard University and the co-operation of Chinese botanists, a special expedition last year obtained an ample supply of seed, and seedlings are now being raised in Britain as well as in the United States. The tree grows to a height of at least 115 ft., with a trunk diameter of at least 7½ ft., and is deciduous. In general appearance it is not unlike a *Glyptostrobus*. An account by Prof. E. D. Merrill of the discovery and introduction of this new *Metasequoia* has recently been published in *Arnoldia* (8, 1; March 1948).

British Fauna

THE Linnean Society of London is to be congratulated upon initiating a very useful piece of work in its "Synopses of the British Fauna", of which the first number was published in January 1944 and the most recent, No. 7, in 1947. The need for such synopses, particularly in the groups which do not attract the ordinary collector, like, say, Lepidoptera and Coleoptera, has long been felt by zoologists, naturalists and ecologists. The numbers so far published in order of appearance are: (1) Opiliones; (2) Caprellidea; (3) Gammaridæ; (4) Freshwater Bivalves; (5) Freshwater Bivalves (Unionacea); (6) Lumbricidæ; and (7) Talitridæ. The synopses are well printed, illustrated and provided with keys which in the two groups that have been used by the reviewer on several occasions are not difficult to use and do work. The price is reasonable, 2*s*. 6*d*., save for the largest, which is 5*s*. Individual numbers will naturally appeal to workers in their particular fields; but no institution that is likely to be concerned, however remotely, with faunistic work can afford to be without the complete set. It is to be hoped that the paper restriction will not slow down the rate of publication, or lead to the printing of insufficient copies of these synopses.

Research at the University of Birmingham

THE eighteenth annual report of the Joint Standing Committee for Research of the University of Birmingham, which covers the sessions 1938–39 to 1946–47, is a reference document of exceptional interest. The first section, covering the years from 1938–39 to 1945–46, gives a summary of the research carried out in the various departments of the Faculties of Science, Arts, Medicine and Commerce and also by the University Library, the Board of Research for Mental Disease, the Cancer Research Laboratory, and the Radiotherapy Department, Birmingham United Hospital. The summaries or notes on these researches are supported by full lists of publications under the Departments concerned. The second section of the report, covering the session 1946–47, in addition to a like list of publications embodying results of research completed in 1946–47, lists the personnel of the Committee, the research funds available for the session 1946–47, the conditions and procedure relating to applications for grants, th subjects of research towards which grants-in-aid have been made by the Committee and also other subjects of research during the session.

Atmosphere of Mars

THE December issue of *Sky and Telescope* contains a short note on the atmosphere of Mars which describes the work of Dr. G. P. Kuiper of the Yerkes and McDonald Observatories, on this subject. Using an infra-red spectrometer employing a Cashman lead-sulphide cell a thousand times more sensitive than any previous instruments of this type Dr. Kuiper has examined the spectra of celestia objects at wave-lengths of 1–2·5 microns, and has found that the atmosphere of Mars contains at least as much carbon dioxide as does the earth's atmosphere. Methane and ammonia appear to be absent. Dr. Kuiper believes that the Martian polar caps are probably ordinary snow and clouds of water vapour, and he was hoping to test this on February 17 when Mars was at opposition and near aphelion. If the polar cap visible at that time is sufficiently large for his test, it will be possible to measure the amount of water vapour on the planet with the new instrument.

Catalogue of Medical Films

THE Catalogue of Medical Films compiled by the Royal Society of Medicine and the Scientific Film Association, which are referred to in the catalogue as RSM and SFA respectively (ASLIB, 52 Bloomsbury Street, W.C.1, 1948. 7*s*. 6*d*. and 6*s*. to members of ASLIB and SFA), is a very useful small volume. It is the outcome of collaboration, suggested by the Royal Society of Medicine when it was considering the formation of a library of medical films. By March, 1946, more than 1,200 titles of films had been collected from lists held by commercial firms, medical schools and societies, university departments and private individuals. All the material thus collected has been entrusted to the care of the Scientific Film Association, to which all inquiries about it should be addressed (34 Soho Square, London, W.1). Eight hundred of the films have been viewed, and Part 1 of the catalogue groups them by subjects and catalogue numbers. Part 2 gives details of the availability of two hundred of the films. It shows that they come from various sources in Britain, Europe and the United States, and range from elementary instructional films suitable for health education of the lay public to films of difficult surgical operations and similar subjects suitable only for medical and scientific audiences. All the films listed in Part 2 are available, and more than one copy of each exists. Many other films not listed in Part 1 are also now available, and details of these can be obtained from the medical cataloguer of the Scientific Film Association.

Origins of Central American Culture

IN "Some Implications of the Ceramic Complex of La Venta" (*Smithsonian Misc. Coll.*, 107, No. 8), Dr. Philip Drucker presents an interim report on this important site in southern Mexico. The name has recently been applied to an early culture found at this and neighbouring sites, but he prefers the older term 'Olmec', which was abandoned owing to its association with a tribe inhabiting the area in historic times, because La Venta does not provide the most complete succession. The La Venta ceramics correspond, in fact, to the middle period only of the succession at the neighbouring site of Tres Zapotes. He gives an outline of the distribution of the culture, the centre of which is on the Gulf Coast of the Isthmus of Tehuantepec, showing how closely it is restricted in at least two directions by geographical obstacles. There is reason for believing that its markedly individual and well-known characteristics, which are seen in the sculpture rather than in the pottery, are due to development in place and not to outside stimuli. This conclusion is very important, since it cuts at the root of the idea, recently repeated in Morley's new book on the Maya, that that talented people was the fount of all Central American civilization.

Indian Society for Quality Control

An Indian Society for Quality Control, "to promote the advancement and diffusion of knowledge of the science of Quality Control and of its application to industrial processes", has been formed at Calcutta. A committee consisting of engineers, industrialists and statisticians has been set up to conduct the affairs of the Society. Mr. B. K. Rohatgi (director, India Fans, Ltd., and president of the Engineers Association of India) is president, and Prof. P. C. Mahalanobis is among the members of committee. Mr. R. D. Vidyarthi (102-A, Netaji Subhas Road, Calcutta) and Mr. N. T. Mathew (Indian Statistical Institute, Presidency College, Calcutta) are secretaries.

National Research Council of Canada: Publications

The second edition (1947) of Publications of the National Research Council of Canada (Ottawa) lists by authors and subjects all papers issued by it up to the end of 1946, these lists merely citing, however, the serial numbers of the publications in the "N.R.C." series. The major part of the document consists of a serial list of these publications, giving the full title, bibliographical reference if published elsewhere and the price of the reprint or paper in the N.R.C. series, up to number 1412. The *Canadian Journal of Research* has its own volume and number series, and for this reason is not included in the "N.R.C." series, although reprints of certain papers from it have been included.

Announcements

Prof. R. C. Punnett, formerly Arthur Balfour professor of genetics in the University of Cambridge, and Prof. A. H. Sturtevant, professor of genetics in the California Institute of Technology, Pasadena, California, have been elected honorary members of the Genetical Society of Great Britain, in recognition of their outstanding contributions to the science of genetics.

Dr. G. S. Hartley has been appointed research manager of Messrs. Pest Control, Ltd., Harston, to take charge of the Chemical Research Department. The company's research programme has for some time been devoted to the development of helicopter spraying, the formulation of aero spray chemicals and the development of selective insecticides to supplement biological control by chemical control on agricultural and horticultural crops in Great Britain, Europe and Africa.

Mr. R. H. Myers, head of the Steelmaking Division of the British Iron and Steel Research Association, has retired on account of ill-health. He is succeeded by Dr. A. H. Leckie, formerly deputy head of the Division.

The Challenger Society is prepared to consider applications for small grants in aid of research in marine biology or oceanography at a recognized laboratory during the year June 1948–June 1949. Applications, accompanied by details of the proposed research, should reach the Honorary Secretary, Mr. Dilwyn John, British Museum (Natural History), London, S.W.7, before the end of May.

Applications are invited for the John Gray Jubilee Scholarship of the Society of Chemical Industry, value £150, tenable for one year at any approved university or technical college. Candidates, who may be of either sex, should be graduates in chemistry whose intention is to enter industry, but those awaiting the result of their final degree examination may apply. Preference will be given to the son of a member of the Society of ten or more years standing. Applications must be made before July 10 to the General Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

A Busk studentship in aeronautics will be awarded during June. The studentship is of the value of about £165, tenable for one year from October 1; but a student may be reappointed on the same terms for a second year. It is open to any man or woman being a British subject and of British descent who has not attained the age of twenty-five years on October 1. Forms of application for the studentship, to be returned by June 1, can be obtained from the Professor of Aeronautical Engineering, Engineering Laboratory, Cambridge.

The first post-war exhibition of German books, periodicals and newspapers from all the occupied zones will be opened by Lord Pakenham on April 19, at 4 p.m., at the Academy Hall, Oxford Street, London, and will remain open for a week. The exhibition is being organised by European Periodicals Publicity and Advertising Co., Ltd., 2, 3 and 5 Studio Place, Kinnerton Street, London, S.W.1, with the view of stimulating the flow of scientific and cultural works from Germany to the rest of the world.

A short course for teachers of chemistry in technical colleges will be held at the Sir John Cass Technical Institute, London, E.C.3, during July 5–16. The main substance of the course will be the theory and practice of micro- and semimicro-inorganic analysis; spectroscopic analysis; small-scale organic preparative methods; electrochemical methods of analysis. There will also be lectures and discussions on teaching methods and recent developments. Visits to works will be arranged. Forms of application may be obtained from any local education authority for further education, or from the Ministry of Education (Short Courses), 14–22 Lennox Gardens, London, S.W.1. The closing date for application is May 15.

We have received from Messrs. Plant Protection, Ltd., Nobel House, London, S.W.1, a well-produced booklet on their 'Agrocide' range of insecticides. These are based on the synthetic compound 'Gammexane' discovered by Imperial Chemical Industries in 1942. In order that 'Gammexane' may be used in the most economical and efficient manner, Plant Protection have formulated its mixture with powders, solvents, etc. The results described are extremely encouraging and include the control of diverse insect types attacking a wide range of crops in many parts of the world.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Velocity of Meteors Measured by Diffraction of Radio Waves from Trails during Formation

IT is now well established that when a meteor enters the earth's atmosphere it creates a trail of electrons at a height of approximately 100 km.[1-4]. During the 1946 Giacobinid shower, Hey, Parsons and Stewart[5] measured the velocity of densely ionizing meteors by observing the radio wave scattered from the ionization at the head of the approaching meteor. We have recently succeeded in detecting the diffraction pattern of radio waves scattered from the electron trail as a meteor passes at right angles through the aerial beam. These observations lead directly to a measurement of the velocity of the meteor.

The basic transmitting and receiving equipment operating on a wave-length of 4·2 metres has already been described[2,3]. The additional apparatus consisted of a single-stroke time-base of duration 0·2 sec. on a separate cathode ray tube. The time base was automatically triggered by the radio echo from the meteor, and a photograph obtained of the successive pulse amplitudes occurring in the first 0·2 sec. of the echo. An example is shown in **Fig. 1**. The received power varies in an oscillatory manner, and the time intervals between maxima and minima are measurable from the photograph.

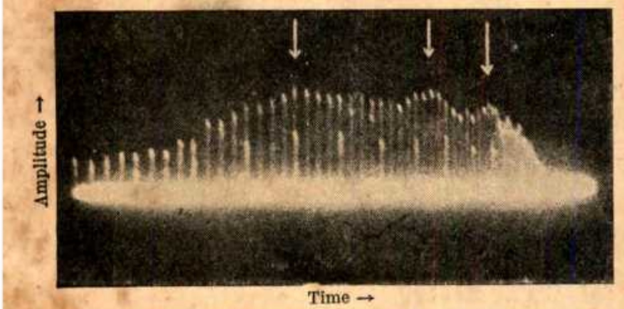


Fig. 1. QUADRANTID METEOR. JANUARY 4, 1948, 05h. 01m. ZONE MAXIMA MARKED BY ARROWS. RANGE 440 KM. MEASURED VELOCITY = 34·7 ± 2·2 KM./SEC. INTERVAL BETWEEN PULSES = 1·6 MILLISEC. EXPONENTIAL TIME BASE

It can be shown theoretically that the variation in the received power, as a meteor trail crosses the region about the perpendicular from the station, should be given by Fresnel's integrals, corresponding to the optical case of diffraction of light at a straight edge. The relative amplitudes of successive zones will not necessarily be given by the Fresnel integrals, owing to the non-linearity of the ionization along the trail[6]; but it will be shown that the *zone-lengths* obtained experimentally from individual meteor photographs agree with the zone-lengths given by the Fresnel integrals.

Calculation of the Fresnel integrals for a spherical wave gives values of the radii of successive zones, and subtraction between pairs of these values gives the theoretical zone widths, shown in Table 1, where R is the range and λ the wave-length. A, C, E are successive maxima, and B, D, F successive minima; A being the first maximum.

TABLE 1

$AC = 0{\cdot}55\sqrt{R\lambda}$ $CE = 0{\cdot}36\sqrt{R\lambda}$

$BD = 0{\cdot}43\sqrt{R\lambda}$ $DF = 0{\cdot}33\sqrt{R\lambda}$

In Table 2 the theoretical ratios of various zone widths are given, together with the equivalent ratios of four experimentally measured meteors at different ranges typical of forty-four obtained during the Geminid and Quadrantid showers of December 11–13, 1947, and January 4, 1948. It is assumed that the velocity of an individual meteor remains constant during the traverse of the zones, so that the measured number of pulses in the zone intervals considered is proportional to the length of the zones. The third meteor tabulated did not show a measurable F minimum.

TABLE 2

Ratios of zone	Theoretical	Experimental ratios (Quadrantid meteors) 1 360 km.	2 110 km.	3 470 km.	4 400 km.
AC/DF	1·68	1·59	1·57	—	1·88
AC/CE	1·52	1·56	1·50	1·48	1·61
BD/DF	1·32	1·16	1·38	—	1·36
AC/BD	1·27	1·37	1·13	1·28	1·38
BD/CE	1·19	1·14	1·32	1·15	1·16
CE/DF	1·11	1·01	1·05	—	1·17

Within the limits of experimental error, the ratios of the zone spacings agree with the theoretical values, so that the observed diffraction of radio waves from meteor trails obeys optical laws, and justifies the use of Fresnel's integrals for the calculation of velocities.

The time, T, to traverse a zone is determined from the measured number of pulses, p, and the known pulse-rate. Therefore the geocentric velocity, U, is given by

$$U = k\sqrt{R\lambda}/2T,$$

where k is the numerical value given in Table 1, appropriate to the particular zone selected.

The method has so far been applied to the Geminid meteor shower of December 11–13, 1947, and to the Quadrantid shower of January 3–4, 1948. The results are given in Fig. 2. The individual results for the Geminids are given in Table 3, which shows that meteors measured at widely different ranges give rise to constant mean values of $k\sqrt{R}/p$ as predicted by the above theory for the case where the velocity U is constant within a group of meteors.

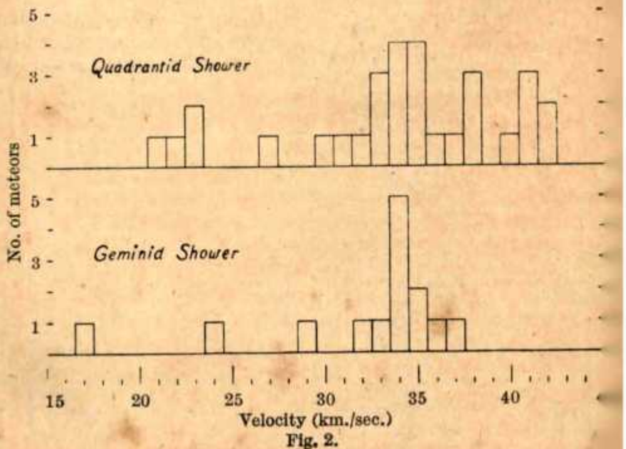


Fig. 2.

TABLE 3. GEMINID METEORS, DEC. 11–13, 1947

Range (km.)	$(k/p)_{\text{mean}} \times 10^{-2}$	$\frac{k}{p}\sqrt{R}$	Velocity (km./sec.)
460	7·85	1·68	33·7
470	7·90	1·71	34·3
170	13·60	1·77	35·6
370	8·95	1·72	34·6
370	8·84	1·69	34·1
420	8·32	1·71	34·2
400	8·74	1·75	35·1
440	7·90	1·66	33·2
220	11·32	1·68	33·8
490	8·30	1·83	36·9
400	8·07	1·61	32·4

The mean value for the geocentric velocity, U, of the Geminid meteors is 34·4 km./sec. (standard deviation 2·8 km./sec.), in excellent agreement with the velocity of 34·7 km./sec. obtained by Whipple[7] from photographic measurements of visible Geminid meteors.

The Quadrantid results indicate the existence of hree velocity groups. The only existing measurements with which these results can be compared appear to be the visual estimates collected by Fisher[8], which gave Quadrantid velocities of 32–46 km./sec., with a mean value of 38 km./sec. The Quadrantid results also contain a group of meteors with a very low mean velocity of 22·4 ± 1·8 km./sec. These were obtained using a non-directional aerial system at the beginning of the shower, and may not be associated with the Quadrantid radiant.

In the present experiments the range was measured visually on a cathode ray tube display and the maximum range error is estimated as ± 20 km. This introduces a mean error of 5 per cent in the range measurements, or 2·5 per cent (± 0·8 km./sec.) in velocity.

Amplitude fluctuations with a frequency of the order of 15 per second have also been found and are being investigated.

This work was carried out at the Jodrell Bank Experimental Station of the University of Manchester. We are indebted to Mr. N. Herlofson for suggesting the possibility that Fresnel zones could be measured[6], and to Dr. A. C. B. Lovell for constant interest and advice.

C. D. ELLYETT
J. G. DAVIES

Physical Laboratories,
University,
Manchester.
Feb. 19.

[1] Hey, J. S., and Stewart, G. S., *Proc. Phys. Soc.*, **59**, 858 (1947).

[2] Prentice, J. P. M., Lovell, A. C. B., and Banwell, C. J., *Mon. Not. Roy. Ast. Soc.*, **107**, 155 (1947).

[3] Lovell, A. C. B., Banwell, C. J., and Clegg, J. A., *Mon. Not. Roy. Ast. Soc.*, **107**, 164 (1947).

[4] Lovell, A. C. B., *Nature*, **160**, 670 (1947).

[5] Hey, J. S., Parsons, S. J., and Stewart, G. S., *Mon. Not. Roy. Ast. Soc.*, **107**, 176 (1947).

[6] Herlofson, N., *Rep. Progress in Phys.*, **11**, 1948 (in the press).

[7] Whipple, F. L., *Proc. Amer. Philos. Soc.*, **91**, 189 (1947).

[8] Fisher, W., *Harvard College Observ. Circ.*, No. 346 (1930).

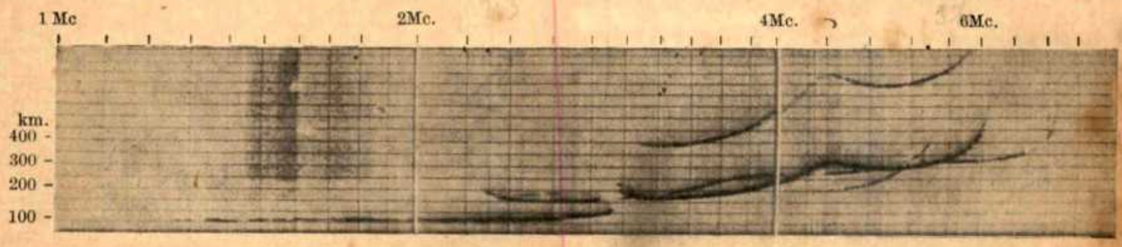
Triple Splitting of Ionospheric Rays

THE well-known theory of the ionosphere indicates the existence in polar regions of a third split in vertical incidence measurements of medium- and high-frequency radio wave reflexions from the ionosphere, its presence being due to the nearly vertical magnetic field of the earth. Its presence was first observed by Harang[1], and since then by others.

It was first seen in Canada in 1943 when the Churchill ionosphere station commenced operation. Since then the phenomenon has been observed frequently at other Canadian stations as well.

To date, observers have noted its presence only in the F_2 region; however, in Canada a complete trace is often seen extending from the E region through the F_1 region to the F_2 region.

The accompanying sample record was made with the National Research Council's automatic ionosphere recorder at The Pas, Manitoba (54·0° N., 101·0° W.). May 16, 1946, at 17.00 C.S.T. and illustrates some of the observed characteristics of the third split (z trace).



The following points may be noted:

(1) The z trace follows through from f^zE to f^zF_2.

(2) The down sweep on the left-hand side of the z trace indicates the presence of f^zE (2·3 Mc.), and on the original record there is evidence of retardation of the E region z trace to this point.

(3) $f^zF_2 = 5{\cdot}45$. $f^xFz - f^zF_2 = 1{\cdot}5$ Mc.
$f^oF_2 = 6{\cdot}10$. $f^xF_2 - F^oF_2 = 0{\cdot}85$ Mc.
$f^xF_2 = 6{\cdot}95$.

(4) The $F_1{}^z$ trace disappears at f^oE; this is a normal occurrence.

(5) Retardation at f^oF_1 is greater than at f^zF_1 and f^xF_1.

(6) The minimum virtual heights of the F region traces increase from z trace to o trace to x trace.

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Jan. 22.

[1] Harang, L., *Terr. Mag. and Atmos. Elect.*, **41**, 143 (1936).

MR. GORDON NEWSTEAD, of Hobart, Tasmania, has observed a triple splitting of the rays reflected from the F region[1]. The occurrence of such triplets had already been observed in 1933, when they were described at a meeting of the Royal Society[2]. The signals were received on a polarimeter, so that the polarization of the triplets was known. These were always of the type of two ordinary rays and one extraordinary ray. The mechanism of the triplet was therefore known, and although no explanation was given in the paper, it had been discussed by Millington and myself.

If these triplets were due to the coupling between the ordinary and extraordinary rays, they would be expected to have one extraordinary and two ordinary characteristics—as, in fact, they have. That such coupling exists is without doubt, so that the explanation that it is the direct cause of the triplets observed is, I think, correct.

The frequency of the occurrence of these triplets is small. We received only five in five months. At Hobart, thirty-nine cases in fifty thousand records have been obtained. This is rather greater than we observed, but the explanation is, I think, quite correct.

The photograph shown is a very clear instance of this triple splitting, which has also been observed by Harang[3].

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Weatheroak, Danbury,
Essex.

[1] *Nature*, **161**, 312 (1948).

[2] *Proc. Roy. Soc.*, A, **141**, 710 (1933).

[3] Harang, *Terr. Mag. and Atmos. Elect.*, **41**, 160 (1936).

Blackett's Hypothesis of the Magnetic Field of Rotating Bodies

PROF. P. M. S. BLACKETT[1] has recently directed attention to the well-known, but forgotten, fact that the ratio of magnetic moment $\vec{P}$ and angular momentum $\vec{U}$ is roughly the same for the sun and for the earth and can be written in the form,

$$\vec{P} = -\beta \frac{G^{1/2}}{2c}\vec{U}. \quad . \quad . \quad . \quad (1)$$

Here G is the gravitational constant, c the velocity of light and β a dimensionless constant of the order of unity, which Blackett estimates to be 0·30 for the earth and 1·14 for the sun. Furthermore, from Babcock's measurements Blackett deduces the value $\beta = 1\cdot 16$ for the star 78 Virginis, but since the mass, radius and angular velocity are all deduced statistically in this last case and the sign is unknown, only little weight can be attached to it.

Next, Blackett urges that (1) may be generally true for all rotating, electrically neutral bodies and thus give a clue to a possible connexion between electromagnetic and gravitational phenomena. Quite apart from the secular variation, the fact that $\vec{P}$ and $\vec{U}$ are not parallel either for the earth or for the sun, and the fact that an eccentric dipole field gives a better description of the main field of the earth than does a centered dipole field, the relation (1) meets with the following difficulties.

On the analogy with the magnetic field of moving electric charges, the magnetic field of a rotating neutral mass may be interpreted from the point of view of non-atomic field theory, that is, as a field property depending on the relative motion of the body and the observer, as was done in the previous theory of H. A. Wilson on the magnetic field created by the translational motion of neutral bodies. However, in this interpretation one would expect the magnetic field to be different in a co-ordinate system which follows the body in its rotation, that is, in which the body is at rest, and in one relative to which the body rotates, because the gravitational field is different in these two co-ordinate systems. Since the main magnetic field of the earth as measured on the earth itself is experimentally found to be the same as that measured in even the fastest moving aeroplanes, the main magnetic field of the earth could scarcely be explained on such lines. (Nevertheless, this hypothesis might, of course, be true, that is, give an additional magnetic field not detectable on the earth itself. In that case we would expect the magnetic field acting on cosmic ray particles, which do not partake in the rotation of the earth, to be different from that measured on the earth.) However, on general principles it is rather unlikely that in classical field theory there should exist a connexion between electromagnetic and gravitational phenomena such as (1), because the sign of $\vec{P}$, but not of $\vec{U}$, depends on the definition of plus and minus electric charge, and thus north and south magnetic pole, which definitions are quite arbitrary. The signs can only be defined in an unambiguous way from an atomic theory involving a knowledge of the atomic constitution of matter.

Consequently, if the relation (1) should be generally true, as conjectured by Blackett, it must be interpreted from an atomic point of view as meaning that the body itself is magnetized, that is, that a magnetic dipole moment density is induced in the body when rotated relative to the inertial co-ordinate system of the fixed stars. However, in that case, first one would expect (1) to contain not only classical constants such as G and c, but also both atomic constants and constants characteristic for the material of the body[2]. Secondly, it is difficult to imagine another atomic mechanism to give a relation like (1) than the gyromagnetic—which, however, gives a uniform magnetization, and thus for a sphere $P \propto M\omega \propto \frac{U}{R^2}$. (This form of magnetization is just an example of one which occurs for rotational but not for translational motion.) Thirdly, also in this case of a rotating electrically neutral mass the body would be associated not only with a magnetic field, but also with an electric field, as pointed out by Blackett in the case of translational motion. For from the Lorentz transformation it follows that each volume element carrying a magnetic dipole moment $\vec{dP}$ will show in a co-ordinate system relative to which the element moves with velocity $\vec{v}$ an electric dipole moment given by $\frac{1}{c}\vec{v} \times \vec{dP}$ (for $\frac{v^2}{c^2} \sim 0$). For example, a symmetric rotating body will thus be surrounded by an electric quadrupole field, and no rotating body can be surrounded by a purely magnetic field. (The influence on the motion of cosmic ray particles of this electric field which must surround the earth ought to be investigated more closely.)

We note that it may be possible experimentally to test Blackett's hypothesis (1) by the experiments of Barnett on the gyromagnetic magnetization (or perhaps by the experiment of Einstein and de Haas on the inverse effect of rotation by magnetization)[3]. For example, for a cylinder with radius R and density d and making ν rotations per second we get from Blackett's hypothesis an average magnetization of $\bar{I}_{\rm Bl} = 7\cdot 9 \times 10^{-15}\ \nu\ dR^2$, whereas the gyromagnetic effect gives a uniform magnetization $I_{\rm gy} = 3\cdot 6 \times 10^{-7}\ \chi\nu$ (χ is the susceptibility of the body). Thus the two magnetizations are of the same magnitude if $\frac{dR^2}{\chi} = 5 \times 10^7$. Taking, for example, a paramagnetic material like aluminium for which $\chi = 1\cdot 7 \times 10^{-6}$ and $d = 2\cdot 7$, this is the case already for $R \sim 5$ cm. Before such experiments are performed with a positive result we think it is more probable that if (1) is not merely accidental, it may be due to a common origin of $\vec{P}$ and $\vec{U}$, since it is possible that their values are determined already by the creation process of the earth and the sun.

NIELS ARLEY

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[1] Blackett, *Nature*, **159**, 658 (1947).

[2] Cf. also the theory of Pauli, *Ann. Phys.*, 18, 337 (1933), especially p. 372 where $G^{1/2}/c$ occurs in connexion with h.

[3] See, for example, Barnett, *Rev. Mod. Phys.*, 7, 129 (1935).

IN his paper on the magnetic field of rotating bodies, P. M. S. Blackett has shown[1] that the relation $(P/U)_1$ between magnetic moment P and angular moment U of a rotating body seems to be independent of its size and constitution (about $0{\cdot}95 \times 10^{-15}$ E.M.U.); he also tried to explain the physical significance of this constant. He based his considerations on the well-known equation for the Bohr magneton, which is written

$$\left(\frac{P}{U}\right)_2 = \frac{e}{2mc} = 0{\cdot}88 \times 10^7 \ [\text{cm.}^{1/2}\ \text{gm.}^{-1/2}]. \quad (1)$$

Blackett points out that the empirically determined relation

$$\frac{(P/U)_1}{(P/U)_2} = 1{\cdot}08 \times 10^{-22}$$

corresponds in order of magnitude with the well-known non-dimensional equation

$$G^{1/2}\frac{m}{e} = 4{\cdot}90 \times 10^{-22} \ [\text{E.S.U.}] \quad (2)$$

(G is gravitational constant). For this reason, the new relationship

$$\left(\frac{P}{U}\right)_1 = G^{1/2}\frac{m}{e}\left(\frac{P}{U}\right)_2 \quad (3)$$

was introduced. By putting (1) in (3) he was able to show that

$$\frac{P}{U} = \frac{G^{1/2}}{2c} \quad (4)$$

represents the magnetic moment of a rotating body as a function on one hand of the angular moment, and on the other of the gravitational constant and the velocity of light.

In its present form, however, equation 4 is, from the physical point of view, not complete. The term c in that equation, for example, should not be identified with the velocity of light. This value is taken from equation 1, where it is only used to transform the value of e, quoted in electrostatic units, into electromagnetic units. Therefore equation 1 should be written in a more general manner, independent of any system of units, as

$$\left(\frac{P}{U/2}\right)_2 = \frac{2P}{h/2\pi} = \mu\frac{e}{m} \quad (1a)$$

(where μ is permeability of a vacuum, h is Planck's constant; the number 2 originates from the definition of the angular momentum and belongs therefore to U). Only in this form is equation 1 correct with reference to any system of dimensions.

Equation 2 also does not contain all the necessary physical quantities to make it correct dimensionally. The equation should be completed and then read as

$$\frac{\varepsilon^{1/2}G^{1/2}m}{e} = 4{\cdot}90 \times 10^{-22} \quad (2a)$$

(where ε is the dielectric constant of the vacuum). It becomes obvious that the above equation is now a non-dimensional one if the reciprocal value of G, namely, $1/G = \gamma$, is introduced; the result is the symmetrical equation

$$\frac{\varepsilon^{1/2}}{\gamma^{1/2}}\frac{m}{e} = 4{\cdot}90 \times 10^{-22}. \quad (2b)$$

Blackett's equation 3 must then be written as

$$\left(\frac{P}{U}\right)_1 = \frac{m}{e}\sqrt{\frac{\varepsilon}{\gamma}}\left(\frac{P}{U}\right)_2. \quad (3a)$$

If (1a) is put in (3a), then finally equation 4 will be replaced by

$$\frac{P}{U/2} = \mu\sqrt{\frac{\varepsilon}{\gamma}}. \quad (4a)$$

This equation is numerically correct not only in the usual non-rational electrostatic system but also in the non-rational electromagnetic system of units, where the following relations are valid:

	E.S.U.	E.M.U.
$\varepsilon =$	1	$\frac{1}{9} \times 10^{-20}$
$\mu =$	$\frac{1}{9} \times 10^{-20}$	1
$\gamma =$	$1{\cdot}5 \times 10^7$	

The removal of the factor c from equation 4 has led now to equation 4a, which is correct in any system of units and dimensions and shows that the new relation ε/γ (of the dielectric constant to the gravitational constant) may be one of the decisive relations concerned in this matter.

It is furthermore easy to understand that the permeability μ must play an important part in (4a), as we are dealing here with fundamental *magnetic* questions; indeed, it would be surprising if this physical quantity were not involved when dealing with such a matter.

In any event, the fact that the general electric properties of matter are decisive for the formation of the steady magnetic field of rotating massive bodies is best shown by equations 4a and 1a in the form

$$P = \frac{U}{2}\mu\sqrt{\frac{\varepsilon}{\gamma}} = \frac{U}{2}\mu\frac{e}{m}. \quad (5)$$

J. FUCHS

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Jan. 11.

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[1] Blackett, *Nature*, 159, 658 (1947).

Spontaneous Waves in Discharge Tubes and in the Solar Atmosphere

A THEORETICAL study has been made of the plane electromagnetic waves which can exist in a strongly ionized gas when a constant electric field $\mathbf{E}_0$ and a constant magnetic field $\mathbf{H}_0$ are both present. As the results of this work appear to be of general interest, a brief account of them is given here.

It is found that in general for waves of a given frequency the medium is octuply refracting and that, under certain conditions the absorption of the medium is negative, that is, the medium acts as an amplifier for one or more of the types of wave which can travel through it with the given frequency.

It is found similarly that in the medium there are eight possible types of wave with a given wave-length and three possible types with a given phase-velocity, and that under certain conditions one or more of these types can exist with the property that at any given place the *amplitude of the wave grows with the lapse of time* up to one of two possible limits.

The presence of a constant electric field is essential for the existence of growing waves. The addition of a constant magnetic field increases the possibility that spatially growing or secularly growing waves can exist in the medium and also increases the range of their frequencies.

These results of the theory can be applied to the ionized gas in a discharge tube or in the solar atmosphere.

In different parts of the tube the electron and ion densities and the electric field can vary in magnitude considerably. It is therefore possible for conditions to exist in which waves can grow from any random fluctuation of these magnitudes. The phase-velocities and the corresponding frequencies of these growing waves will depend on the form of this initial fluctuation as expressed by means of a Fourier integral. In this way electric noise can arise over a large range of frequencies. The addition of a magnetic field serves to increase these possibilities. The existence of boundaries in a discharge tube will under certain conditions favour the development of certain waves into steady types each with a definite wave-length and its associated frequency.

The abnormal solar noise which has been much studied in recent years can be explained in a similar way if we postulate that constant (or slowly varying) electric fields can arise in the solar atmosphere, and that large local transient changes in this atmosphere can occur from time to time. There is little doubt that both these conditions do occur on the sun.

A similar explanation can be advanced for cosmic noise if we regard this noise as originating in the ionized atmospheres of stars, especially of those which are magnetic.

A detailed account of this work will be published elsewhere.

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Dec. 19.

Method of Steepest Descents: Improved Formula for X-Ray Analysis

BOOTH[1] uses two formulæ as a starting point of the method of steepest descents, applied to X-ray crystal structure analysis:

$$R_1 = \Sigma \Big| \, |F_0| - |F_c| \, \Big| = \text{minimum}, \qquad (1)$$

$$R_2 = \Sigma \, (F_0^2 - F_c^2)^2 = \text{minimum}. \qquad (2)$$

According to the method of least squares, a formula of the form Σ (error)^2 = minimum is correct only when all the observations have the same weight and when the errors follow Gauss's law. As the intensities are $I \sim F_0^2$, formula (2) assumes equal weights of all the measured intensities. This might hold for initial steps of approximation; but for final steps the average errors are proportional to the intensities and the errors do not obey Gauss's law. However, when logarithms of intensities are plotted, the average errors in the logarithms are constant and Gauss's law is obeyed. It follows thus that, at the later stages,

$$R_3 = \Sigma \, (\log I_0 - \log I_c)^2 \qquad (3)$$

should be minimized rather than (1) or (2). Zero observed intensities can be avoided by substitution in (3) for I_0 the threshold observed intensities I_t, except when $I_c < I_t$; then the error should be put equal to zero. The formula (3) should be used only at a stage of approximation when all the signs of F_c remain constant.

The change ε_{rj} of the atomic co-ordinates x_{rj} in any one step can be regarded as a vector ε in the $3N$-dimensional space; its direction is given by the direction cosines grad $R/|$ grad $R|$ and its magnitude by $|\varepsilon| = s$. Writing $|$grad $R| = D$, we have

$$\varepsilon = \frac{s \text{ grad } R}{D}. \qquad (4)$$

Along the normal, R is a function of s only; we can thus write:

$$R(s) = R(0) + Ds + \frac{1}{2!} D_2 s^2 + \frac{1}{3!} D_3 s^3 + \ldots, \qquad (5)$$

where D, D_2, D_3, etc., are the derivatives of R along the normal at the point $s = 0$.

Neglecting higher power terms in s than the second,

$$dR/ds = D + D_2 s, \qquad (6)$$

so that for a minimum of R, the value of s is $s_m = - D/D_2$. By substituting this in (4)

$$\varepsilon_m = - (\text{grad } R)/D_2, \qquad (7)$$

which is equivalent to the first formula of Booth. Neglecting higher-power terms in s than the second, (5) can be written as

$$R(s) = R(m) - \frac{1}{2} D(s - s_m)^2/s_m. \qquad (8)$$

If we assume $R(m) = 0$, or negligible compared with $R(0)$, we have $s_m = - 2R/D$. Substituting this in (4),

$$\varepsilon = - 2R \text{ grad } R/(\text{grad } R)^2, \qquad (9)$$

which is the second formula of Booth, and which contains first partial derivatives only. When, however, $R(m)$ cannot be neglected, then (9) gives too large a shift. When x_{rj} are near their optimum values, ε calculated from (9) may be much larger than ε_m, and R may even increase; Booth then recommends the use of (7).

A method has been devised by which the laborious calculation of D_2, which contains many second partia derivatives of R, is obviated even near optimum values of x_{rj}, resulting in a great saving of time According to this method, ε is first calculated from (9) even when x_{rj} are near their optimum values and R increases. The shift calculated is thus $s_1 = - 2R/D$ The value of $R(s_1) = R(1)$ is calculated from (3) However, now we know two points $R(0)$, $R(1)$ and a tangent D at $s = 0$ of the curve $R(s)$. This allow us to calculate from the three conditions the value of D_2:

$$D_2 = 2(R(1) + R(0))/s_1^2,$$

and thus $s_m = s_2$ is given by

$$s_2 = - D/D_2 = R(0) \, s_1/(R(0) + R(1)). \qquad (10)$$

At this point

$$R(m) = s_2 R(1)/s_1. \quad (11)$$

Using now s_2 instead of s_1, we calculate $R(2)$ from (3) and compare it with $R(m)$ calculated from (11). If $R(2) = R(m)$, our assumption of higher derivatives being zero or negligible was justified. If the effect of higher derivatives is not negligible, the process can be repeated until minimum is reached.

If the observed F_0 are not on an absolute scale, they can be adjusted by multiplying them by a constant K, given by

$$\log K = -\frac{1}{N} \Sigma (\log F_0 - \log F_c). \quad (12)$$

This adjustment of the scale can be repeated after each approximation, as the changes of the co-ordinates may also affect the value of K.

We have successfully applied these methods to the three-dimensional refinement of parameters of a crystal of potassium caprate, a preliminary report of which was given by Vand, Lomer and Lang[2], and to the structure of lauric acid.

I wish to thank Messrs. A. Aitken, W. M. Morley and Miss B. Edkins for testing the method, and the directors of Lever Brothers and Unilever, Ltd., for permission to publish this note.

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[1] Booth, A. D., *Nature*, 160, 196 (1947).

[2] Vand, V., Lomer, T. R., and Lang, A., *Nature*, 159, 507 (1947).

Surface Resistance of Metal Films at a Frequency of 24,000 Mc./s.

The reflexion, transmission and absorption coefficients (R, T, A) of a thin metal film can be expressed in terms of its surface resistance S, if the frequency is low enough for classical electromagnetic theory to apply. Then measurements of R, T, or A yield theoretical values of S which can be compared with the value (S_0) obtained from D.C. measurements on the film. Experiments of this type have been carried out[1-3] at infra-red wave-lengths (6–110 μ); but while a measure of agreement has been obtained, the anomalies suggest that dispersion occurs at these short wave-lengths. With the view of effecting a similar comparison between S and S_0 at centimetre wave-lengths, the theory has been investigated afresh[4] to include the effect of multiple reflexions occurring in the film and its support, and has been extended to find the resonance condition for a cylindrical cavity resonator operating in the H_{01} mode, when it is loaded with a film of metal carried by a low-loss support travelling on the plunger. The theoretical value of the surface resistance is then given by the expression

$$S = \frac{120\pi\lambda_1}{\lambda\left[1 + \cot\frac{2\pi l'_1}{\lambda_1}\left\{2\cot\frac{4\pi l_1}{\lambda_1} - \cot\frac{2\pi l'_1}{\lambda_1}\right\}\right]^{1/2}},$$

where λ is the wave-length in air, λ_1 that in the empty resonator, while l_1 and l'_1 are the resonant lengths of air space in front of the support in the presence and absence respectively of the film. In practice, λ is calculated from λ_1 and a resonator dimension, while l'_1 may either be measured directly, or calculated from the thickness and permittivity of the film support.

Extensive measurements have been made at a frequency of 24,000 Mc./s. to test this relation and certain other theoretical predictions. For this purpose films of chromium, gold, aluminium, silver, copper and nickel of uniform thickness have been prepared by evaporation *in vacuo* on silica disks, some of which have been optically flat. Silica was chosen as the material for the film support because of its extremely small loss, and its permittivity at this frequency has been evaluated as 3·8 ± 0·001. After measuring S, the value of S_0 has been determined in each case by evaporating thick silver contacts on to the film and measuring the resistance of a circular annulus by bridge and other methods. The film thicknesses investigated have lain in the range 5–300 A.; for most metals this covers a range of values for S_0 lying between infinity and a few ohms/cm.[2].

Throughout this range the qualitative agreement between S and S_0 has been excellent. Thus if $S_0 = \infty$, the A.C. measurement always yields a value of $l_1 = l'_1$, so that $S = \infty$. Again, a low value of S_0 always corresponds to a low value of S, that is, $l_1 \sim \lambda_1/2$. Films with intermediate values of S give values of l_1 lying between these extreme limits, and the phase shift due to the film may be large. However, the high absorption of such films lowers the effective Q of the resonator, and the broadening in the response renders the precise determination of l_1 difficult. Nevertheless, the quantitative agreement between S and S_0 over the entire range of values is good. It is found that S is always less than S_0, the ratio S_0/S generally lying between 1 and 2. A part of this small discrepancy can be attributed with certainty to the effect of the evaporated contacts on the film, since different contacts give slightly different values of S_0. Aggregation in the film or surface oxidation occurring on exposure of the film to air would also contribute to the higher value of S_0. Finally, the same agreement between S and S_0 has been found for films of metal contaminated with oxide, suggesting that the agreement is of a statistical nature.

Since any wave trapped in the resonator is partially reflected and transmitted by the film several times, the expression given for S represents a more stringent test of the theory than any of the expressions for R, T, A used in the infra-red, which depend on a single encounter between the wave and the film. The agreement obtained experimentally between S and S_0 must therefore be regarded as very satisfactory, indicating that the theory and underlying assumptions are valid and that no dispersion occurs in the metal at this frequency. The resonator method can thus be used to study other film properties connected with the electrical conductivity, for which purpose it has the advantage that no contacts to the film are required.

This work was partly carried out at the Clarendon Laboratory, Oxford; a fuller account will appear elsewhere.

L. Speirs

Washington Singer Laboratories,
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Exeter.

Dec. 20.

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[1] Murmann, H., *Z. Phys.*, 54, 741 (1929).

[2] Barnes and Czerny, *Phys. Rev.*, 38, 338 (1931).

[3] Woltersdorff, W., *Z. Phys.*, 91, 230 (1934).

[4] Speirs, L., *Phil. Mag.*, 39, 105 (1948).

A Large Field Compensator for Measurement of Birefringence

A FROZEN stress compensator using a *C R* 39 resin strip, such as is described by Messrs. P. E. Jellyman and A. J. Milne in *Nature* of March 27, p. 477, was constructed and used at the Naval Construction Research Establishment, Rosyth, in 1944. It was briefly described in a paper read to the Edinburgh and District Association of the Institution of Civil Engineers in November 1944.

The instrument could not be made to be as stable as a quartz wedge compensator, but fulfilled a useful purpose, while the delivery of a Soleil-Babinet compensator was awaited.

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The Swimming of Dolphins

DOLPHINS in the Gulf of Panama have been seen moving through the sea at a speed of ten knots, their entire bodies showing no apparent swimming motion. This performance was confined, in my observations, to the area immediately forward of the stem (prow) of a sea-going tug and to an estimated depth of one metre or less. Elsewhere near the bow, vertical oscillations of dolphins' tails were readily timed with a stop watch.

When this 'motionless' swimming was first noticed, the animals were in the normal swimming position. In this position it was difficult to be sure that vertical motions of their tail surfaces were not occurring, since the direction of such motions would be nearly parallel with the line of sight of the observer. However, on several occasions dolphins were seen to turn on their sides during the 'motionless' swimming in such a position that their usual swimming motions would have been normal to the line of sight. No motion was visible in these animals, which were clearly seen just below the surface of the water. One animal remained on its side in this manner for 59 sec., which represented a distance, at 5·15 m./sec. (10 knots), of 304 metres. At this time dolphins swimming near by used 1·9 tail oscillations per second in keeping pace with the vessel.

These 'motionless' dolphins seemed to be riding the bow wave (that is, falling down the inclined surface). However, if dolphins are equal in weight to the weight of the water they displace, wave riding is not possible. No data have been found concerning their density. Kellogg[1] says, however, that dolphins usually sink when shot. Is it possible that they are dense enough to fall down the advancing slope of the bow wave, having achieved terminal velocity initially by swimming? A low over-all resistance to motion through the water would seem to be required. Gray[2] has indicated that the work done by dolphin muscle in producing a speed of 10 m./sec. is comparable to the work of other mammalian muscle tissue, if laminar flow is assumed around the dolphin. With turbulent flow, Gray found that the work done by dolphin muscle at 10 m./sec. would be about seven times the work of other mammalian muscle. If a laminar regime exists at a speed of 5 m./sec., perhaps the over-all resistance to the motion of a dolphin is low enough to allow an animal, of sufficient negative buoyancy, to fall down the inclined water surface of a bow wave or other waves.

It may be thought that the dolphins were gaining a forward thrust by placing their tails against the ship's stem. Dolphins have been seen with their tails in momentary contact with the hull, but in the above observations of 'motionless' swimming the animals were clearly forward of the vessel.

Shoulejkin[3] suggests that the speed of motion of the dolphin's tail may be very rapid. Dolphins seen 'motionless' in the bow wave may have been using rapid tail oscillations of very small amplitude, causing them to appear to be motionless. If such swimming motions were in fact occurring, it is curious that the use of this propulsive technique should be confined to the immediate vicinity of the bow, while other dolphins a few metres away always used a large amplitude vertical tail motion with a period of about half a second (at 10 knots).

I would like to know whether other observers have seen this 'motionless' swimming, and what explanations may have been given.

ALFRED H. WOODCOCK

Woods Hole Oceanographic Institution,
Mass. Jan. 30.

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[1] Kellogg, Remington (personal communication), U.S. National Museum, Washington, D.C., 1948.

[2] Gray, J., "Studies in Animal Locomotion. VI. The Propulsive Powers of the Dolphin", *J. Exp. Biol.*, 13, 192 (1936).

[3] Shoulejkin, W. W., "Physics of the Sea", Publication Acad. Sci U.S.S.R., Moscow-Leningrad, see pp. 715–724 (1941).

Control of Cattle Trypanosomiasis

MRS. ELSPETH HUXLEY suggested in a letter in *The Times* (Sept. 16, 1947) that possibly cattle trypanosomiasis might come to be controlled by immunological methods. If this were achieved, resettlement of tsetse-infested land could be accomplished without such undesirable features as the destruction of plant and animal life. On the assumption that man and tsetse flies are ecologically incompatible, resettlement must cause recession of the 'fly'. Domestic stock are, therefore, the key to the problem, since tribal customs in East Africa are such that a threat to the stock constitutes a threat to the community. Resettlement is only possible if stock can be enabled to survive in 'fly'-infested areas.

There is a certain amount of evidence that, with intensified research, means could be found to 'salt' cattle, so as to enable this to be accomplished.

Survival of game in tsetse-fly areas. Carmichael at Entebbe (unpublished data) found that the young of game animals, notably duiker and sitatungu, which abound in tsetse-fly areas, are as susceptible as domestic animals, to artificial infection with *T. congolense.* It follows that the immunity of some game animals at any rate is acquired and not hereditary.

Survival of cattle in tsetse-fly areas. Cattle in many parts survive in tsetse-fly areas, as reported from Kenya, Southern Rhodesia and the Gold Coast. Such cattle are usually deliberately exposed by the owners to tsetse-fly attack from birth onwards.

Immunity of cattle to T. congolense. Young calves usually recover from infection with *T. congolense*[1-3]. Taliaferro[4] has demonstrated solid immunity to *T. lewisi* in rats following recovery; the same has been demonstrated by Fiennes[5] in the case of cattle, but only to the infecting strain.

Laveran and Mesnil[6], in re-infection experiments with goats, could only demonstrate four strains of *T. congolense.*

Control by drug therapy. Trypanosomiasis of cattle can be successfully controlled by drug therapy. Observations on the cattle of a European farmer who has established a herd of nearly a thousand cattle in a tsetse-infested area appear to show that drug control over a period of years will lead to the development of stock which become somewhat resistant to, or tolerant of, the parasite.

Development of resistance in cattle by artificial means. In the case of twenty cattle, some infected with *T. congolense* and some with *T. vivax*, a fatal course has been converted to a benign one by means of subcurative dosage with phenanthridinium compounds. This work is not yet complete, but it can be said that all the cattle are healthy and some are surviving after carrying the trypanosome for more than fourteen months. One calf was born to an infected dam and was infected at birth. The calf has never been sick, and at six months old is thriving. It remains to be seen whether the parasite will eventually be eliminated, and if so what degree of immunity will be developed.

Control of trypanosomiasis in cattle. The evidence given is scanty, because the pathology and immunology of the trypanosomiases have been virtually neglected for the past thirty years. Nevertheless, it may suggest that an attack on these lines might bring the most rational solution to the tsetse-fly problem, by enabling breeding herds to be established in 'fly' areas and by resettlement with human populations and consequent elimination of 'fly' by natural ecological means.

What has been written is a simplification of the problem, inevitable from lack of space.

R. N. T.-W.-FIENNES
Veterinary Research Laboratory,
East African Veterinary Research Organisation,
P.O. Kabete. March 17.

[1] Livingstone, "Missionary Travels in South Africa".

[2] Van Saceghem, R., *Bull. Soc. Path. exot.*, 27, 170 (1934); *Bull. agric. Congo Belge*, 47 (1936); *Bull. Soc. Path. exot.*, 31, 296 (1938).

[3] Fiennes, R. N. T.-W.-, Jones, E. R., and Laws, S. G., *J. Comp. Path. and Therap.*, 56, 1 (1946).

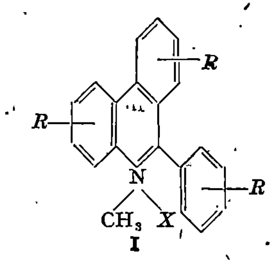
[4] Taliaferro, W. H., "The Immunology of Parasitic Infections" (London, 1930).

[5] Fiennes, R. N. T.-W.-, *Vet. Rec.*, 59, 291 (1947).

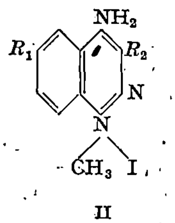
[6] Laveran, A., and Mesnil, F., *C.R. Acad. Sci., Paris*, 140, 831 (1905).

Cinnoline Derivatives as Chemotherapeutic Agents for *Trypanosoma congolense* Infections

THE most important disease of cattle throughout tropical Africa is that due to infection with *Trypanosoma congolense*, the cause, both directly and indirectly, of a vast amount of impoverishment. The most effective chemotherapeutic agents for this disease yet described in the literature are phenanthridinium compounds[1] having the general structure (I), in which two of the substituents are amino-groups and the third is a hydrogen atom.



I



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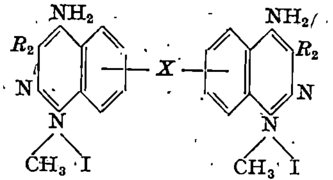


III

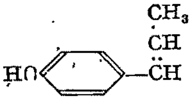
In view of the somewhat complex nature of such molecules, and of the difficulty of introducing amino-groups into any selected combination of positions, we have sought to ascertain whether trypanocidal activity is retained in simplifications of the phenanthridinium molecule, and have synthesized quaternary salts of a variety of mono- and di-amino-cinnolines, -quinazolines and -quinolines. In contrast to the highly active phenanthridinium compounds, our bicyclic heterocyclic quaternary salts have little or no trypanocidal action, and a possible explanation of this loss of activity is that the molecular weights of the cations of these bicyclic salts may be below the minimum necessary for activity.

Two of the compounds prepared during this investigation were 4 : 6-diamino-1-methylcinnolinium iodide (II; $R_1 = NH_2$; $R_2 = H$), m.p. 273–274° (found: C, 35·6; H, 3·7; N, 18·5; I, 42·2; $C_9H_{11}N_4I$ requires C, 35·75; H, 3·7; N, 18·5; I, 42·05 per cent), and its 3-methyl analogue (II; $R_1 = NH_2$; $R_2 = Me$), m.p. 283–284° (decomp.) (found: C, 36·0; H, 4·55; N, 16·8; $C_{10}H_{13}N_4I,H_2O$ requires C, 35·9; H, 4·5; N, 16·75 per cent). The constitutions of these compounds were established by the synthesis of each of them by two different procedures, and both these diamines were inactive in the pure state. However, the crude reduction products of the corresponding 6-nitro-salts (II; $R_1 = NO_2$; $R_2 = H$ and Me) (which were intermediates in one of the methods of synthesis) showed definite activity; the trypanocidal power varied considerably according to the conditions used for reduction, the most favourable result being a chemotherapeutic index of about 2 against *T. congolense* in mice (maximum tolerated dose about 4·5 mgm., intraperitoneally; minimum curative dose about 2·25 mgm. per 20 gm. body weight) obtained with a crude reduction product of II ($R_1 = NO_2$; $R_2 = Me$). Tested by the same technique, the two best-known phenanthridinium compounds, 'dimidium bromide' ('1553') and 'phenidium chloride' ('897') gave indices of about 15 and 3, respectively.

The observed trypanocidal activity is seemingly due to the incidence of side-reactions accompanying the conversion of the nitro- to the amino-quaternary salts; and, assuming that the same side-reaction is responsible for the development of activity in each of the two cases, the active components may possibly be the azo-compounds (III; $X = 6 : 6'$—N=N). On grounds of analogy, also, there is some reason for anticipating that structures such as (III) may be active, because one of the striking features of many non-arsenical trypanocidal compounds is that they are symmetrical molecules containing two identically constructed cyclic units (for example, diamidines, trypan red, suramin, surfen C, and Bayer 7602 Ac).

Our work is being continued along lines suggested by these observations. If our anticipations prove to be correct, this would indicate the desirability of synthesizing and examining a series of compounds of type (III), with variations in the linkage X as well as in the nature of the two quaternized heterocyclic units.

The steps leading to the finding of trypanocidal activity in compounds of type (III) would provide an interesting parallel to the course of events in quite a different field, that of synthetic sex hormones. The sequence leading to the discovery of œstrogenic activity in symmetrical compounds of the type of stilbœstrol (V) consisted in exploring simplifications of the naturally occurring *cyclo*pentenophenanthrene type of compound, followed by the demonstration of activity in crude preparations of anol (IV); purified preparations of (IV) were, however, found to be inactive, and the activity of the earlier crude preparations was then shown to be due to their contamination by (V)[2,3,4].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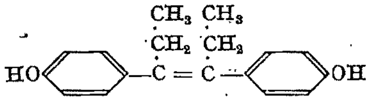
V

This work was supported by grants from the Medical Research Council and Messrs. May and Baker, Ltd.

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Dec. 30.

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[1] First described by Browning, Morgan, Robb and Walls, *J. Path. Bact.*, 46, 203 (1938); later work reviewed by Walls, *J. Soc. Chem. Ind.*, **66**, 182 (1947).

[2] Dodds and Lawson, *Nature*, **139**, 627 (1937).

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Effect of Under-nutrition in Man on Hepatic Structure and Function

DURING August 1946 investigations were carried out on twenty-one civilian citizens of Wuppertal, an industrial German city south of Essen. For at least three months the official rations had not provided more than 35 gm. of protein, 15 gm. of fat and 176 gm. of carbohydrate a day, a total of 1,050 calories. Most of the subjects had been on short commons for twelve months. They were all under-nourished and had lost 6–46 per cent of their body weights. All stated that they had had nutritional œdema, and in sixteen this was clinically detectable. There was nothing in their clinical histories or examinations to suggest hepatic dysfunction. Their livers were not enlarged and no examples of gynecomastia, spider nævi or palmer hyperæmia were encountered.

Liver tissue was obtained from each subject by aspiration biopsy[1]. Histologically this tissue was generally normal, and there were no signs of necrosis, cirrhosis or fatty change. The liver cells sometimes contained considerable amounts of iron and chromolipoid pigment. Diminished blood volumes and low concentrations of hæmoglobin were found in these under-nourished subjects. There was, therefore, a withdrawal of hæmoglobin from the circulation with the liberation of much iron. Moreover, muscle myoglobin, released as muscles waste, may have provided further free iron. Iron in excess of immediate requirements cannot be excreted to any extent[2], and is stored in the liver. The hepatic siderosis observed in these subjects was never of the same extent or distribution as that reported in malnutrition in South Africa[3]. 'Ceroid' pigment was not present in the liver.

The urinary urobilinogen was often increased, and the fæcal urobilinogen diminished. The serum total bilirubin was within normal limits, and the bromsulphthalein excretion test gave normal results. Hepatic glycogen estimated quantitatively, fasting blood sugar concentration, oral glucose tolerance, adrenalin tolerance, and insulin sensitivity tests were all normal. Alkaline phosphatase in the liver was normal both in amount and in histological distribution. Serum alkaline phosphatase was also within normal limits.

In fourteen of the subjects the serum taken in the recumbent position contained a concentration of less than 6·0 gm. of protein/100 ml. The serum colloidal gold reaction was usually negative. The concentration of total serum cholesterol was often low. The percentage of the total cholesterol in ester form was also low. The intravenous hippuric acid synthesis test gave normal results.

The subjects had been living for about a year on a diet the protein content of which was low and mainly of vegetable origin. The intake of lipotropic compounds (which are mainly in and associated with animal protein) must have been diminished. We have failed, however, to demonstrate the hepatic necrosis, cirrhosis or fatty change produced in experimental animals by low dietary protein or a deficiency of lipotropic compounds. Correlation of our results with recent reports of malnutrition in the Far East and elsewhere, and in experimental animals, is extremely difficult. The present report refers only to the effects of under-nutrition on one group of Europeans in one town in Germany, at one particular time, namely, August 1946.

The detailed results of this work will be given in a Medical Research Council Special Report now in preparation.

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Medical Research Council Unit,
Wuppertal, B.A.O.R., and
Department of Medicine,
Postgraduate Medical School of London.
Jan. 6.

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Isolation of Stilbœstrol Monoglucuronide from Human Urine

IN a recent letter[1] in *Nature*, Dr. A. E. Wilder Smith reports that he finds, by indirect methods, that about 50 per cent of stilbœstrol administered to human beings is excreted as a monoglucuronide. He was, however, unable to isolate this conjugate from the urine of patients treated with the drug. Although stilbœstrol monoglucuronide has been isolated[2,3] from the urine of rabbits receiving relatively large doses of stilbœstrol, it has never been isolated from human urine owing to the small doses normally used. We have now succeeded in isolating a glucuronide of stilbœstrol from human urine and proved it to be identical with that obtained from rabbit urine.

Through the courtesy of Prof. T. N. A. Jeffcoate, we have been able to obtain urine from two women immediately after parturition, who had received, in 24 hours, five 4-hourly doses of 20 mgm. of stilbœstrol. From this urine we were able to isolate the benzylamine salt of stilbœstrol monoglucuronide in a pure crystalline state. This salt had melting point and mixed melting point 223° C. and showed $[\alpha]^{20}_{D} = -55°$ ($c = 0{\cdot}2$ in 50 per cent aqueous acetone) and was identical with a sample (m.p. 223° C. and $[\alpha]^{20}_{D} = -55{\cdot}3°$ (in 50 per cent aqueous acetone)) which we had previously[3] prepared from pure stilbœstrol monoglucuronide isolated from rabbit urine. The yield of benzylamine salt corresponded to 35 per cent of the stilbœstrol administered. Small amounts of free stilbœstrol were also detected in the urine.

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Preparation of Œstrogens from Urine by Application of High Temperatures

ŒSTROGENIC substances are usually extracted from the urine of pregnant women, pregnant mares or stallions with organic solvents not miscible in water. There are certain disadvantages inherent in this method: large extraction vessels are required; in view of the great bulk of the initial liquid containing the œstrogenic substances in low concentration and the relatively small total interface between the urine and the solvent, a relatively large volume of the latter has to be used; this in turn involves the use of a large distillation apparatus and a high fuel consumption for the evaporation of the solvent from the extract. Moreover, a high proportion of ballast substances which later require separation accompanies the œstrogenic substances in the extract.

We found the following process helpful for the concentration and preparation of œstrogens: evaporate the initial liquid until a sticky, gum-like residue is left; and heat the residue to a temperature not exceeding 245° C. for five minutes so as to carbonize the bulk of the ballast substances, while substantially preserving the œstrogenic substances.

Extracts of the carbonized mass with organic solvents contain the œstrogenic substances in rather high concentration, so that the evaporation is a step of only minor importance. Owing to the virtually complete destruction of the ballast substances by the heating, the dry residue remaining after the evaporation of the solvent already possesses a high degree of purity. It can, of course, be further purified by the known methods.

None of the usual œstrogenic substances, such as œstrone, œstradiol, œstriol, hippulin, equilin, equilenine, and the like, are destroyed by the procedure of heating.

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Jan. 4.

A Rapid Method for the Estimation of Pregnanediol

THE presence in urine of pregnanediol can be detected easily and rapidly by the following procedure, elaborated in the course of recent investigations and based upon protection of pregnanediol by zinc dust during acid hydrolysis, thereby also preventing discoloration affecting the final colour reaction.

To 100 ml. of urine are added 1·5 gm. of zinc dust and the mixture is brought to the boiling point. Concentrated hydrochloric acid (10 ml.) is added and the mixture is boiled for five minutes. The flask is immersed in cold water, when the zinc dust settles rapidly; the supernatant fluid is then decanted on to a sand column. The zinc retained in the flask is washed successively with 25 ml. *N*/1 hydrochloric acid, 25 ml. *N*/10 hydrochloric acid and three lots of water, each 25 ml.

The washing fluids are also decanted on to the sand column after the zinc has settled. The sand column is dried by sucking hot air through it. The zinc dust retained in the flask is shaken up with about 20 ml. hot alcohol (95 per cent), and the hot extract is decanted on to the sand column. As an appreciable proportion of pregnanediol is retained by the zinc dust, the hot extraction has to be repeated three times. The alcohol is passed rapidly through the sand and the filtrate is evaporated to dryness. The residue is redissolved in 5 ml. alcohol (95 per cent), to which 20 ml. of *N*/10 aqueous caustic soda are added. After standing for one hour in the cold a precipitate forms, and this contains the pregnanediol fraction; it is collected on a fritted glass filter, washed with water and dried. About 10 ml. of hot alcohol are then slowly passed through the filter.

The filtrate may be used for the Gutterman colour reaction. For this purpose it is evaporated to dryness and the residue is dissolved in 5 ml. of concentrated sulphuric acid. In the presence of not less than 0·5 mgm. of pregnanediol per 100 ml. of urine a deep yellow or orange colour develops rapidly. In the absence of pregnanediol, the solution is pale yellow or colourless.

The method may be adapted to quantitative estimations by the use of larger quantities of urine and gravimetric methods. In a series of cases, 24- or 48-hour specimens of urine were divided into portions and pregnanediol was determined quantitatively both by Astwood and Jones' method and by the method described above, utilizing gravimetric and colorimetric procedures. Similarly, weighed samples of sodium pregnanediol glucuronidate were subjected to hydrolysis, pregnanediol being recovered by the two methods. It was found that the sand–zinc method gives yields of practically the same order as the Astwood–Jones method. The sand–zinc method is rapid and easy to carry out. It has been found useful in replacing the established but laborious methods in the diagnosis of pregnancy, impending miscarriage and other clinical conditions for which the detection of pregnanediol is required.

It is hoped to publish the work on which this method is based, along with some account of the cases to which it has been applied, in fuller detail elsewhere.

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Jan. 12.

Higher Fatty Acid Dehydrogenase of Mammalian Liver

AN enzyme dehydrogenating higher fatty acids has been described by several workers, including Lang and Mayer[1] and Annau *et al.*[2]. Lang and Mayer showed that adenylic acid activated such a system in rat liver, while Annau *et al.* showed that hypoxanthine similarly activated a fatty acid dehydrogenase of ox liver.

In order to elucidate the mechanism of the dehydrogenation, the purification of the responsible enzyme system has been attempted, but without appreciable success. Some experimental results obtained during this work, however, may be not without interest.

After dialysis against distilled water, both the preparations previously described[1,2] have now been shown to require coenzyme I, or at any rate a factor present in 45 per cent pure preparations[3] of the coenzyme. The purine or nucleotide activator is also required. Previous workers have reported that the enzyme activity is lost after standing for three days at 0° C., but with added coenzyme I the activity has been demonstrated after dialysing for ten days at 0° C.

REQUIREMENT FOR COENZYME I AND THE EFFECTS OF HYPOXANTHINE AND ADENYLIC ACID AS ACTIVATORS

Expt.	Activator (0·25 μmole of each compound)	Coenzyme I (45%)	Reduction times (min). With lauric acid (t_1)	Reduction times (min). No lauric acid (t_2)	Dehydrog. activity = 100 ($1/t_1 - 1/t_2$)
1	—	1 mgm.	24	27	0·5
2	Hypoxanthine	,,	7·1	15	7·3
3	,,	none	>50	>50	—
4	Adenylic acid	1 mgm.	7·0	10	4
5	,,	none	>50	>50	—
6	Hypoxanthine and adenylic acid	1 mgm.	6·0	8·5	4·5

A convenient source of enzyme is the dialysed aqueous extract of acetone-dried rat liver (1 ml. ≡ 40 mgm. dry wt.). The reaction velocity is measured by the rate of anaerobic reduction of methylene blue at 38° C. The stopper of the Thunberg tube contains 0·2 ml. of 1 : 2,000 methylene blue, while the tube itself contains 1·0 ml. enzyme, 1·5 ml. 0·02 *M*-lauric or palmitic acid emulsion in 0·15 *M*-potassium phosphate, *p*H 7·5, 20 μgm. hypoxanthine or adenylic acid and 1 mgm. coenzyme I preparation in a total volume of 3·0 ml. A control tube is otherwise identical except for the omission of fatty acid. To ensure that the two tubes are comparable, the *p*H values are checked by the glass electrode after the reduction of the methylene blue.

Added diaphorase has not been found to be necessary, but, assuming that the dye is reduced by the coenzyme I—diaphorase hydrogen—carrying system, there is sufficient diaphorase activity in the enzyme preparation to account for the slow reduction observed.

Hypoxanthine is a better activator than an equivalent amount of adenylic acid, adenosine di- or triphosphate, or xanthine. Uric acid and allantoin are inactive. The effects of adenylic acid and hypoxanthine are not additive, and since Kalckar[4] has shown the formation of hypoxanthine from adenylic acid in a similar enzyme preparation, it is reasonable to suggest that there is but one dehydrogenase system activated by hypoxanthine or a closely related compound.

In several repetitions of the preparation described by Annau, the high but variable recorded activities could not be repeated, even after dialysis and the addition of coenzyme I and diaphorase.

The use of dyes of higher redox potential than methylene blue (for example, 2 : 6 dichlorophenolindophenol and indophenol) did not affect the rate of decolorization.

The optimum *p*H is between 7·0 and 7·7. Kinetic measurements are not easy to interpret because of the relatively high 'blank'.

The enzyme system is soluble after prolonged dialysis against distilled water, and no activity is sedimentable on centrifuging at 10,000 × *g* for twenty minutes. 2×10^{-3} *M* sodium cyanide inhibits 40 per cent, while 3×10^{-4} *M* ammonium vanadate, 3×10^{-6} *M* chloracetophenone, 6×10^{-3} *M* hydroxylamine, 10^{-4} *M* oleic acid and 4×10^{-6} *M* silver nitrate inhibit completely.

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Enzymic Action of Viruses and Bacterial Products on Human Red Cells

HUMAN red cells incubated with a broth culture filtrate of *V. choleræ* acquire three new properties: they become panagglutinable[1]; they are no longer agglutinated by viruses of the influenza group[2]; and in the case of rhesus-positive cells, they become agglutinable by the corresponding incomplete *Rh*-antibody[3]. The finding that the influenza and Newcastle disease viruses produce the same three reactions on red cells[2,4] has stimulated further study of this phenomenon.

Appropriate human red cells were incubated at 37° C. for an hour with both a suspension from agar culture and supernatant from centrifuged broth culture of a number of bacteria. After washing and resuspension, the red cells were tested for virus hæmagglutination with influenza *A* (*PR* 8), influenza *B* (Lee), swine influenza (Shope) and Newcastle disease virus (Doyle), and for panagglutination by mixing them with serum from the same donor. The *Rh* test was performed either with serum containing incomplete anti-*D* antibody diluted beyond its panagglutination titre, or by suspending cells sensitized with anti-*D* and washed, in the bacteria products.

A survey of more than sixty organisms showed tha a number of bacterial species produce the active sub stance. Besides *V. choleræ*, potent preparations producing all three reactions have been obtained fron *V. proteus* and pneumococcus irrespective of type o virulence. Other organisms, including one strain eac of *Streptococcus* Group *D*; *Streptococcus viridans* *Staphylococcus albus*, *aureus* and *citreus*, *B. subtilis* *B. mycoides*, *Erysipelothrix rhusiopathiæ*, *Erysipelothrix monocytogenes* and *Salm. choleræ-suis*, eithe produce panagglutinability alone, or also weake hæmagglutination by some viruses, but are withou appreciable effect on red cells sensitized with incomplete anti-*D* antibody. Both bacterial suspensions and broth supernatants bring about these changes, although to somewhat different extent with different organisms. The different behaviour of different bacteria may be due to minor differences in the range of their substrates, or may be merely quantitative, depending on the differing sensitivity of the three tests. If the latter assumption is true, then the panagglutination test appeared to be most sensitive, the virus test came next and the incomplete anti-*D* test the least sensitive.

A preparation of concentrated and semi-purified enzyme from *Cl. welchii* type *B*, capable of destroying blood group *O*, *A* and *B* substances, was kindly supplied by Dr. W. T. J. Morgan and was found to produce all three changes in human red cells. These changes in red cells can be completely prevented by the previous addition of blood group *O* substance, and less completely so by *A* substance, both prepared from human ovarian cyst and hereafter referred to as human *O* substance and human *A* substance respectively. The same preparation of enzyme also inactivates the 'Francis inhibitor'[5] present in human *O* substance. These results do not necessarily mean that the same enzyme which destroys the *O* activity is also responsible for the red cell changes and inactivation of 'Francis inhibitor'. According to Morgan[6], the blood group *O* enzyme resists heating at 56° C. for thirty minutes, whereas heating in the same circumstances completely destroyed the activity on red cells and on 'Francis inhibitor'.

The enzymic nature of the process seems to be amply established by accumulated evidence. Freidenreich[1], in a detailed study of the panagglutination phenomenon produced by *M* and *J* diphtheroids and *V. choleræ*, concluded that the process is probably enzymic in nature. All these agents (cholera filtrate, *welchii* enzyme and viruses) are first adsorbed on to, and then released from, red cells, requiring an induction period which in the case of viruses can be studied by the visible agglutination and elution reactions. The active principles are either very thermolabile or moderately so. Thus, pneumococcus and cholera filtrates were greatly weakened after heating to 56° C. for half an hour, while the Newcastle disease virus and *welchii* enzyme were completely destroyed at this temperature. Red cells treated with heat-inactivated enzymes gave negative results by all three reactions.

Since the three reactions of red cells are produced by preparations derived from widely different sources, and since all three are simultaneously prevented by inactivation of the enzymes at a given temperature, it seems most probable that each preparation contains a single enzyme responsible for the production of all three reactions. This explanation is strengthened in the case of *welchii* enzyme by the observation that all three activities are inhibited by the presence of human *O* or *A* substance. Burnet, McCrea and Anderson[7] have reported that both cholera filtrate and influenza viruses destroy the 'Francis inhibitor' present in crude mucin and purified blood group *O* and *A* substances, without, however, altering the immunological specificity of *A* substance, which was the only one tested. The presence of 'Francis inhibitor' in human *O* substance, and to a much less extent in human *A* substance, has been confirmed. However, a mixture of blood group *A* and *O* substances purified from hog gastric mucin and containing comparable *O* activity to that of *O* substance from a human source has no 'Francis inhibitor' activity even at 0·1 per cent concentration.

I have also found that influenza *B* virus, Newcastle disease virus, cholera and pneumococcus filtrates, although capable of destroying the 'Francis inhibitor' property of human *O* substance, nevertheless have no significant effect on its immunological activity. Furthermore, their action on red cells is not inhibited by the presence of either human *O* or *A* substance. These findings seem to suggest that the blood group substances *per se*, as defined immunologically, are not the true virus receptor substance. A fuller report will appear elsewhere.

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Jan. 10.

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Choleglobin Formation in the Erythrocyte

The pioneer researches of Lemberg and his co-workers[1] have provided a new approach to the problems of hæmoglobin breakdown and bile pigment formation. Using his methods, we have recently re-examined the question of the occurrence of the intermediate choleglobin in the intact erythrocyte.

To determine the quantity of choleglobin present, the pigment is disrupted by 66 per cent acetic acid to biliverdin, which is extracted with 5 per cent hydrochloric acid, and measured colorimetrically. During the acetic acid treatment, further oxidation of biliverdin to biliviolin was observed, but Lemberg was able to prevent this change by addition of 10 mgm. ascorbic acid as antioxidant. It appeared to us that this procedure might lead to error, since choleglobin is itself formed rapidly by coupled oxidation of ascorbic acid with oxyhæmoglobin.

In the present work this difficulty was avoided by carrying out the whole Lemberg procedure in an apparatus that could be completely evacuated or filled with an inert gas, so that all the reactions could be carried out in an oxygen-free atmosphere. In this way, the following side-reactions were inhibited: (1) formation of choleglobin from oxyhæmoglobin by coupled oxidation with intracorpuscular ascorbic acid or glutathione; (2) oxidation of biliverdin to biliviolin by atmospheric oxygen, or by active oxygen liberated by acid denaturation of oxyhæmoglobin; (3) conversion of choleglobin to 'green pigment'.

Lemberg and Legge[2] have observed that normal human red blood corpuscles contain 1–5 μgm. biliverdin per c.c. combined as choleglobin.

In our anærobic experiments no choleglobin could be detected in a series of twelve separate samples of normal human blood, nor in blood samples taken from patients suffering from pernicious anæmia, leukæmia, hæmolytic anæmias, hepatic and obstructive jaundice, or polycythæmia, with the following exceptions: in one case of leukæmia we found 0·4 μgm. of biliverdin per c.c., while in one case each of pernicious anæmia and obstructive jaundice (pancreatic carcinoma) the concentration of pigment was at the lowest limit of optical measurement.

It would appear, therefore, that choleglobin production from oxyhæmoglobin does not take place in the normal erythrocyte, and this and subsequent changes to form biliverdin can only ensue after disruption of the corpuscle.

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Origin of Noble Sugar-Canes (*Saccharum officinarum* L.)

The cultivated sugar-canes belong to two main groups: (1) the thin and hardy types of north Indian canes botanically classified under *Saccharum Barberi* Jesw. and *Saccharum sinense* Roxb.; and (2) the thick or noble types, *Saccharum officinarum*. The origin of these noble canes is still obscure, and Barber[1] and Jesweit[2] were of opinion that it was in the mountainous islands of the Malayan Archipelago, New Guinea and Polynesia. It is considered that these types of cane were introduced into India only very recently and are referred to as 'the introduced canes', while the north Indian canes are held to be indigenous to India and any mention of sugar-cane in India in early historical records or mythological legends is believed to refer only to north Indian canes.

Cytogenetical studies[3], supported by morphological evidence, have indicated that the north Indian canes are complex polyploid hybrids derived from the extensive natural hybridization of *S. officinarum* with *S. spontaneum* L., a related wild species which has a geographical distribution extending from the slopes of the Himalayas down to the tropical plains of Sumatra and Java. Therefore, it was concluded that the north Indian canes are of a later origin than the noble canes and that the thick canes must have been in cultivation in India earlier than the 'indigenous' or north Indian canes.

Studies are now in progress to identify the fundamental species composition of the noble cane, *S. officinarum*, which is considered to be an octoploid ($2n = 80$) with a basic number $x = 10$ characteristic of Andropogoneæ[4]. In interspecific and intergeneric hybrids with *S. officinarum* it is found that the haploid complement ($n = 40$) of *S. officinarum* pairs auto-syndetically to the exclusion of pairing between parental chromosomes. This was to be expected owing to the polyploid composition of the haploid complement itself. When, however, the chromosome complement of *S. officinarum* was reduced to the diploid and haploid number by successive back-crossing with the *Sclerostachya fusca* A. Camus, a wild species of a related genus, the homology between parental chromosomes began to manifest itself. Thus, with the diploid number, although ten bivalents of *S. officinarum* were commonly noticed, a certain number of multivalents resulting from the pairin of parental chromosomes were also noticed. In th haploid state it was clearly noticed that five chromosomes of *S. officinarum* invariably paired with five o the other parental species, thereby showing homolog between them.

One of the types of the noble class of canes, namely *Vellai* ($2n = 80$), was crossed with *Sclerostachy* ($2n = 30$) and the hybrid was successively back crossed with the same wild species. The accompanying table gives in the main the analysis of chromosome associations at metaphase I of meiosis in th derived hybrids.

Association of chromosomes at metaphase I

	$2n$ (number)	No. in the species complements of hybrids		Pairing at metaphase I
		S. officinarum (*O*)	*Sclerostachya fusca* (*S*)	
Parents:				
S. officinarum (Vellai)	80			40^{II}
Scl. fusca	30			15^{II}
Hybrids:				
F_1 hybrid	55	40	15	$20^{II}(O) + 5^{II}(S) + 5^{I}(S)$
F_1 × *Scl. fusca* (back-cross I)	70	40	30	$20^{II}(O) + 15^{II}(S)$
B.C. I × *Scl. fusca* (back-cross II)	50	20	30	$10^{II}(O) + 15^{II}(S)$ $5^{III}(O+S) + 15^{II}(O+S) + 5^{I}(O)$ $2^{IV}(O+S) + 21^{II}(O+S)$
B.C. II × *Scl. fusca* (back-cross III)	40	10	30	$5^{III}(O+S) + 10^{II}(S) + 5^{I}(O)$

The basic number of ten chromosomes is now seen to be really constituted of two different sets of $x = 5$ chromosomes each, one set of which is common to both *Sclerostachya* and noble cane. A detailed account will be published elsewhere. The identification of these fundamental complements now remain to be investigated through a series of interspecific and intergeneric crosses by the utilization of the back-cross hybrids with the reduced complement of *S officinarum*.

It is interesting to note that *Sclerostachya fusc* was originally included in the genus *Saccharum*[5], and later was separated as a different genus. This specie is found widely distributed in India from Kashmi to Bengal and Assam and also in the Western Ghats It is clear from the above studies that *S. officinarun* and *Sclerostachya* have had a common ancestry through an unidentified basic species with $x = 5$ chromosomes. This would lend further support to the view that *S. officinarum* has been in existence in India from very early times and that it playec a part in the evolution of the north Indian or indigenous canes.

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Occurrence of the Amphipod *Orchestia bottæ* and Other Organisms in Britain

The range of *Orchestia bottæ* M. Edws. is greater than that indicated by Messrs. Cain and Cushing[1]. Besides the records from the Thames, I have specimens given me in 1945 by Mr. A. E. Ellis from the River Yare at Brundall, Norfolk. In 1947 I received specimens from the same area, but taken from much higher up the river, about twenty miles from the sea. In fact, it seems possible that this species is widely distributed throughout south-east England, and that recent discoveries disclose an established range rather than a late immigration from the Continent.

A similar case is that of *Eucrangonyx gracilis* (S. I. Smith), specimens of which I have from the Metropolitan Water Board's works at Lee Bridge; from a garden pond at Harrow (on the water system of the Colne Valley Water Co.); from ponds in Surrey; and lastly, in great abundance, from among floating dead leaves in a small backwater of the River Cherwell at Oxford in 1944.

Gammarus lacustris G. O. Sars has long been known to have a wide range in Scandinavian and other Continental fresh waters, and yet has only been discovered in Britain comparatively recently (1939). Despite this late discovery, persistent search has shown the species to be established in very many lochs in the north of Scotland, and so one concludes that it is really an old inhabitant.

In other words, it is not necessarily the range of some of these animals, I believe, that is increasing, but our knowledge of their range.

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Discovery of Radioactivity

In *Nature* of January 3, a review entitled "Atomic Energy" by Prof. J. A. Crowther referred to the progress made "since the spontaneous release of atomic energy fogged a packet of photographic material in the drawer of Becquerel's desk".

This sentence seems to imply that the discovery of radioactivity by Henri Becquerel, my father, in 1896, was fortuitous—which is incorrect. He intentionally subjected a photographic plate—not a "packet"—to the action of salts of uranium. His first idea was that phosphorescence of uranyl salts might be accompanied by a radiation similar to X-rays, which had just been discovered. Instead of rays associated with phosphorescence, Henri Becquerel found a new spontaneous radiation, emitted by all uranium compounds, phosphorescent or not, and he established that this radiation was an atomic property.

Hence it is undesirable that any idea of radioactivity being discovered by chance should arise.

Jean Becquerel

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Paris.

I am surprised that Prof. Becquerel should have read into a passing reference to his distinguished father's work, in my review of Prof. Gamow's book, a suggestion that the discovery of radioactivity was in any way "fortuitous". No such suggestion was intended. I had always imagined that the historic photographic plate was enclosed in some sort of light-proof wrapping, and might be legitimately, if briefly, described as a "packet of photographic material".

J. A. Crowther

Operational Research

In his admirable article on operational research in *Nature* of March 13, Sir Charles Goodeve makes the statement: "The application of the statistical tool is still on the increase, but there is no need or likelihood of the tool itself being developed further". Quite apart from the dangers inherent in making general prophecies about the likely advance (or lack of advance) in any field of science, this statement implies a degree of perfection in existing methods of dealing with statistical problems arising in operational research which would not, I think, be claimed by practising statisticians. In particular, the analysis of data (such as survey data) which can be classified in a number of different ways, and multivariate analysis, both require further development.

In the analysis of survey data it is often of considerable importance to determine differences between the different classes of any one classification, free from the disturbing effects due to disproportionate representation in the other classifications. The basic theory (that of fitting constants by the method of least squares) is well known, but no analytical technique suitable for routine application to extensive data has yet been worked out. In multivariate analysis, which is of the greatest interest in economics as well as in many other fields, progress in both theory and analytical technique may be expected.

The dependence of the development of any given technique of statistical analysis on the availability of suitable machines is often not sufficiently realized. Without the modern desk calculator, the development of the technique of the analysis of variance appropriate to experimental results, and the associated development in the theory of design of experiments, could scarcely have taken place. In like manner, multivariate analysis has been waiting on the further development of machine design which is only now being effected.

With Sir Charles Goodeve I confidently look forward to the introduction of novel methods primarily dependent on advances in other fields of science; but if these are to reach their maximum effectiveness they must be integrated with, rather than regarded as alternatives to, the statistical approach.

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I am grateful to Dr. Yates for correcting false impressions which may arise from my remark. Operational research as I have seen it has so far found the statistical tool adequate for that side of its work, but I might have guessed that there would always be 'frontiers' with unexplored fields or unsolved problems beyond.

Charles Goodeve

FORMATION AND BREAKDOWN OF SERPULID TUBES

By JEAN HANSON
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DURING an investigation of the blood systems of serpulid worms (Annelida, Polychæta), opportunities occurred to make the following observations on the mode of formation and breakdown of the calcareous tubes in which these animals live.

Although much research has been carried out on the asexual reproduction of *Salmacina* and *Filograna* by Malaquin, Faulkner[1] and others, it is not known how a newly formed individual leaves its parent's tube and makes its own tube. During last summer, specimens of *Salmacina incrustans* Claparède settled on the sides of a glass aquarium in the Zoological Station at Naples, and daily observations were made on the growth of the colonies. The new individual is formed at the posterior end of the parent, and after separation it moves backwards down the parent's tube and makes a hole in the side of the tube from which it protrudes its branchial crown (Fig. 1, *X*). It may destroy the posterior end of the parent's tube and thus separate it from the rest of the colony (*Y*). It may also form a new tube which grows out from the original opening (*Z*). These colonies spread out over the wall of the aquarium. Colonies taken from the sea usually consist of masses of entangled tubes raised off the substratum to which the basal parts are attached. These three-dimensional colonies are built up of tubes with side-branches which are presumably formed in the same way as in the two-dimensional colonies growing in the aquarium.

It is not known how the newly separated bud makes the hole in the side of its parent's tube. One is reminded of the ability of the sabellid *Potamilla* to bore into calcareous rocks[2]. At Naples *Potamilla* often lives inside the walls of the calcareous shell of the mollusc *Vermetus*. How *Potamilla* bores its holes is also unknown. Some observations of Fox[3,4] are interesting in this connexion. He has found that when the anterior end of the tube of *Sabella spallanzanii* is artificially closed, the animal can make a hole in the side of the tube, from which it then protrudes its branchial crown. The tube of *Sabella* consists largely of mucus and is not calcareous.

Alkaline phosphatase is probably concerned in the calcification of bone and in the formation of the calcareous shells of molluscs[5]. It was therefore interesting to find this enzyme in *Pomatoceros triqueter* L. (Fig. 2) which, like the other serpulids, builds a calcareous tube. When *Pomatoceros* is removed from its tube, it begins to form a new one[6]. The new tube first appears on the ventral surface of the anterior part of the thorax under the ventral collar fold. It is not known how this new tube is produced; but it seems likely that it is secreted by glands in this part of the thorax.

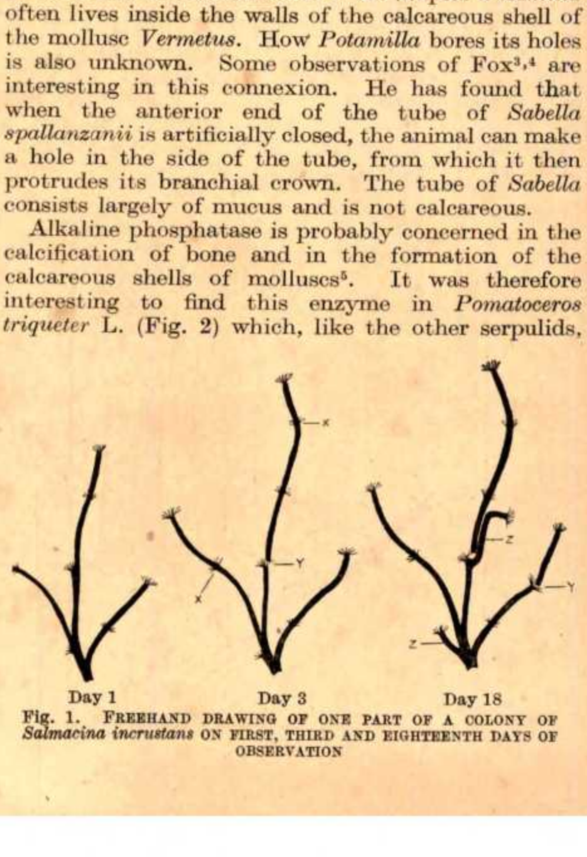

Fig. 1. FREEHAND DRAWING OF ONE PART OF A COLONY OF *Salmacina incrustans* ON FIRST, THIRD AND EIGHTEENTH DAYS OF OBSERVATION

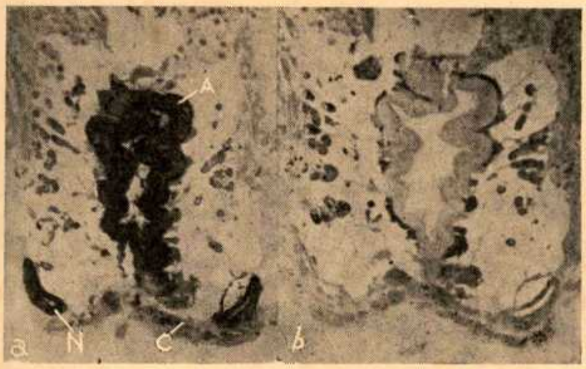

Fig. 2. PHOTOMICROGRAPHS OF HORIZONTAL LONGITUDINAL SECTIONS THROUGH THE THORAX OF *Pomatoceros triqueter*. × 25. (*a*) TREATED BY GÖMORRI'S METHOD FOR ALKALINE PHOSPHATASE (SITES OF ENZYME BLACK); (*b*) CONTROL

One specimen of *Pomatoceros*, fixed immediately after removal from its tube, was sectioned and tested for alkaline phosphatase by Gomori's method[7]. The enzyme was found in the following places:

(1) The epithelium of the alimentary canal (Fig. 2, *A*) from the posterior end of the œsophagus to within a few segments of the anus. This is the part of the alimentary canal concerned with the digestion and absorption of food[8]. Phosphatase was concentrated at the inner and outer borders of the cells and was also found in the nuclei and in small granules in the rest of the cytoplasm. There was a thick deposit of phosphatase on the cilia. Bourne[5] has shown that the enzyme is confined to the absorptive regions of the guinea pig's alimentary canal and is there concentrated in the brush borders of the epithelium. He has discussed the hypothesis that alkaline phosphatase is concerned in the phosphorylation of sugars being absorbed from the canal.

(2) The epithelia of the thoracic nephridia (Fig. 2, *N*) and their ducts. In the excretory sacs of the nephridia the phosphatase was distributed in the same fashion as in the gut epithelium, and was also present on the cilia. Alkaline phosphatase has been seen in the brush borders of the proximal convoluted tubules of the mammalian kidney[7] and in the brush borders of the Malpighian tubules of the goat-moth caterpillar and a spider[9]. Danielli[7] has discussed the suggestion that in the kidney alkaline phosphatase plays a part in the reabsorption of substances from the glomerular filtrate.

(3) The contents of the alimentary canal.

(4) The chloragosomes (yellow- or brown-coloured globules) in the chlorogogen cells which in serpulids lie on the thoracic ring vessels. Globules of similar appearance, also giving a positive phosphatase reaction, are found in the epithelium of the excretory sacs of the thoracic nephridia. According to Liebmann[10] chloragosomes contain food substances, and he has found that in the chloragosomes of the oligochæte *Eisenia fœtida*, phospholipins are transformed into fats, lipoproteins appearing as transitional substances. Alkaline phosphatase may play some part in this process.

A second specimen of *Pomatoceros* was fixed three days after it had been removed from its tube; it had not begun to form a new tube. Alkaline phosphatase was again found in the same four sites as in the other specimen, and also in the following places (Fig. 2):

(5) The borders of small irregular cavities (*C*) situated in the thick epithelium on the ventral surface of the thorax under the ventral collar fold. This is the tissue which probably secretes the calcareous tube, and alkaline phosphatase is perhaps concerned in this process, as it seems to be in the calcification of bone and in the formation of the calcareous shells of molluscs[5].

(6) The epithelium of the dorsal and ventral lips of the mouth.

(7) The nuclei of the endothelium in the walls of the blood vessels in some of the pinnules of the branchial crown. Bourne[5] has found the enzyme in endothelial nuclei of vertebrate capillaries.

I wish to thank the staff of the Zoological Station of Naples, the British Association for the Advancement of Science for the use of its Table, and the University of London for a grant towards travelling expenses. I am also indebted to Dr. A. Stock for advice on the use of Gomori's method.

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PLANT VIRUS PROTEINS AND ANTIBODY–ANTIGEN REACTIONS

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PROTEIN mixtures such as those found in blood have been widely used in the study of antibody–antigen reactions. It is difficult to prepare pure samples of single proteins from such naturally occurring mixtures. On the other hand, preparations of certain plant virus proteins, derived from a single infectious unit, can be isolated in quantities sufficient for experimental work in a state which fulfils all the usual criteria of homogeneity. As they are also good antigens, they would appear to be especially suitable objects for the study of antibody–antigen reactions.

The method used by Boyd[1] has been applied to the study of the turnip yellow mosaic virus antisera produced in rabbits. Successive doses of 0·01, 0·1, 1·0, 10·0, and 100·0 mgm. of turnip yellow mosaic virus[2] (prepared by the method of Markham and Smith[3]) were given intravenously to a single rabbit. Bleedings were taken two weeks after each injection, followed by a rest period of a few days before the next injection.

The antiserum produced by the 0·01 mgm. injection was of low titre with marked suppression of precipitation in the region of antiserum excess. This antiserum would be of the *H* type according to Boyd's classification. With increasing dosage of antigen the antiserum produced gave progressively higher titres, and the type of precipitating system produced tended progressively towards Boyd's *R* type, with less-marked inhibition in the region of antiserum excess.

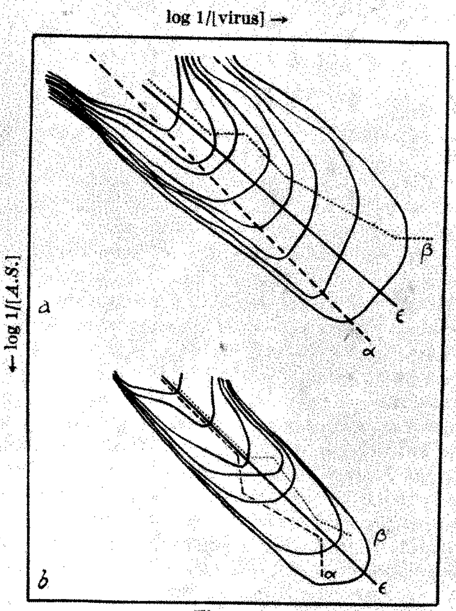

Fig. 1

Fig. 1*a* shows the precipitating system for the antiserum produced after the 0·01 mgm. plus 0·1 mgm. injections. Fig. 2 shows the system for the antiserum from the same rabbit after the full course of injections.

If this antiserum obtained after the full course of injections is diluted with normal serum to make its titre approximate to one of the earlier antisera obtained, then the type of system produced approximates fairly closely to that produced by the earlier bleeding. For example, the antiserum obtained after the full course of injections (with a titre of 1 : 8192) was diluted to 1 : 256 with normal serum and a precipitation diagram prepared (Fig. 1*b*). This antiserum precipitated to a titre of 1 : 64, and there was fairly marked inhibition in the region of antiserum excess similar in amount to that found for the antiserum of Fig. 1*a* with a titre of 1 : 128.

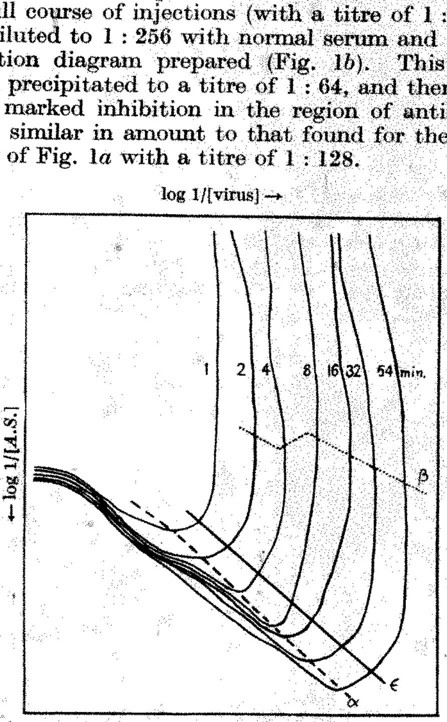

Fig. 2

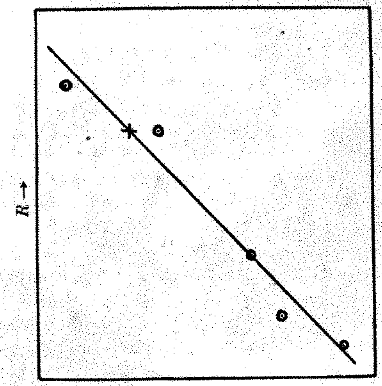

Fig. 3

The lowest concentration of virus which gives a precipitate is in general independent of the antiserum used, at antiserum dilutions where there is no inhibition by antiserum excess. The maximal inhibition by antiserum excess occurs with antiserum at 1 : 1. The ratio between the lowest concentration of virus giving precipitation with antiserum at 1 : 1 to the true virus end-point concentration gives a value for the amount of inhibition by excess antiserum which can be used to compare various antisera.

In Fig. 3 the ratio

$$R = \frac{[V] \text{ for antiserum at } 1:1}{[V] \text{ at real virus end point}},$$

where $[V]$ is end-point concentration of virus in mgm./ml., is plotted against the titre of the antiserum for the five sera used.

The point marked with a cross in Fig. 3 shows the position of the antiserum of Fig. 1*b*.

The inhibition in the region of antiserum excess shown in Fig. 1*b* can be due only to the presence of the non-specific constituents of the normal serum. On this account and in view of the close correlation between titre and amount of inhibition in the region of antiserum excess, it is suggested that the phenomenon of inhibition in the region of antiserum excess, the type of isochrones produced in this region, and the occurrence and position of the β-optimum, can be largely accounted for by some non-specific effect of normal serum constituents, at least in the system under investigation. Any theoretical consideration of the mechanism of this reaction, in the region of antiserum excess, will have to take this fact into account.

Rod-shaped plant viruses give a flocculent *H*-type precipitate whereas the spherical plant viruses give a dense granular *O*-type (Bawden[4]). Advantage has been taken of this fact in an investigation of the type of antiserum produced by a protein mixture. A rabbit was given a single intravenous injection of 1 ml. containing 1 mgm. of turnip yellow mosaic virus plus 1 mgm. of tobacco mosaic virus. An antiserum reacting with both viruses was obtained after two weeks. The same rabbit was given a second dose of 16 mgm. of each virus and a second antiserum obtained, of higher titre. These two antisera were tested against each virus separately, and against a mixture of known amounts of these.

That the two systems were precipitating independently was indicated by the following facts: (1) The position of the two α-optima for the two systems precipitating together was that which could be predicted from the two systems precipitating singly. (2) No significant decrease in titre of the antiserum for one virus was obtained after absorption with the other. (3) In the case of the two systems precipitating together, where the times for precipitation of the two systems were widely different in a single tube, the faster precipitate settled in the tube before the second precipitate formed, so that the latter formed a layer on top of the first.

In tubes where both systems precipitated about the same time, particularly in the higher concentrations, the gross floccules which were observed were homogeneous, and of indeterminate type. In view of the above, it is considered that this may possibly be due to mechanical entanglement of the smaller aggregates.

It is considered that, for the system studied, the antibodies produced in the rabbit are specific for the individual proteins of the mixture injected, and that in the *in vitro* reaction the two systems precipitate independently, except under conditions where the times for precipitation of the two systems are approximately the same, especially with high concentrations of the reagents.

A full account of these and other results will appear elsewhere. I wish to record my thanks to Dr. Roy Markham for his helpful encouragement and criticism.

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THE DISORDERING OF β-BRASS BY COLD WORK

By R. W. K. HONEYCOMBE and Dr. W. BOAS
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THE order–disorder transformation in β-brass has received much attention in recent years. However, it has not yet been found possible to obtain the disordered state at room temperature by quenching. Furthermore, an attempt to produce the disordered state by cold work[1] has not been successful, because the maximum amount of deformation which could be given to the pure β-brass was only 9·5 per cent reduction in area by drawing.

Since crystals of β-brass can be very heavily deformed when embedded in crystals of the more ductile α-phase[2], the use of a duplex brass provides a more likely way of producing the disordered state in β-brass. The X-ray method of showing the existence of the super-lattice in the case of β-brass presents great experimental difficulties; consequently we have used the electrical resistivity of the alloy to indicate its state of order. If the order is destroyed by cold work, an increase in resistivity is to be expected, by analogy with experiments which have been made with other alloys[3].

Lengths of duplex brass wire containing 41·3 per cent zinc were annealed for 30 minutes at 800° C., then furnace-cooled to room temperature over a period of 12 hours. This treatment resulted in a coarse structure in which the α- and β-phases were present in approximately equal proportions. The wires were then cold drawn to various reductions in area up to 95·5 per cent, and the electrical resistivities were measured on a Kelvin double bridge within two hours of drawing.

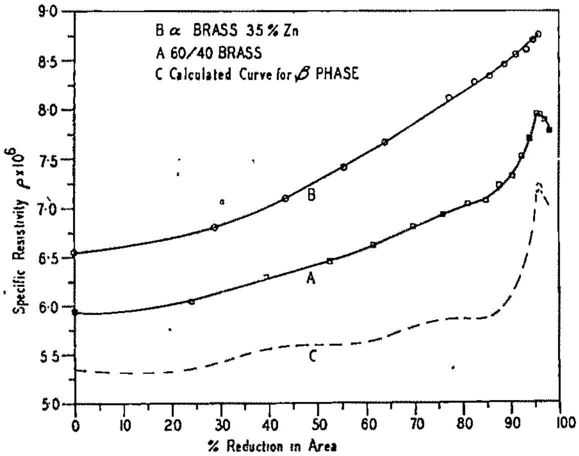

Fig. 1. SPECIFIC RESISTIVITY OF COLD-DRAWN α AND $\alpha + \beta$ BRASS WIRES

In Fig. 1 (curve *A*) the electrical resistivity is plotted against the degree of deformation. The resistivity increases with deformation, at first almost linearly, but more rapidly at higher deformations. After 95 per cent reduction in area, the specific resistivity had increased by about 33 per cent. At still higher deformations the resistivity slightly decreased.

To determine the individual behaviour of the α- and β-phases in the duplex wire, a similar series of measurements was made on a single-phase brass wire containing 35·1 per cent zinc, which is approximately the zinc content of the α-phase in the duplex brass. The results are shown in Fig. 1 (curve *B*). Although the resistivity of the α-brass also increases markedly with deformation, there is no rapid increase after heavy deformations. Assuming that the duplex alloy consists of equal parts by volume of each phase and that the α-phase in it behaves in the same way as the α-phase wire, then the behaviour of a wire consisting entirely of the β-phase can be deduced (Fig. 1, curve *C*). This curve indicates that the resistivity of the β-phase changes little up to 85 per cent reduction in area, where the curve turns steeply upwards. After 95 per cent reduction in area, the curve begins to fall.

In order to ascertain that this increase at high deformations was not a result of cracking, the wires were annealed in hydrogen at 800° C. for 30 minutes and furnace-cooled, that is, they received the same treatment as before deformation. Thus no difference in the distribution of the two phases should have occurred. The results of resistivity measurements on the annealed wires are shown in Fig. 2 (curve *A*), which indicates that all the wires have specific resistivities close to that of the original wire prior to drawing. Moreover, microscopic investigation showed no evidence of cracking, and the mere fact that the wires can be drawn still further points in the same direction. Thus the steep increase in resistivity of the duplex wires after heavy deformations can only be attributed to the disordering of the β-phase. After 95 per cent reduction the β-phase has apparently become completely disordered when further cold work has little effect on the resistivity. That this occurs only after an unusually high extent of total deformation is probably due to the fact that in the duplex alloy the β-phase receives a smaller fraction of the deformation than the ductile α-phase.

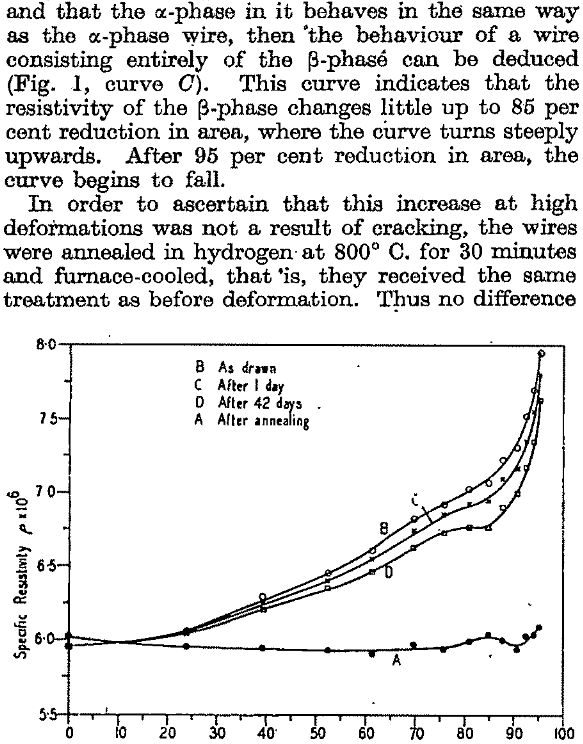

Fig. 2. SPECIFIC RESISTIVITY OF COLD-DRAWN $\alpha - \beta$ BRASS WIRES

The resistivity of the duplex wire decreased with time after drawing. Fig. 2 shows the resistivity on drawing (*B*, corresponding to Fig. 1 *A*) after one day (*C*) and after forty-two days (*D*). It will be seen that after forty-two days the increase in resistivity produced by intensive cold work has decreased by 20 per cent. Further experiments showed that this recovery was in fact complete after twenty-seven days, and a subsequent decrease in resistivity after a period of seventy-nine days was only just measurable. In contrast with these results on duplex wires, α-phase wires showed no pronounced recovery, any decreases being of the order of ½ per cent six days after drawing. It is thus concluded that the β-phase is responsible for the changes in resistivity with time of the drawn duplex brass wires. The disordered state produced in the β-brass is presumably not completely stable, and a certain degree of re-ordering occurs at room temperature.

The marked change in resistivity produced by working a single-phase brass wire (35 per cent zinc) is also interesting. We found that the resistivity of brass wires of other compositions also increased, although that of pure copper did not. This fact is in contrast to statements made in the literature[4] that the electrical resistivities of terminal solid solutions are not affected by cold work. It does not seem improbable that a certain degree of order exists in α-brass and even in other α-solid solutions.

The work described above was carried out as part of the programme of the Section of Tribophysics, of the Council for Scientific and Industrial Research, Australia.

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ROOFS SUPPORTED BY AIR PRESSURE

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ROOFS supported by air pressure are being seriously considered for long-span building construction as the result of tests conducted at New York University for the United States War Production Board in 1944.

Flat, circular membranes, fixed around the periphery, were stretched above the elastic limit by air pressure to shallow dome shape, and were tested for load-bearing properties and stability at slight, continuously maintained pressures. Neither unsymmetrical loading on sheet steel models up to 12 ft. in diameter nor wind-tunnel tests disclosed undesirable features.

Besides theoretical studies of stress and strain distribution in the membrane, construction features and experience obtained with actual pressure-supported roofs were investigated. One of these structures was a semi-cylindrical roof, 25 ft. radius, 200 ft. long, built of 22-gauge sheet steel on formwork which was supplanted by 0·5 lb. per sq. in. air pressure after the ends were closed with a flexible connexion and the floor rendered airtight. This structure was built in 1934 at Minneapolis and was used as a 70,000-bushel grain bin for a year, after which it was dismantled because grain dust in suspension constituted an explosion hazard. Another structure investigated was a series of flexible-roofed inflated gas holders built of thin steel plates up to 300 ft. in diameter.

Because air-supported roofs offer enormous spans with the minimum of structural materials, they have caused considerable interest. The aeroplane manufacturer, Glenn L. Martin, proposed an 800-ft. diameter roof for a football stadium at Baltimore in 1945, shortly before the construction of amusement structures was forbidden by the U.S. Government. This roof was to have been of 52–SO aluminium alloy 0·109 in. thick with welded seams, and was to be supported by 0·06 lb. per sq. in. (gauge) air pressure maintained by ordinary ventilating fans discharging into the enclosure formed by the walls and ground. Entrance and exit were to be by revolving doors, and means were included for raising the pressure to balance snow loads and to supply power in case of power failure. The roof membrane was to be anchored to a concrete compression ring around the periphery of the stadium having sufficient strength to withstand the inward pull of the membrane to its yield strength. The membrane was to be formed by air pressure to finished shape from a somewhat flatter constructed shape. This would relieve stresses in the welded seams and tight spots in the membrane, and constitute a proof test of the structure. The air pressure to do this was calculated to be about 0·22 lb. per sq. in., a pressure of small physiological importance, and one obtainable with the ventilating blowers. This pressure would be about that needed to support 2·5 ft. of snow; and the roof capable of containing this pressure would also be capable of withstanding the lifting effect of a wind velocity of 125 miles an hour. These figures were based on the experiments previously mentioned. It was also found with a flutter model in the wind tunnel that a slight excess pressure maintained in the structure prevents rippling or flutter of the roof.

A number of other buildings using this roof have been considered, although none, so far, has been built. These include smaller structures about 300 ft. in diameter in which the circular anchor ring is carried overhead on columns and the building space extended underneath to fill out the corners of the lot. Structures ranging upwards to 1,800 ft. in diameter for industrial buildings, storage warehouses, commercial and amusement structures where clear span and low cost were important factors have been investigated. It was discovered that such structures could probably be built over the poorest of soils, since the roof loads were evenly transmitted to the floor and not concentrated at the footings. Another factor of interest is that positive pressure within the structure precludes outside air leakage into the building, making exceptional control of the interior atmosphere possible.

A weatherproof transparent plastic of possible use for these roofs is being developed in the United States. If the material, now in pilot-plant construction, is satisfactory, the utility of these roofs would be enormously extended. An unofficial group in Washington, D.C., is investigating the use of a transparent roof over a central courtyard surrounded by a block of apartments for human habitation, and following a suggestion of Prof. J. D. Bernal, a group in Salt Lake City, Utah, is investigating its possibilities for the growing of plants in waterless areas where the moisture may be conserved by the roof. The possibilities of extending the food-growing areas of the world by a technique involving little more than the cost of the plastic and the anchoring means might be of great importance. Likewise the possibility of inexpensively separating large areas from the prevailing atmosphere, and rendering them climatically inhabitable, may have considerable effect in the tropics.

A British Patent 591985 has been allowed on this construction and is endorsed Licence of Right.

PRODUCTION OF AN ANTIBIOTIC SUBSTANCE ON WHEAT STRAW AND OTHER ORGANIC MATERIALS AND IN THE SOIL

By ERNA GROSSBARD

Experimental and Research Station, Cheshunt

MANY soil micro-organisms produce under artificial conditions antibiotic substances which inhibit the growth of certain plant pathogens. On the assumption that a similar process may take place in the soil, investigations on this problem were commenced at the Research Station, Cheshunt, and an attempt made to devise a method whereby antibiotic substances will be produced abundantly in the soil for the purpose of controlling soil-borne diseases. Blair[1], Garrett[2], Millard and Taylor[3], West and Hildebrand[4], Sanford[5], and others, have reported that organic manuring reduced the incidence of certain soil-borne diseases and have suggested that microbial antagonism may be one of the important factors.

Our experiments here have shown that certain micro-organisms known to produce antibiotic substances on synthetic media, such as *Aspergillus clavatus*, *Aspergillus terreus*, *Penicillium patulum* and *Streptomyces antibioticus*, will do so when grown on autoclaved wheat straw to which water has been added[6].

Penicillium patulum has been studied in detail because patulin (clavacin), the antibiotic substance produced by it, has a considerable inhibitory effect on the growth of certain plant pathogens[6,7,8,9]. The organism grew well on sterilized soil, but aqueous soil extracts did not inhibit the growth of the test organisms *Bacterium coli*, *Bacillus mycoides* and *Bacterium phytophthorum*. An antibiotic substance was formed, however, when the fungus was grown on sterilized wheat straw, bracken and sugar beet

TABLE 1

Medium	Diameter of area of inhibition (mean to nearest mm.)
Straw and water	20
Straw and water and 3·5% glucose	27
Sugar beet waste and water	29
Bracken and water	17
Bracken and 3·5% glucose and water	27

TABLE 2

Medium	Inhibition of *B. mycoides* (1 : 10 suspension)	Diameter of area of inhibition
(*a*) Soil and water	None	—
(*b*) ,, ,, and 2·5% straw	Partial	12
(*c*) ,, ,, and 5% straw	Complete	15
(*d*) Soil, water and 2% glucose	Complete	21
(*e*) ,, ,, and 2 5% straw	Complete	26
(*f*) ,, ,, and 5% straw	Complete	28

waste. The addition of glucose (3·5 per cent by weight) increased the inhibitory action of the wheat straw and bracken cultures. The undiluted culture fluid was assayed by the cylinder plate method. The plates were bulk-seeded with a 1 : 10 suspension of *B. mycoides*.

Among plant pathogens inhibited by the culture fluid of *P. patulum* grown on wheat straw and water were *B. carotovorum*, *B. aroideæ*, *B. phytophthorum* and several species of *Phytophthora*. There are indications that a number of other phytopathogens are also sensitive.

Autoclaved composted wheat straw when inoculated with *P. patulum* gave an antibiotic substance only in the presence of glucose. This also applied to peat, and to some extent to fescue, lucerne, mustard and sainfoin. Without glucose, cultures on the four latter materials gave inconsistent results varying with the sample used. In general, the inhibitory agent appeared to be rather unstable. Fescue gave the best results.

Experiments were then made to determine whether an antibiotic substance could be produced within the soil. Fresh wheat straw, 5 per cent, and water, 50 per cent by weight, were mixed with oven-dried soil, autoclaved and inoculated with *P. patulum*. After incubation the liquid expressed from the soil was assayed against *B. coli*, *B. mycoides* and *B. phytophthorum* by the cylinder plate method. It completely inhibited the growth of the test organisms.

A decrease in the quantity of wheat straw reduced the inhibitory action on the test organisms, while the addition of glucose greatly increased it. When straw was omitted and glucose (2 per cent) added, figures were only slightly lower than those obtained, for example, from a soil, straw (2·5 per cent) and glucose (2 per cent) medium (see photograph, Table 2).

It appears that carbohydrate decomposition is an essential factor for the production of an antibiotic substance in sterilized soil by *P. patulum*. A sterilized medium loam such as was used in this experiment may be an adequate substratum for the growth of the fungus; but it does not provide the conditions necessary for the production of an antibiotic substance. Yet as a matter of precaution it should be said that the absence of an inhibitory agent in the liquid expressed from the soil is not conclusive evidence that the antibiotic substance has not been formed at all. At low concentrations adsorption may take place. Garrett, West and Hildebrand, and Sanford have found that the addition of glucose to the soil decreased the incidence of certain diseases. These workers suggested that glucose effected a favourable modification of the microflora of the soil.

Glucose or other sources of carbohydrates such as wheat straw appear to be necessary for the manufacture of an antibiotic substance by *P. patulum*, at least in sterilized soil. It is tentatively suggested that, apart from altering the microflora, glucose may, in addition, induce the production of antibiotic substances in the soil not only by *P. patulum* but also by other micro-organisms.

This work has been carried out with a grant from the Agricultural Research Council. I am greatly indebted to Dr. W. F. Bewley, director of the Experimental and Research Station, Cheshunt, for guidance and advice.

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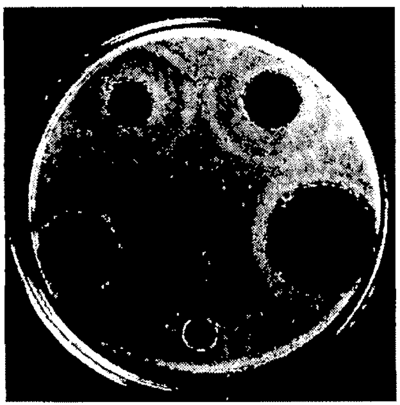

VARIATIONS IN THE ZONES OF INHIBITION. CYLINDERS WERE FILLED WITH SAMPLES OF MEDIA *a*—*e* (TABLE 2). AN UNDILUTED SUSPENSION OF *B. mycoides* WAS USED. NOTE ALSO ZONES OF STIMULATED GROWTH

SEISMOLOGICAL RESEARCH IN GREAT BRITAIN

THE report of the British Association Seismological Committee to Section A (Mathematics and Physics) at the Dundee meeting in September 1947 covers a wide field of work during the period 1942–47.

During the war years, much of the time of the staffs of British seismological stations was devoted to war work. At Kew the three Galitzin instruments and the short-period vertical seismograph were maintained continuously. The Wood–Anderson seismographs were discontinued in May 1942, but were restarted for the Heligoland explosion of April 18, 1947. One of these is to be sent on loan to the Royal Observatory, Helwan. The analysis of seismograms is complete to date, and the Kew monthly bulletin, discontinued in May 1940, is being restarted. During the War, information on the recording of flying bomb and other explosions was supplied to Government departments, and help was given to the Admiralty Research Laboratory at Teddington for studies on the correlation of water-waves and microseisms. At Bidston, the seismograph was maintained so far as possible throughout the War, but at times the supply of paper for recording ran out. At Durham, continuous recording ceased from July 1, 1939 until December 31, 1945. The observatories at Aberdeen, Stonyhurst and West Bromwich were kept going by Dr. A. E. M. Geddes, Rev. J. P. Rowland, and Mr. J. J. Shaw, respectively, as has also the Jagger shock recorder at Comrie, thanks to Messrs. W. Macbeth, Bruce, White and Clark. At Edinburgh the seismograph has been maintained in operation throughout the war years, but in view of the pressure of other work no readings from the records have been made since August 10, 1939. Mr. E. W. Pollard has continued his seismograph at Binstead, Isle of Wight.

Natural earthquakes occurred in Great Britain on December 30, 1944, at Skipton in Yorkshire, and at Spean Bridge (Scotland) on Christmas Day, 1946.

Use of Explosives

A Joint Committee of the Royal Society and the Ministry of Supply was formed early in 1946 to investigate the use of surplus explosives for seismological purposes. It was found impracticable to detonate large charges in Britain, but observations have been made on explosions in Germany. Very thorough arrangements were made for the observation of the results of the detonation of about 6,000 tons of explosive at Heligoland on April 18, 1947, and the seismograph records are being studied at Cambridge, in Germany, and by the U.S. Naval Ordnance Laboratory. From Cambridge, also, parties are examining the cross-sections of steep-sided valleys filled with glacial deposits south of Cambridge, in the Lake District and in Wales. A method has also been evolved of carrying out controlled explosions in the water at sea for seismic purposes, but at present there is some difficulty in borrowing a ship.

International Seismological Summary

The work on the International Seismological Summary has now moved from the University Observatory, Oxford, to its temporary home at Kew Observatory, Richmond, Surrey. It is intended that it shall find in due course a permanent home at Cambridge. As the final part of the work from Oxford, Miss E. F. Bellamy, who has just retired, has published an Index Catalogue of Epicentres for 1931–35. This is a supplement to the Index Catalogue 1913–30. The epicentres are arranged by latitude and longitude into four groups: N. and E.; N. and W.; S. and E.; S. and W.; and the date for each shock is given. At the end of the paper two valuable maps on Mollweide equal-area projections are given showing the epicentres. Seismologists will be indebted to Miss E. F. Bellamy, Prof. H. H. Plaskett and the University Observatory at Oxford for the work and for meeting the cost of the printing, also to the American Museum of Natural History for the outline maps. As the first instalment of the work from Kew, the International Seismological Summary for the period January, February, March 1936 has been issued. This contains the readings from observatories, epicentres in geographic co-ordinates and initial times for 116 earthquakes, eight of which are deep-focus earthquakes. The task of bringing this, the final word anywhere on any earthquake, more up to date is formidable. The United Nations Educational, Scientific and Cultural Organisation is expected to contribute funds, and then with sufficient computational assistance the work can be brought as near to date as observatories can send in their final readings of seismograms.

Applied Seismology

In the realm of applied seismology we have the use of the seismograph to obtain news of storms at sea, and in prospecting for minerals, including mineral oil. Both these ways of utilizing seismological methods are being actively employed in Great Britain. The work on the correlation of sea waves and microseisms carried out by the Admiralty has been described by Dr. G. E. R. Deacon, in *Nature* (**160**, 419; 1947); taken in conjunction with the work of the Jesuit Seismological Association, St. Louis, U.S.A., it is a most important piece of work. This work is being followed up by the Admiralty, by the Jesuit Seismological Association and by the U.S. Coast and Geodetic Survey.

Exploration for oil by the seismic method has been going on for some time. Artificially produced earthquakes are sent through the surface layers of the earth, which, if they have sufficiently diverse elastic properties, affect the waves in such a way that, afte making certain assumptions, the character and thickness of the layers may be deduced from the readings of the seismograms. The seismic method i thus used to locate structures such as closed anticlines or domes of porous material likely to contai mineral oil, capped by impervious shale which prevent the escape of the oil. The 'refraction shooting' metho has been used largely in Great Britain, but 'ar shooting' by the Anglo-Iranian Oil Co. was th deciding factor in the opening up of the Eakrin oilfield in Millstone grit sandstones capped by th coal measure shales of Nottinghamshire, which ha produced to date more than 100 million gallons of oil Traces of mineral oil have also been found in th Cretaceous and Jurassic strata in the south o England, but attempts to extract oil from th Mesozoic beds have proved disappointing.

The search for oil by geophysical means ha incidentally discovered new coalfields in Grea Britain. In the search for coal, extrapolations ar carried out from known geological facts, and th likely areas are then surveyed in order by (1) magnetic (2) gravity, (3) seismic methods; and if the are passes all these tests it is then drilled. The magneti survey is quick and easy to carry out, and gives broad outline of the structure provided there is marked magnetic property associated with th structure. The gravitational survey will give an ide of the variation in density in the underlying strat and is rapid and easy to carry out with such instruments as the Frost gravimeter which is, in effect, very sensitive spring balance. The seismic metho takes longer and is more expensive, but gives better idea of the underlying structure.

So far, an extensive coalfield has been verified b boring to 4,000–5,000 ft. in Central Lincolnshire, an it is hoped that the measures will rise as the approach the Wash. Coal measures have bee disproved by a boring at North Creake in nort Norfolk. Seismic surveys have been completed i the vicinity and to the west and south-west Market Drayton in Shropshire, and between he and Burton-on-Trent. Gravity and magnetic survey have been carried out in Wiltshire as an eastern continuation of the Somerset Coalfield, or there may be an independent coalfield, in the Cotswold country of Gloucestershire and in southern Worcestershire, and in certain areas in Oxfordshire—between Oxford and Reading. Work in eastern Essex was also contemplated. In all the above areas there is a possibility of coal being found. Other areas are under consideration, including extensions of present known coalfields.

UNITED NATIONS CONFERENCE ON THE CONSERVATION AND UTILIZATION OF RESOURCES

A REPORT by the Secretary-General of the United Nations, presented as a result of the decision of the Economic and Social Council on March 28, 1947, to call a Scientific Conference on the Conservation and Utilization of Resources, for the purpose of exchanging information on techniques in this field, their economic costs and benefits and their interrelations, recommends that the Conference should be held in the United States during May 16–June 3, 1949. A note on the financial implications is being prepared on the assumption that it will be held at Lake Success; but possibilities of another location are being explored. Four classes of participants in the Conference are contemplated: representatives from Government services, members of non-Government services and individuals selected by member Governments; individual specialists selected with the advice of the Preparatory Committee to prepare papers or to lead discussion, invited by the Secretary-General, in consultation with the Governments concerned; representatives of the United Nations and its specialized agencies; and representatives of interested international organisations and learned societies, and distinguished members of the professions, to be admitted at the discretion of the Secretary-General.

The primary concern of the Conference is with the practical applications of science to public administration and human needs, rather than with minute refinements in research and scientific methodology, and the Conference should serve a uniquely important function by bringing together experts from many related fields. About half the time of the Conference will be given to primary sessions on subjects of general interest such as resource requirements for industrialization, the contribution of improved agriculture to living standards, the planning of multiple use development of regional resources, education in conservation, and the sources and methods for mobilization of capital and man-power for resource development. Technical sessions in the remaining half of the programme will give experts concurrent opportunity of exchanging information on minerals, fuels, power, water, soils, crops, livestock, forests, fish and wild-life, and though primarily devoted to the discussion of methods for the development of natural resources, will reflect the importance in such developments of techniques relating to standards of health and living. Particular attention will be devoted to the special problems of the under-developed countries.

These technical sessions may be expected to stimulate the economic development of such countries by defining the technical knowledge gained in the last decade in determining the resource requirements for various types of industrialization, by exploring the technical problems involved in raising the standard of living by increased agricultural production, by considering the institution of new techniques and by the modification of existing curricula to facilitate the provision of trained personnel in such countries and by directing the attention of the scientific men and technicians of the world to the research and design problems of these areas. A draft programme is being prepared for circulation to all members of the United Nations for comment, and the Secretary-General also proposes to establish a standing Preparatory Committee as well as to convene in certain regions informal meetings of experts. The Economic and Social Council is also being requested to establish a small temporary Consultative Committee representing about six member Governments.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, April 20

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. A. J. Wakefield: "The New East African Ground Nuts Scheme".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. W. G. C. Forsyth: "Carbohydrate Metabolism in Soil".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Colonel D. H. Gordon: "The Prehistoric Cultures of the Zhob and the Indo-Iranian Connexion".

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. C. J. Milner: "Long-Wave Infra-Red Detectors".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. E. A. G. Johnson: "Flooding in the Fens and Remedial Measures Taken".

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. L. Brooks: "Geography in Education and Citizenship".

OIL AND COLOUR CHEMISTS' ASSOCIATION (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. K. McTaggart: "Esters of Titanium".*

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Symposium on "Modern Techniques in Stereoscopy".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Mr. F. Turner: "Some Applications of the Supersonic Frequency Detector in Steelworks Inspection".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at St. Enoch Hotel, Glasgow), at 7 p.m.—Mr. G. H. Lister: "An Investigation into the Practical Aspects of the Absorption of Acid and Chrome Dyes by Wool".

BRITISH POLISH SOCIETY (at the Polish Institute, 81 Portland Place, London, W.1), at 8 p.m.—Prof. S. Loria: "The Organisation of Scientific and Cultural Life in Wroclaw".*

Wednesday, April 21

TEXTILE INSTITUTE (in the Council Chamber, Town Hall, Macclesfield), at 12 noon.—Annual General Meeting; at 2.30 p.m.—Mr. Allan Walton: "Art in relation to the Textile Industry" (Mather Lecture).

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 2.30 p.m.—Dr. D. T. A. Townend: "Recent Developments in Combustion".*

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Robert Robinson, P.R.S.: "The Structural Relationships of some Plant Products" (Trueman Wood Lecture).

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 4 p.m.—Symposium on "Laboratory Layout and Construction".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Dr. H. G. Booker: "Some Problems of Radio-Meteorology" (Symons Memorial Lecture).

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. E. S. Horning: "Researches on Cosmic Radiations at the High Alpine Scientific Station, Jungfraujoch"; Dr. E. P. George: "Physical Properties of Cosmic Radiation".

British Institution of Radio Engineers, Scottish Section (at the Institution of Engineers and Shipbuilders in Scotland, Elmbank Crescent, Glasgow), at 6.45 p.m.—Mr. J. B. Birks: "The Physical Applications of Microwaves".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Publication and Classification of Scientific Knowledge" (Speakers: Sir David Chadwick, Prof. J. D. Bernal, F.R.S., Dr. Alexander King and Dr. H. T. J. Ellingham).

Thursday, April 22

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. A. N. Drury, F.R.S.: "The Lister Institute of Preventive Medicine".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. B. Barnes: "White Flowers in *Ranunculus Flammula* Linn."; Prof. W. E. Le Gros Clark, F.R.S.: "A Review of the African Fossil Primates discovered during the Year 1947".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. J. G. van der Corput: "Properties of Rationality in Geometry".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. B. H. C. Matthews, F.R.S.: "The Nervous System as an Electrical Instrument" (Thirty-ninth Kelvin Lecture).

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Mr. H. King: "Curare Alkaloids—Constitution of *dextro* tubocurarine Chloride and its Botanical Origin"; Mr. P. Oxley, Mr. M. W. Partridge, Mr. D. A. Peak, Mr. T. D. Robson and Mr. W. F. Short: "New Methods for the Preparation of Amidines".

Friday, April 23

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Solar Radio Noise".

Chemical Society, Newcastle and Durham Section (at King's College, Newcastle-upon-Tyne), at 5 p.m.—Prof. Linus C. Pauling: "The Valence of Metals and the Structure of Intermetallic Compounds" (Bedson Club Lecture).

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Prof. A. F. Burstall: "The Work of the Engineering Department in a University".

Royal Statistical Society, Industrial Applications Section (at the Mining and Technical College, Crumlin, Mon.), at 6.30 p.m.—Dr. B. P. Dudding and Mr. W. J. Jennett: "Applied Statistics and Industrial Efficiency".

Saturday, April 24

Institution of Chemical Engineers, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. S. H. Wilkes: "Dust Explosions in Factories".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Responsible Lecturer in Electrical Engineering—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (April 24).

Lecturer or Assistant Lecturer in the Department of Physics—The Registrar, The University, Sheffield (April 24).

Assistant Lecturer in Physics—The Principal, Municipal College of Technology, Manchester (April 26).

Professional Officer (Plankton Research), Division of Fisheries, Department of Commerce and Industries, Cape Town—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, W.C.2 (April 30).

Lectureships and Senior Lectureships in Physics—The Secretary of University Court, The University, Glasgow (April 30).

Museums Assistants in the Victoria and Albert and Science Museums—The Museum Superintendent, Science Museum, or Victoria and Albert Museum, South Kensington, London, S.W.7 (May 1).

Lecturer or Assistant Lecturer in the Department of Civil Engineering—The Registrar, The University, Sheffield (May 1).

Registrar, and a Librarian, of University College, Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (May 1).

Technician (male) in the Pathological Department of the West Midland Forensic Science Laboratory, Birmingham—The Establishment Officer, Home Office, Room 297, Whitehall, London, S.W.1 (May 10).

Chair of Bacteriology at St. Mary's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 12).

Chair of Physiology at London Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 13).

Senior Assistant in the Academic Department of the Headquarters Administrative Staff—The Principal, University of London, Senate House, London, W.C.1 (May 15).

Professor in Civil Engineering at Ceylon Technical College—The Ceylon Government Representative, 28 Cockspur Street, London, S.W.1 (May 15).

Assistant Lecturer in the Department of Physics—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (May 20).

Demonstrator in the Department of Geology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (May 21).

Assistant Lecturer in the Department of Zoology and Comparative Anatomy—The Registrar, University College of South Wales, Cathays Park, Cardiff (May 31).

Chair of Statistics at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, W.C.1 (May 31).

Associate Professor of Anatomy (Sub-Department of Human Embryology and Histology) at the University of Queensland, Brisbane—The Agent-General for Queensland, 409 Strand, London, W.C.2, or the Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Brisbane, May 31).

Professor of Physiology, and a Professor of Anatomy, in the University College of the West Indies—The Secretary, Special Committee of the Senate on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (June 1).

Lecturer in Personnel Practice in the Department of Social Studies, University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Melbourne, June 30).

Nuffield Fellowships for Experimental and Theoretical Research in Nuclear Physics—Professor of Natural Philosophy, The University, Glasgow, W.2 (June 30).

Senior Lecturer in Botany at Victoria University, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Wellington, June 30).

Fisheries Officers in Malaya—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1.

Design Engineers and Planning Engineers in the Department of Atomic Energy (Production)—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

Lecturer in Biology—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Scientific and Technical Liaison Officer of the International Wool Secretariat for its North American Section, New York—The Secretary, International Wool Secretariat, 18 Regent Street, London, W.1.

Lecturer in Radio Engineering—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Physical Chemist or Physicist to undertake fundamental work on metal finishing problems, including electro-deposition and electro-polishing—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

The Outlook for the Radio Industry. By David Sarnoff. Pp. 20. (New York: Radio Corporation of America, 1947.) [306

Union Géodésique et Géophysique Internationale: International Union of Geodesy and Geophysics. Report of the Union for the War Years 1939–1945 with the Proceedings of the Executive Committee of the Union, Oxford, December 1945, and the Extraordinary Assembly, Cambridge, July 1946. Edited by Dr. J. M. Stagg. Pp. 158. (Richmond: Dr. J. M. Stagg, General Secretary, Kew Observatory, 1947.) [77

Federation of American Scientists. The Purposes of the F.A.S. Pp. 8. (Washington, D.C.: Federation of American Scientists, n.d.) [77

Questions and Answers about Atomic Energy. Pp. 32. (Washington, D.C.: National Committee on Atomic Information, n.d.) [77

I'm a Frightened Man. By Dr. Harold C. Urey. Pp. 8. (Washington, D.C.: National Committee on Atomic Information, n.d.) 5 cents. [77

U.S. Department of State. A Report on the International Control of Atomic Energy. (Publication 2498.) Pp. viii + 55. (Washington D.C.: Government Printing Office, 1946.) [77

U.S. Department of State. The United States and the Unite Nations Report Series, 9: The International Control of Atomi Energy; Scientific Information transmitted to the United Nation Atomic Energy Commission, December 15, 1946, Vol. 7. Prepared i the Office of Bernard M. Baruch, United States Representative (Publication 2775.) Pp. ix + 30. (Washington, D.C.: Governmen Printing Office, 1947.) 15 cents. [7

Radiology: being Section 14 of Excerpta Medica. Vol. 1, No. June. Pp. 58. (Amsterdam: N.V. Excerpta Medica, 1947.) 15 dollars; 75*s*. per year. [10

Carnegie Institution of Washington: Department of Terrestri Magnetism. Publication 578: Description of the Earth's Ma Magnetic Field and its Secular Change, 1905–1945. By E. H. Vestin Lucile Laporte, Caroline Cooper, Isabella Lange and W. C. Hendri Pp. v + 532. (Washington, D.C.: Carnegie Institution, 1947 2.50 dollars. [15

International Institute of Agriculture. International Yearbook Agricultural Statistics, 1941–42 to 1945–1946. Vol. 1: Agricultur Production and Numbers of Livestock. Pp. xxiv + 245. 1.50 dollar Vol. 2: International Trade. Pp. xi + 570. 3 dollars. Vol. 3 Apportionment of Areas, Agricultural Production and Numbers Livestock in various Countries. Pp. vii + 328. 2 dollars. (Rom International Institute of Agriculture, 1947.) [1

Annals of the New York Academy of Sciences. Vol. 47, Art. Muscular Contraction. By Alexander Sandow, R. S. Bear, Ern Fischer, A. S. Gilson, Jr., Eugene Guth, C. E. Hall, M. A. Jakus, C. V Kuffler, Otto Meyerhof, Severo Ochoa, Robert W. Ramsey, F. Schmitt, G. M. Schoepfle, Shih-Chang Shen, H. Burr Steinbach a S. M. Walker. Pp. 665–980 + 9 plates. (New York: New Yo Academy of Sciences, 1947.) 3 dollars. [2

International Journal of Opinion and Attitude Research. Publish Quarterly. Vol. 1, No. 1, March. Pp. ii + 144. (Mexico: D Laszlo Radvanyi, Donato Guerra 1, Desp. 207; London: Soc Research Publications, Ltd., 1947.) 1.25 dollars; 4 dollars a year. [2

Uganda Protectorate. Working Plan for the Budongo and Si Forests. First Revision, Period 1945–1954. Revision prepared by D W. J. Eggeling. Pp. iv + 66. (Entebbe: Government Print 1947.) [2

NATURE

No. 4095 SATURDAY, APRIL 24, 1948 Vol. 161

CONTENTS

Page
Responsibility in Nationalized Industries 619
Induction of Tumours by Chemical Compounds. By Prof. E. Boyland 621
Dogon Personality. By G. I. Jones 622
Personality. By Prof. T. H. Pear 622
Palæobotany. By Prof. John Walton 623
Logical Realism. By Prof. A. D. Ritchie 623
Reclamation Disease in Agriculture 624
Temperature Measurement. By S. Weintroub 624
Meteorology for the Professional Meteorologist. By Prof. P. A. Sheppard 625
Organisation and Work of the Cavendish Laboratory. By Sir Lawrence Bragg, O.B.E., F.R.S. 627
Man's Organs of Speech. By Prof. H. A. Harris 628
Interaction of Water and Porous Materials. By Prof. N. K. Adam, F.R.S. 629
An Experiment in Marine Fish Cultivation. By L. H. N. Cooper and G. A. Steven 631
Obituaries :
  Prof. Alexander Ogg. By Dr. B. F. J. Schonland, C.B.E., F.R.S. 633
  Mr. Harry Price 633
News and Views 634
Letters to the Editors :
  Purification of Anti-pernicious Anæmia Factors from Liver.—Dr. E. Lester Smith 638
  A New Extraction Procedure for the Preparation of Heparin.—Olle Snellman, Robert Jensen and Dr. Bengt Sylvén . . . 639
  Effect of Thyroid Deficiency on the Level of Pseudo-Cholinesterase in the Plasma of Rats.—R. D. Hawkins, Prof. B. Mendel and N. Nishikawara 639
  Phase Memory of the Ear : a Proof of the Resonance Hypothesis.—Dr. R. J. Pumphrey and T. Gold 640
  Osmotic Work Performed by the Renal Tubules.—David F. Cole 640
  White-eyed Mutants of Diptera.—Dr. P. Tate 641
  Action of Heating on *Rh*-Positive Human Red Cells.—Dr. P. O. Hubinont 642
  A Method for Estimating Percentage Germination of Fungal Spores.—O. L. Davies, R. B. Duckworth and G. C. M. Harris 642
  A Rare Cœlom-Dwelling Trematode.—Dr. Ben Dawes . . . 642
  Interspecific Fertilization in Ascidians.—Dr. Antonio Minganti . 643
  Toxicity of Azo-Compounds and Other Substances to the Fruit Tree Red Spider Mite.—Dr. J. K. Eaton and R. G. Davies . 644
  Height of Meson Formation.—Dr. A. Duperier 645
  A Solar Noise Outburst at 600 Mc./s. and 1,200 Mc./s.—F. J. Lehany and D. E. Yabsley 645
  Cosmic Rays and the Magnetic Field of the Moon.—Dr. M. S. Vallarta 646
  Initiation of High Explosives.—Prof. G. Herzberg and G. R. Walker 647
  Principle of a Counter-streaming Centrifuge for the Separation of Particles of Different Sizes.—Per Eric Lindahl 648
  Electrokinetic Potential and Surface Structure of Barium Sulphate.—A. S. Buchanan and Dr. E. Heymann 649
  Chemical Effects of Ionizing Radiations.—Gabriel Stein and Dr. Joseph Weiss 650
  A Coefficient of Viscous Extension.—Dr. K. H. Swainger . . 650
  Addition of Maleic Anhydride to Anethole.—Prof. V. Bruckner and Dr. J. Kovács 651
Oscillographic Analysis of the Non-Acoustic Functions of the Vertebrate Ear. By Dr. Otto Lowenstein 652
Power and Personal Leadership 654
The Fourth South American Chemical Congress 654
Science Masters' Association (Scottish Branch) 655
A 150-Ton Universal Structure Testing Machine. By Dr. C. F. Tipper 656
Growth-Promoting Substances in Horticulture 656
Forage Resources of Latin America 657
Earthquakes during July–August, 1947 657
Recent Scientific and Technical Books . . . . . Supp. ii

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RESPONSIBILITY IN NATIONALIZED INDUSTRIES

ALTHOUGH, as Mr. Wilfred Roberts did well to remind the House of Commons in the debate on nationalized industries on March 3, the public corporation is no new feature of the social and political life of Great Britain, public concern about the efficiency and accountability of such bodies has steadily grown with the execution of the Government's programme of nationalization. The debate on March 3, which was concerned mainly with the extent to which ministers could be held responsible and questioned in Parliament concerning the activities of such bodies, followed up an earlier debate in the House of Lords on December 2 on the problems of nationalized industry. Both Mr. H. R. G. Greaves in his recent book "The Civil Service in the Changing State", and Sir John Anderson in his Romanes Lecture on "The Machinery of Government" have considered some of the fundamental problems involved in this newer type of government organisation, and there have already been published at least two critical full-length appreciations of British experience in this field—notably the study of "Public Enterprise" edited by Dr. W. A. Robson in 1937, and Mr. T. H. O'Brien's book "British Experiments in Public Ownership and Control" of the same year.

The essential problems were, in fact, well displayed fully ten years ago, but neither debate in Parliament suggests that anything like full use has been made of that experience in determining the structure of the industries already nationalized. The Lord President of the Council has on several occasions admitted the importance of proceeding cautiously and not committing ourselves to any one form or type of organisation that would hinder changes which experience might indicate as desirable. He emphasized this point particularly in an address read before the Institute of Public Administration last autumn, and, both in that address and in his reply in the House of Commons debate on March 3, he showed that he is fully aware of the importance of taking account, not merely of the questions of efficiency, accountability and responsibility, but also of ensuring enterprise and of solving the problems of economic and industrial democracy involved in the association of all classes of workers, scientific and technical as well as operatives, in the conduct of the undertaking.

None the less, Mr. Morrison rejected Capt. Crookshank's very moderate suggestion for either informal discussions between representative members of the House or for a Select Committee to investigate and report on the best way of dealing with the specific aspect of ministerial responsibility and the limits of Parliamentary questions. The distinction between administration and management was clearly grasped on all sides of the House, and it was evident that there was a general realization of the importance of the Parliamentary question, the dangers of such procedure if not used with restraint, and the vital importance of the fullest possible information being available for Parliament and the general public. Efficiency, as Mr. Bowles rightly said, would be promoted only by Parliamentary vigilance and interest, and the essential problem is to secure the appropriate balance which will ensure the continual review of institutions and yet not hamper day-to-day management or repress initiative and enterprise.

One of the many dangers, as Mr. Molson observed, is that nationalized industry may be unwilling to move with the times or to admit that mistakes have been made; and on this point he suggested that the annual reports to be presented to Parliament should be examined by a Select Committee analogous to the Public Accounts Committee and assisted by a special permanent staff. A somewhat similar suggestion for an efficiency audit was made by Mr. Diamond; but both these constructive suggestions were dismissed by Mr. Morrison without any alternative proposal being made.

Sir John Anderson's part in the debate was limited to the elaboration of one only of the principles he had emphasized in his Romanes Lecture and earlier, before the Institute of Public Administration, as essential in determining the constitution of the authority to which a particular public task is to be entrusted and the relation of that authority to Ministers and to Parliament. Parliament, he insisted, must have adequate opportunity for inquiry, debate and public judgment; but he addressed himself more particularly to the question of the extent of ministerial control and the limits within which a Minister could be questioned in Parliament. Sir John appeared to suggest that, without interfering in day-to-day matters, a Minister should be willing to deal with questions on matters which might not strictly fall within his responsibility where the supply of information was obviously in the public interest.

The importance of that point was scarcely brought out sufficiently in either House, and Sir John himself did not refer to his own earlier comment that, where an annual report was laid before Parliament under statutory requirement, the report should be debatable. That procedure would go far, if properly implemented, to provide the opportunity for constructive criticism both inside and outside Parliament, and to ensure that there was at least an attempt to secure that, under changing conditions, public corporations could be relied upon to act with vigour, to show initiative and enterprise and to accept such risks as are normally taken by private enterprise. If we must rely on the vigilance of Parliament and the alertness of public opinion to avoid inertness, inefficiency or undue public suspicion, adequate information must be available, and whatever other means are provided, the annual report appears to be one invaluable, if not indispensable, means.

Much experience has clearly to be gained before Parliament can be satisfied that a reliable technique has been evolved, and the recent debates indicated doubts on all sides as to whether we are not being asked to move too quickly. Moreover, as Lord Lindsay pointed out, there is already a large body of common knowledge which should be used to the full both in determining the structure of nationalized industry and in its operation, and it should not be forgotten how powerful an instrument for efficiency local patriotism can be. Conversely, wise decentralization can make a vital contribution not merely to the efficiency of the nationalized industries but also to the health of local government; and doubts may well be entertained as to whether the present organisation, for example, under the Transport Commission, sufficiently meets such criticism or even those of administrative theory.

The two things that stand out most clearly are, first, the necessity for self-restraint in the attitude of Parliament to the public corporations, and secondly, the need for self-restraint on the part of the Government in extending the sphere of nationalized industry before sufficient evidence is acquired that those already nationalized are working sufficiently well to encourage further steps in that direction. The most imperative need is, in fact, that the question should be taken out of the arena of party politics and examined objectively on a scientific plane. The additional and independent scrutiny of the work of nationalized industries demands information beyond that available in published reports and accounts, and if a proper public judgment of their efficiency is to be possible the boards must come into the open. Lord Knollys, for example, suggested that the chairman and other appropriate officers should be required to appear each year before the Select Committee on Estimates and the Public Accounts Committee; but Mr. Diamond, in making his own proposal, gave as one reason the opinion that such scrutiny lies, at least in part, outside the terms of reference of these two Committees. Whatever method may be adopted, however, the boards should anticipate questions by a generous disclosure of information about their plans and activities. If Parliament is to be expected to act with restraint and confine questions to matters for which Ministers are genuinely responsible, information of other kinds must be readily accessible from the corporations. The corporations must not display the resentment which has sometimes been shown, for example, by the governing body of the British Broadcasting Corporation, as a result of requests for public information; and enough should be made known as a matter of course for their progress and difficulties to be assessed accurately and promptly by outside and impartial observers. The boards are public servants and have no need of the reticence of private business in matters of finance; but they are not Civil servants, and they have a right and a duty to answer public criticism as vigorously and as independently as it is made.

That there is room for clear thinking and impartial study of the whole question is obvious from the recent debates, and it is by no means certain that the Government yet appreciates how, until the appropriate structure has been determined, the change from private to public ownership may increase the difficulties of good technical and economic management. There can be no doubt that in time independent investigation, and possibly studies by the British Institute of Management and like bodies or by the universities, as Prof. K. C. Wheare has suggested, may throw much light on the appropriate means of securing accountability and, equally important, public support and understanding of the work of such national boards.

What must be recognized is that, if we are, as the Lord President of the Council admitted, developing a field as yet comparatively unexplored, it is the scientific method that can be our best guide. There must be dispassionate and objective inquiry, self-restraint, and a rigorous refusal to let either sectional or private interest or party dogma interfere with the determination of the appropriate instruments by which to secure that the change from private to public ownership is marked by enterprise, initiative, and the rigorous service of efficiency and of the welfare of the nation. In particular, the question of accountability and of Parliamentary question and control must not be allowed to obscure those equally important issues, to which Dr. W. A. Robson has directed attention, namely, the necessity and extent of centralized control, the relation between size and efficiency in these nationalized undertakings and the means by which we are to measure the efficiency of a public service. Even in private enterprise, too narrow a conception of efficiency may be unsound; in public enterprise, to think of it in rigid financial, mechanical or even economic terms, may be disastrous. Yet when we leave these spheres and enter that of social accountancy, we may well find ourselves without reliable criteria or yardsticks. The devising and application of such yardsticks is one of the outstanding challenges for the student of social and economic science.

Questions of staffing cannot be entirely divorced from these questions of public responsibility, general and social efficiency and independence of pressure from sectional or private interests. Staff possessing the requisite qualities of initiative and enterprise, integrity, judgment and administrative ability will only become available when the service of the corporations is manifestly seen to encourage their exercise and to afford them ample scope as well as commensurate rewards.

INDUCTION OF TUMOURS BY CHEMICAL COMPOUNDS

Radiophysiologie expérimentale, cancer et hormones. 6: Etude de la cancérisation par les substances chimiques exogènes

Par Antoine Lacassagne. (Actualités scientifiques et industrielles, 1026.) Pp. 150. (Paris: Hermann et Cie., 1947.) n.p.

IN the preceding monograph in this series, Prof. A. Lacassagne discussed the chemistry of experimental carcinogenesis. The present work deals with the biological aspect of the subject. The pathology of chemical carcinogenesis, including the transport of carcinogenic substances in the body, the effect of carcinogens on cells, and the action of substances which modify the carcinogenic process, are discussed.

The outstanding known facts about the transport of carcinogenic substances are that they are changed chemically and excreted as derivatives in bile. The details of the chemical transformations which carcinogens undergo are still uncertain, and it is not known with certainty whether chemical change of the carcinogenic substances in the tissues is necessary for them to exert their carcinogenic action. If 1:2:5:6-dibenzanthracene or 3:4-benzpyrene is injected into animals, the greater part of the material is excreted rapidly; but a small fraction appears to remain at the site of injection for many months. The slow nature of the carcinogenic process would suggest that it is the small amount of fixed material which is the cause of the carcinogenesis. The observation of R. R. Bensley and N. C. Hoer (1934) that injected benzpyrene becomes concentrated in the mitochondria of cells is perhaps of importance in the process.

The specific changes which carcinogens are known to produce, apart from the induction of cancer and inhibition of growth, seem rather unimportant. More is known of the factors capable of modifying carcinogenesis. The process of carcinogenesis can be markedly affected by diet. Thus the carcinogenic action of tar or hydrocarbons on the skin is greater in animals maintained on diets with high fat content, and the effect of azo compounds in producing hepatomas is reduced by giving animals diets with high protein and vitamin B content. The carcinogenic action of hydrocarbons in subcutaneous tissue is influenced to some extent by the nature of the solvent used to introduce the carcinogen. These effects do not help much, as yet, in the understanding of the underlying changes of carcinogenesis. A vast amount of work carried out on the modifying action of physical agents on carcinogenesis is reviewed by Prof. Lacassagne, with the conclusion that it is difficult to say whether physical and chemical carcinogenic agents act synergistically, independently or in antagonism.

Prof. Lacassagne describes the growth-inhibitory action of carcinogenic substances discovered by Prof. A. Haddow, and discusses the antagonistic effect of weak carcinogenic compounds on potent carcinogens, which has been largely investigated in the Paris laboratories. In a typical experiment showing the antagonism, carried out by Prof. A. Lacassagne and his colleagues, one group of mice was treated with methylcholanthrene, a potent carcinogen, while a second group was similarly treated with a mixture of methylcholanthrene and a weak carcinogen, 1:2:5:6-dibenzfluorene. Tumours appeared later and life was prolonged in the second group, so that the weak carcinogen appeared to have an anticarcinogenic action, possibly by a blocking or competing mechanism. Even the growth-inhibiting action of 1:2:5:6-dibenzanthracene is reduced by addition of the feebly carcinogenic 1:2:5:6-dibenzacridine. This last result indicates the close correspondence which exists between growth inhibition and carcinogenesis. The action of carcinogenic hydrocarbons is neutralized by agents other than feeble carcinogens, including vesicants and substances which can combine with sulphydryl groups of amino-acids.

Theoretical chemistry has given to students of carcinogenesis a unifying hypothesis, which appears to be possibly more satisfactory than experimental work alone had been able to supply. The development of the theory by O. Schmidt, N. Swartholm and the French workers, R. Daudel, A. Pullman and B. Pullman, is described. Calculations of the distribution of free electrons in many series of polycyclic compounds indicate that there is often particularly high density of electrons about certain bonds between carbon atoms. In the polycyclic carcinogenic compounds, the charge or density of electrons is above a certain limiting level, and high carcinogenic power is associated with high electron density or charge. This hypothesis, if further substantiated, should lead to better understanding of the underlying mechanism of the actions of carcinogenic substances.

Prof. Lacassagne's last chapter contains descriptions of many different substances which have produced tumours in animals. These include carbon tetrachloride, hydrochloric acid and sodium hydroxide in mice, glucose and sodium chloride in rats, and zinc chloride in cockerels. This list of odd carcinogenic agents would give the impression that carcinogenesis is not a specific property associated with definite chemical structures. Most of the work carried out in the field, however, points to definite correlation between structure and carcinogenic action, although the basis of the relationship is as yet unknown. Any comprehensive theory of carcinogenesis must also account for the action of the ionizing radiations, as well as the hundreds of known carcinogenic substances, the hormones and possibly the viruses.

In these monographs, Prof. Lacassagne has stated the main known facts of the subject and so revealed the gaps in our knowledge, and also the way to better understanding of this fascinating corner of science which is so important to mankind.

E. BOYLAND

DOGON PERSONALITY

Les Âmes des Dogons

Par G. Dieterlen. Pp. viii+268+15 plates. 100.70 francs.

Les Devises des Dogons

Par Solange de Ganay. Pp. viii+194+9 plates. 100.70 francs.

(Université de Paris: Travaux et mémoires de l'Institut d'Ethnologie, Tomes 40 and 41.) (Paris: Institut d'Ethnologie, 1941.)

THE social and religious institutions of the Dogon, a cliff-dwelling Negro tribe of Mendi origin who occupy the Bandiagara escarpment of the French Sudan, have formed the subject of extensive study by members of the Institute d'Ethnologie of the University of Paris under the leadership of Prof. M. Griaule. Their eight years of field-work, perhaps the most extensive and sustained yet undertaken in Negro Africa, is now beginning to bear fruit; "Jeux Dogons" and "Masques Dogons", both by Prof. Griaule, appeared in 1938; "Organisation social des Dogons" by Mme. de Paulme-Schaeffner in 1940, and these were followed in 1941 by the two monographs now reviewed, which only recently reached Great Britain.

The first, by Mme. Germaine Dieterlen, is on the Dogon conception of the soul, and is a clear and lucid exposition of a very complicated subject. A Dogon, in addition to his shadow (*kikinu bumone*), has two conceptions to which the term 'soul' could be applied: his *kikinu say*, an oversoul or true soul and a kind of super ego, and his *nyama*, a life-force or under soul, equivalent to his ego or personality. At death the *kikinu say* goes to join the ranks of immortal spirits and ultimately becomes an ancestral spirit, while the *nyama* is transmitted to his descendants. Thus the object of Dogon ancestor worship is to maintain the goodwill of the ancestral *kikinu say* and to sustain the power of his *nyama* among his descendants. For the *nyama* is not reincarnated intact in a particular descendant. A man's *nyama* is a complex affair derived from a number of different sources; part of it comes from the father who begat him, part from a particular ancestor transmitted to him while still in the womb, and part again from the clan and lineage ancestors imparted to him after birth at his naming ceremony.

The second work, by Mme. Solange de Ganay, is a study of the titular forms of address (*tige*) found among the Dogon. This custom of using special terms of address towards a person, or in many cases towards an animal or natural object, is characteristic of the Mandingo, Mossi, Joloff, Susu and other peoples of the French Colonies of Sudan and Senegal; but this is the first specialized study that has been made of it. A Dogon can be addressed by no less than twelve different kinds of *tige* indicating respectively his tribe, village, family and other social groupings, his occupation, his personal idiosyncrasies and even particular parts of his body. The particular *tige* used will show how well known he is to the speaker, and the degree of familiarity that exists between them. The author concludes that these *tige* are no mere empty titles or honourable names recording a particular or a memorable feature, but contain enduring and supernatural qualities which have been transmitted to the bearer from other individuals or groups or supernatural beings, qualities which he bears during his life-time and then transmits to his descendants. As such they are analogous to the complex of *nyama* which compose his personality. To address a person by one of his *tige* is not merely a form of politeness but also an efficacious formula for placing oneself in accord with his personality.

Of the 250 pages of Mme. Dieterlen's monograph fifty are taken up with details of the mythology connected with the foundations of the various component villages of the Dogon tribe. This could well have been relegated to an appendix or omitted altogether, as it has no bearing upon her subject. Had she given instead an outline of Dogon social or economic structure, some background against which this study of their religious beliefs could be set, she would have left the reader with a more adequate and complete impression of Dogon personality. As it is, her study, like the shorter one by Mme. de Ganay, remains an expert piece of dissection of a part of Dogon ritual and belief, but one necessitating a perusal of the three previous works for its proper appreciation.

G. I. JONES

PERSONALITY

The Cultural Background of Personality

By Prof. Ralph Linton. (International Library of Sociology and Social Reconstruction.) Pp. xii + 102. (London: Kegan Paul and Co., Ltd., 1947.) 10*s*. 6*d*. net.

THE late C. P. Scott and H. W. Nevinson were once exchanging stories which had never been printed; Nevinson complained ruefully that when he was sent to report the 'Black and Tans' in Ireland, he was shot at by both sides. Prof. Linton takes a greater risk; in his brave attempt to cross-fertilize several different studies, he may be attacked from three sides. Obviously he cannot be ignored.

During man's long effort to understand himself, there have recently arisen the disciplines of psychology, sociology and anthropology. In Britain there are now few universities without a department of psychology, and few with departments of anthropology or sociology. So perhaps readers in Great Britain will be less touchy about threatened vested interests, but more aware of sins of omission.

Prof. Linton discusses the interrelation of the individual, society and culture, clearly, fairly, with masterly compression, in ninety-nine pages. The present reviewer wishes that reference to the work of psychologists had been less allusive, perhaps even less complimentary. But Prof. Linton writes, "most . . . of the information which we have on personality in non-European societies has been collected by anthropologists who had only a nodding acquaintance with psychology". Characteristically he includes himself in this category.

The author tackles the difficulty presented by the lack of a consistent terminology shared by all three sciences, basing his definitions upon those meanings about which there seems to be general agreement, and ignoring minority usages. As a result, he discusses very successfully the relation of the individual to culture and to society. He deprecates the practice of speaking of societies as if they have needs of their own, as distinct from those of the individuals composing them. His careful definitions of culture may build a bridge across the present gulf between psychologically minded sociologists and 'culturologists'.

There is an excellent study of personality and of attempts to find 'basic personality types' for a society. The author cites many more concrete examples than is usual in a book of this type. Its prevailing mood is enthusiasm, and its sentences are not written with the sole aim of rendering them criticproof. The dedication is "To the students whose questions may induce their professors to read this book". The effects upon both will be excellent.

T. H. Pear

PALÆOBOTANY

An Introduction to Paleobotany

By Prof. Chester A. Arnold. (McGraw-Hill Publicaions in the Botanical Sciences.) Pp. xi+433. New York and London: McGraw-Hill Book Co., nc., 1947.) 27*s.* 6*d.*

THE author of this book is one who has made valuable additions to our knowledge of American ossil plants, especially those of the Devonian period. Here he has produced a very comprehensive treatment of the whole subject, and deals with the history f the plant world from the earliest periods in which we find evidence of the existence of plant-life down to the present day. He discusses the bearing of the vidence furnished by fossil plants on past climates, istribution of floras over the earth's surface and Wegener's theory: there is an excellent chapter on ossilization. Something more might have been added on the methods used in palæobotanical investiations, for they furnish a very clear idea of the physical nature of fossil plants. His deliberate election of American examples makes the book of reater value to the American student than to those ho are not acquainted with details of American eography and geology.

There are many illustrations which have not therto appeared in text-books, and for the European palæobotanist it gives an excellent idea of American palæobotanical material. The illustrations are scarcely adequate for the amount of text, or for a book which claims to be an introduction. The treatment of the groups is rather uneven: in the chapter on the ancient Lycopods there are no figures illustrating the structure of a 'cone', a Stigmarian base or a reconstruction of a complete arborescent Lycopod, although the considerable mass of evidence available would justify one. The Calamites, though less important constituents of carboniferous vegetation, have in comparison adequate illustration. In the later chapters there are twenty-one illustrations of dicotyledonous leaves, which seem more than necessary. The space utilized for two-thirds of them might have been more effectively used in the illustration of other chapters.

The book more nearly approaches a text-book than an introduction to the subject. The very large number of types, many merely introduced by name or with brief descriptions, will make the book rather heavy going for anyone who has not a fairly wide knowledge of the subject already. It is a useful addition to the library of those engaged in palæobotanical research; but it is doubtful whether a university undergraduate would find it of much assistance except for occasional reference.

John Walton

LOGICAL REALISM

A Preface to Logic

By Morris R. Cohen. Pp. xix+202. (London: George Routledge and Sons, Ltd., 1946.) 8*s.* 6*d.* net.

The Revival of Realism: Critical Studies in Contemporary Philosophy

By James Feibleman. Pp. vii+333. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1946.) 22*s.* net.

THESE two books both advocate logical realism, as opposed to the conceptualism or nominalism which has been fashionable in Western thought since the fourteenth century. Undoubtedly universals are concepts, but concepts are not generic images, as Prof. Cohen points out; nor are universals merely concepts if they play their parts successfully. Undoubtedly names are special kinds of universals, but to say that universals are merely names is to make knowledge illusory.

The greater part of Prof. Feibleman's book is devoted to criticism of recent thinkers. C. S. Pierce, as a realist, is approved; so is Whitehead, with reservations. Dewey, Lovejoy and Russell are dealt with more severely; especially Russell, for deserting his first love and for his prolonged, though half-hearted, flirtation with nominalism. There is an interesting section on history and the views of Toynbee. Prof. Feibleman's methods are Procrustean. If a thinker is not a proper (Aristotelian ?) realist, he is either an idealist, the exaggerated Platonic kind of realist, or a nominalist; and nominalists are either materialists or subjective idealists. This is hard on thinkers who do not fit the labels, like Kant. These, if not actually engaged in crime, are convicted of 'loitering with intent'.

Prof. Cohen's book, though smaller, carries more weight than the other, because he is constructive, never extreme, always balanced in judgment. He discusses topics that lie on the borders of logic; the relation of form and content in assertion and inference; the nature of symbols, meaning, concepts, fictions and probability, and the logic of ethical judgments.

A reading of both books raises the old puzzle of what logic really is. Both writers repudiate the psychological interpretation. Prof. Feibleman says that logic is the general science of system or of types of order, and that pure mathematics are branches of logic. But surely the value of the mathematical sciences comes from dealing with specific types of order which are definitely of one sort and not another sort; as, for example, arithmetic deals with what has certain sorts of serial order and not with anything else. Can there be an entirely general science of order or system as such? Would it not be like that science of pure being, which, in spite of Aristotle and the Schoolmen, has never yet appeared? Aristotle's logic may be, as Prof. Feibleman says, a calculus of substance and a rather inferior business, while recent symbolic logic is a calculus of relation and far superior. Even so, they remain distinct specific sciences, and where is the generic science? Prof. Cohen in his preliminary statements says that logic is the formal element within any science, and does not appear to commit himself further. There seems to be no objection to this view, and perhaps this is all that needs to be said.

A. D. RITCHIE

RECLAMATION DISEASE IN AGRICULTURE

Koper als onmisbaar element voor plant en dier

Door W. J. Melchers en H. J. Gerritsen. Pp. 56+25 plates. (Wageningen: Gebr. Zomer en Keuning, 1944.) 1.90 fl.

"RECLAMATION disease", due to a faulty copper balance in the soil, is of considerable importance in Holland, and much research has been done on it. Melchers and Gerritsen have set out the more recent results dealing with the control of the disease, and an English summary renders the book accessible to a wider circle of readers.

Reclamation disease was originally thought to occur only on peaty-humus soils, but it is now known that it may be associated with various other types, such as pure sandy and also peat bog soils. Apparently soil containing black pitchy heather humus and/or bleached sand is the most susceptible to the disease. Early work assumed that reclamation disease was the result of definite copper deficiency; it is now realized that copper may be present in the soil but fixed in such a form as to make it difficult for the plant to absorb and utilize it.

The susceptibility of crops to reclamation disease varies with the species, cereals and leguminous plants suffering most. The symptoms vary, but usually the reproductive phase is more affected than the vegetative, though white clover offers a good example of profuse flowering and feeble leaf formation in sick plants. The chief agricultural crops are listed according to their liability to reclamation disease, with the special symptoms in each case. On grassland the botanical composition of the herbage may indicate copper deficiency, and the colour is usually strikingly dull and yellow. The better-quality grasses disappear, and the inferior varieties predominate. Cattle grazing on such grassland exhibit symptoms of disease which vary with the type of soil, and these have been proved to be associated with copper deficiency.

The degree of copper deficiency in the soil is usually determined by tests with *Aspergillus niger*, a fungus which requires minimal quantities of copper for its growth and spore formation. The only remedial measure at first used was the application of town compost; but this was limited to areas where transport costs were not prohibitive. Stable manure proved inefficient in action, but good results have been obtained by covering the deficient soils with a layer of sand about 10 cm. thick.

The application of sulphate of copper at the rate of 50–100 kgm. per hectare has proved successful in preventing reclamation disease on ploughed land. On grassland direct application is of little use, and it is necessary to plough up and cultivate the land with other crops for about two years until the lime and copper contents have been adjusted, after which grass can again be sown with more hope of success. The beneficial effect of the copper sulphate will last for several years, but for some crops, as wheat, that are more susceptible to reclamation disease, it may be necessary to give a second application sooner than with others. Finely ground slags containing a low percentage of copper produced by copper foundries are as efficient as copper sulphate, and they may be of special advantage owing to the better distribution obtained by the larger quantities necessary to supply the requisite amount of copper. Such slags are also a useful source of supply of various minor or trace elements. It may well be that continued experiments along these practical lines will do much to improve crop production in areas where reclamation disease is liable to occur.

TEMPERATURE MEASUREMENT

Methods of Measuring Temperature

By Dr. Ezer Griffiths. Third edition, revised and reset. Pp. x+223. (London: Charles Griffin and Co., Ltd., 1947.) 20*s*. net.

THE adequate control of temperature is of fundamental importance in nearly all branches of science, and there are numerous applications i industrial and technical fields. Courses of study an text-books for students of physics, chemistry, engineering and metallurgy, invariably include, in the hea section, a discussion of the methods of temperatur measurement; but, in general, the treatment is to brief and inadequate. The practical difficultie inherent in all thermal measurements are very rarel appreciated, and insufficient regard is paid to th necessity of a correct choice of instrument an method for the temperature or temperature-differenc measurement.

Those responsible for research or for the successf operation of industrial processes involving the precis measurement of temperature, therefore, have nee of a suitable book, which, while giving a gener survey of the subject, pays particular attention to th experimental basis of the methods in general us to the accurate calibration of the instruments, an which points out clearly the errors, and the means c countering such errors, to which pyrometric observ tions are liable. Dr. Ezer Griffiths, who, as a princip scientific officer in the Physics Division of the Nation Physical Laboratory, is engaged in directing researc in this particular field, and who has himself contributed much to the advances made in the subject, is undoubtedly one of the few people well qualified to write such a book. The first edition of his book on temperature measurement appeared in 1917, was quickly exhausted and for four years was unprocurable. In 1925, the second edition, a substantial improvement on the first, was published, and now, after an interval in which the second edition also has been out of print, a completely revised and re-set version has been issued. Both earlier editions were widely accepted, a clear indication that the author succeeded admirably in his task of presenting his material in a form acceptable and useful to those engaged in industry and research.

The second and third editions, superficially, appear to be little different. The chapter and sectional divisions, including their headings, are essentially the same. The illustrations and diagrams, though slightly fewer in number in the new edition, are exactly as before, and, in spite of an interval of twelve years, only minor corrections and additions have had to be made to the numerical tables. A closer examination of the text, however, reveals that the author has made a careful revision in accordance with his own practical experience, and that of others. For example, Chapter 3, on the resistance thermometer, by omitting discussion of the Smith's difference bridge, finds space for the constructional details of the standard resistance thermometers in use at the National Physical Laboratory, and in Chapter 4, on the thermocouple, brief references to thermo-elements suitable for temperature measurements of liquid steels, in gases, and of the cylinder walls of engines, have been added.

In 1927, the International Temperature Scale was provisionally adopted, and due importance is given to this scale by the reproduction, in an appendix, of the specification finally accepted. The composition of temperature-indicating points, and a table of the agreed melting-points of the elements, form two other new appendixes.

The new edition is very well produced, and the reader will find that the larger type now used makes the book easier for reference and more pleasant to use. One minor blemish is that, although the references at the ends of the several chapters have been brought up to date and arranged in chronological order, care has not always been taken to give the complete reference, or to be consistent in the form and abbreviations used. S. WEINTROUB

METEOROLOGY FOR THE PROFESSIONAL METEOROLOGIST

Meteorology

Theoretical and Applied. By Dr. E. Wendell Hewson and Richard W. Longley. Pp. xii+468. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1944.) 4.75 dollars.

THE writers of this book have been ambitious; they have attempted, within their 450 pages, 8¼ in. × 5⅜ in., to provide the physicist with an adequate text on all those parts of meteorology which are likely to be of concern to him in practising his profession in, say, one of the national meteorological services of the world. Whether they can be said to have been successful depends largely upon one's like or dislike of the plan they have adopted, which is to divide the subject somewhat arbitrarily into the two parts indicated by the title, and to make each part more or less self-contained, so that the 'practical' aspects of the subject can, if required, be read separately from the basic theory on which the applications depend. Thus, following an introductory chapter outlining the broad features of observations over the globe, Part 1 on theoretical meteorology comprises chapters on subjects of the expected kind (statics, thermodynamics, radiation, dynamics, etc.), but also one on the principles of meteorological statistics—a rather happy inclusion. Part 2 on applied meteorology deals with instruments and observations; the general circulation; vertical stability, air masses, weather systems and winds; fog, cloud, precipitation and aircraft icing; climatology; chart analysis and weather forecasting; and meteorology in relation to human activities. Rigour is claimed for the treatment in Part 1, to which the reader is referred for the derivation of results used in Part 2, which is more sparing of mathematics than Part 1.

Such a structure has no great appeal to the reviewer, for the content of much of Part 2 is as genuinely theoretical as Part 1, and the student coming to the subject for the first time is liable to get an unbalanced view. It is true that a more formal treatment can result in a lack of knowing 'what the subject is all about'; but that is readily avoided by bringing theory into relation with observation at every possible stage so as to provide the student with a coherent view of atmospheric processes. The writers of the book under review have certainly tackled very successfully the relation between theory or fundamental physical principles and observation in a number of cases, at the expense, however, of an irritating accumulation of cross-references and the loss of logical development in the exposition.

Aspects of the book which appeal to the reviewer are the treatment of instability; the nature, causes and occurrence of fog, cloud and precipitation (within the bounds of existing knowledge); and the application of climatological factors to an understanding of weather and its variations at particular places—one rather regrets, however, the limited definitions of the content of climatology. The rigour claimed for the treatment in Part 1 is not always evident; this is sometimes due to problems being incompletely specified, for example, the transfer of heat and matter by turbulence. There is a frequent insistence that a geostrophic wind field implies a stationary pressure field, but no mention of the fact that this derives from the neglect of the variation of the Coriolis parameter with latitude; on the other hand, there is frequent reference to vertical motion with north–south geostrophic flow—the relation of vertical motion and the equation of continuity to pressure change needs far more careful handling. Occasional looseness in definitions is also evident, as in confusing thermal conductivity with diffusivity and frequency with wave-number.

The book is, however, mainly workmanlike and within its structure attractive. If a second edition is called for, many blemishes can be removed, and the reviewer hopes that the writers will then reconsider their policy of omitting references from the text—a few are given in chapter bibliographies at present. He also hopes they will omit the existing diagram showing the high atmosphere to be composed of helium, unless, of course, some evidence accrues for this in the meantime. P. A. SHEPPARD

Mechanisms of Reactions at Carbon–Carbon Double Bonds

By Prof. Charles C. Price. (Polytechnic Institute of Brooklyn: Lectures on Progress in Chemistry.) Pp. viii+120. (New York and London: Interscience Publishers, Inc., 1946.) 15*s*.

THIS is the first of a proposed series of books by visiting lecturers to the Brooklyn Polytechnic Institute, who are reviewing progress in chemical topics. The treatment is not comprehensive, but stimulates interest by an able summary of many recent trends in olefinic chemistry. About half the book deals with the electronic theory of double-bond reactivity in ionic and free-radical processes; in the remainder these themes are developed with special reference to polymerization. Prof. Price writes from the point of view of an organic chemist; but is quick to perceive relevant physical evidence, and makes a number of interesting suggestions on problems of mechanism.

Particular prominence is given to electrostatic field effects of substituents, especially on π-electrons. Quantitative treatment is carried out by resolving electric dipole moments into bond moments and into separate charges. Rather a wide choice of sizes and arrangements of charges would appear possible, so that while the magnitudes of the effects are fittingly emphasized, the numerical results may well only be accepted with reserve. Descriptions would have been easier if there had been a greater readiness to admit into the vocabulary the term 'resonance', while the distinction drawn in places between this term and mesomerism will mean nothing to many chemists, to whom the words are synonymous.

The chapters on copolymerization and emulsion polymerization are especially interesting, and opportunely emphasize the fact, regretted by academic chemists, that publication of knowledge of these phenomena, though increasing, is still the exception rather than the rule. The apparently established use of the term 'condensation polymerization' for polycondensation is unfortunate.

More description might be given, in the text, of some of the reactions formulated; but the book is pleasantly printed. J. SHERIDAN

The Microscope

Its Theory and Applications. By J. H. Wredden. Pp. xxiv+296. (London: J. and A. Churchill, Ltd., 1947.) 21*s*.

The Intelligent Use of the Microscope

By C. W. Olliver. Pp. viii+182. (London: Chapman and Hall, Ltd., 1947.) 12*s*. 6*d*. net.

BOTH these books give a detailed account of the use and the optical theory of the microscope. It is unfortunate that so little training in the proper use of the instrument is given in biological courses, and the student often arrives at the research stage with little or no knowledge of its finer use, particularly in regard to lighting, screens, sub-stage focusing and the aperture of the objective. These books may then be welcomed as directing attention to the many optical problems affecting the critical use of the microscope. Both are well provided with illustrations, and particular attention is paid to the sub-stage optical equipment and the careful selection of a light source.

Chapters on photomicrography, light filters, and the polarizing microscope are given, and Mr. Wredden, who writes from the point of view of one who uses the microscope in the study of industrial and electrical problems, includes a chapter on micrometry. This book also contains tables of refractive indices of various substances, an index of visibility and a number of useful constants. The chapter on the preparation of specimens, although containing a number of useful hints to the beginner, is not very applicable to biological technique.

While Mr. Olliver goes into rather less detail, his book would be of great value to everyone engaged in microscopic work. At the same time, it may be observed that these instructions are of little use unless improvement is made in the condition of microscopes used by students in some biological departments, for many of these date from the early days of the century and are long past useful service.

Petrographic Micro-technique

A Practical Handbook for the Preparation of Thin Sections of Rocks for use with the Petrological Microscope. By A. V. Weatherhead. Pp. x+102. (London: Arthur Barron, Ltd., 1947.) 12*s*. 6*d*. net.

THE author of this little book has performed a notable feat, namely, to arrive within a reasonable distance of making a manual process comprehensible by means of the printed word. Nothing will compensate for lack of practice (and patience) in making thin petrographic sections, but much fruitless labour will be avoided by following in Mr. Weatherhead's steps. Perhaps the most interesting points are his experience with 'Norbide' (B_4C), as an abrasive of extreme hardness, and his use of complementary colours in controlling thickness in the course of preparation of specimens. To have achieved vertical and horizontal sections of eggshell is remarkable. If a blemish may be mentioned it is the use of the phrase "doubly polarized light". Maybe this is scarcely wrong, but it is not traditional, and is apt to mislead. "Between crossed nicols" (even if in these days we use calcite substitutes) seems preferable as a description. But this is a trifle: as a guide to micro-technique, this monograph is a first-class effort. F. I. G. RAWLINS

Algebra

By Dr. A. Page. Pp. vii+346. (London: University of London Press, Ltd., 1947.) 18*s*. net.

THIS book is designed to meet the requirements of students preparing for examinations of the higher school certificate, intermediate and final general degrees, as well as university scholarships. It is a thoroughly sound course enhanced by many practical applications of algebra to physics, chemistry, engineering, economics and medical science. There is also, among the thirteen chapters, a valuable one on statistics. The difficulties of the subject are skilfully surmounted in an interesting way, and the book is well provided with exercises both on the text of the several chapters, and miscellaneous in the form of revision papers, to all of which answers are supplied. Only one small point calls for comment: the chapter on determinants—the last in the book—seems to come a little too late in the course. Further, it appears to contain no applications to the solution of equations, which is rather a pity, in view of the practical importance of this aspect of the subject. Nevertheless, the book may be confidently recommended as a very useful text-book for students generally, as well as for those studying for the specified examinations.

ORGANISATION AND WORK OF THE CAVENDISH LABORATORY*

By Sir LAWRENCE BRAGG, O.B.E., F.R.S.

THE Cavendish Laboratory is faced with problems which are common to most scientific laboratories in this post-war period, and arise from the great expansion in the numbers of undergraduate and graduate students. Part of this increase is a temporary phenomenon. Men are being released from the Forces who have missed the whole or part of their undergraduate time at the university, and are returning to swell the classes. The increase in the first- and second-year students at Cambridge is perhaps not as great as it is in other universities, because the undergraduate population is limited by college accommodation; in physics these classes at present are some 50 per cent greater than they were before the War. The numbers in the final honours class, however, have almost trebled, because men returning from war-work for the most part join this class, which now has about a hundred and twenty students. It will probably remain considerably higher than its pre-war level, because the recommendations of the Barlow Report reflect the need of the nation for more scientists, and demand is creating a supply. The greatest increase of all is in the number of research students, and here the Laboratory is crowded to capacity, if not overcrowded. Although all available places are used, the number of those who apply for admission as research students is three or four times as great as the number which can be accepted each year. More than a hundred and sixty researchers are now working in the Laboratory, of whom 110 are research students working for their Ph.D. degrees —between one-fifth and one-sixth of the total number registered for research degrees in Cambridge.

This large increase implies a major change in the organisation of the Laboratory. The old days when the head of the department could be in close contact with all his research students are a matter of the past. There would appear to be a limit in organisations of all kinds to the number of men whom any one head can direct by close personal contact, this number being about six. It applies in the direction of research ~~as well~~, and devolving of responsibility is essential when numbers rise above this limit. Even before the War, numbers of researchers in the larger laboratories were approaching the 6^2 level, and now they are in the 6^3 region. In other words, the organisation of the research work involves splitting up the men into large groups under leaders, and these again into smaller groups, so that the head of the department is two removes from the researcher himself. Except in a few special cases of work in which he is particularly interested, he cannot afford to spend that two- or three-hour period every fortnight or so talking over his work with the individual, which is essential for real direction.

The major groups in the Cavendish Laboratory are nuclear, radio and low-temperature physics, crystallography, metal physics and mathematical physics, with some minor groupings. It may be interesting to give some account of the extent to which these groups are independent, and of the common ground on which they meet. The great foe of research is administrative responsibility. A nice adjustment has to be made between giving the heads of groups as much freedom as possible to make their plans for using their facilities to the best advantage, and at the same time relieving them of the more tiresome and mechanical details of administration which can be properly centralized. In our organisation each group has its own allocation of the budget for the year, and its own order-book, so that apparatus and supplies can be bought within that budget; each has its own staff of assistants and its workshop; it has its own secretary for clerical work; further, each group runs its own colloquium, where scientific papers from other laboratories are discussed and the researchers give reports of their progress. The days are past when most researches in a department were on closely related lines and a joint colloquium was possible. A colloquium in one group or another is now an almost daily event, and no individual can spare the time to go to them all. Common touch is kept up by the fortnightly meetings of the Cavendish Physical Society, where the heads of the groups give an account of the work going on in their sections, and distinguished visitors speak, and by more informal meetings of the leading researchers, such as the little club which was founded by Kapitza when he was head of the Mond Laboratory.

The administrative burden of the teaching staff has been much lightened by the appointment by the University of a secretary to the Laboratory. This officer has in his charge finance, appointments of assistant staff and rates of pay, the formal work concerned with admissions, structural alterations and upkeep of the buildings, preparation of agenda for meetings, and other matters of this kind.

A main workshop serves all sections of the Laboratory, where work requiring special tools and skills is carried out; glass-blowing is also centralized. There is also a separate central workshop where research students can use the machine tools, where the young assistants are trained, and where repairs to class-apparatus are carried out. In addition, two special centres deserve mention. It has been found convenient to have a 'special techniques' workshop where the most highly skilled and delicate work of especial kinds is carried out, and to place this workshop in charge of a member of the staff. It is largely concerned with the construction and sealing of Geiger counters, and the purification of the gases with which they are filled. Special thermionic devices are made there, and evacuated, baked and sealed. It manufactures delicate metal parts by a photographic technique, such as supports for thin-walled windows, makes special metal-to-glass or metal-to-silica joints, and has apparatus for preparing thin metal films by evaporation. The other centre, also in charge of a member of the staff, constructs and maintains electronic equipment of all kinds, such as decimal scalars and multiple coincidence circuits, or pulse and D.C. amplifiers for nuclear work. The capital value of the electronic equipment of this kind approaches five figures, and it is a saving of time and money to place it in charge of an expert.

The largest group in the Laboratory is the nuclear physics group, under Prof. O. R. Frisch and Mr. E. S. Shire, with some forty researchers. The Cambridge equipment includes the one-million and two-million volt sets in the high-tension laboratory, and a cyclotron with 37-in. pole-pieces. A five-million volt Van de Graaff generator is being built for the Laboratory by the English Electric Company, and it is hoped to get it running by the end of 1948.

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* From a course of three lectures at the Royal Institution on March 4, 11 and 18.

The maintenance of these large and complex units introduces problems of a new scale in a physics laboratory. It creates the need for a new type of staff member, the 'technical officer'. He must be a trained physicist, in general a university graduate, but a man who has the engineer's outlook and who is interested in the construction and functioning of the apparatus rather than in the research which is done with it.

The radio group represents the continuation in the Laboratory of the work which Sir Edward Appleton started when he occupied the Jacksonian chair at Cambridge ; it is now under the direction of Mr. J. A. Ratcliffe. It has field stations as well as its section of the main Laboratory. The work on propagation is mainly concerned with the longer wave-lengths which are reflected below the *E*-layer. Another section is making measurements of the waves in the metre wave-length region coming from the sun; recording their intensity and propagation and estimating the size of the source from which they come by a method analogous to Michelson's method of measuring the angular diameter of a star.

The Mond Laboratory is now under the direction of Dr. D. Shoenberg, its former head, Dr. J. F. Allen, having been recently appointed to St. Andrews. A main interest is the properties of superconductors, in particular the penetration of magnetic fields into superconductors. It has equipment for the magnetic method of cooling. Liquid helium is at present made by Kapitza's expansion machine; but a new machine of greater capacity and more orthodox type is under construction.

In crystallography, under Dr. W. H. Taylor, the arrangement of atoms in minerals, alloys, organic compounds and proteins is being studied. The section studying proteins under Dr. M. F. Perutz and J. C. Kendrew has this year been accorded the backing of the Medical Research Council. The elucidation of the structure of such enormous and complex molecules is the most ambitious problem as yet tackled by X-ray analysis, and success would cast a flood of light on the structure of living matter.

The metal physics section, under Dr. E. Orowan, is concerned with problems of slip and plasticity, fracture, crystal growth, and metallic phenomena in general investigated by physical methods.

The Laboratory houses an electron microscope service which is used by all departments of the University. It provides hospitality for several researchers from other departments. Particularly welcome guests are the mathematical physicists, including the Plummer professor, D. R. Hartree, who have rooms in the Laboratory.

It may be of interest to assess in round figures the cost of research in the Cavendish Laboratory. The figures must be approximate, since many of the services are common to teaching and research. As an example, in the following estimate the time of the University staff is regarded as divided equally between teaching and research, and its cost apportioned accordingly. Making similar adjustments for administration, assistant staff, stores and apparatus (almost entirely research) and so forth, the total expenditure on research in the Laboratory (including the Mond) was just short of £60,000 in 1946–47, of which £10,000 came from outside sources. To this must be added a sum to represent the rental of the buildings, which does not appear in the estimates. In estimating the cost per research student, the abnormal position of nuclear research must be taken into account. Not only are the running expenses above the average, but also units such as the cyclotron represent a large outlay of capital, and special grants are made by the Department of Scientific and Industrial Research to meet needs which the University cannot finance from its own resources. Such requirements vary very greatly from year to year, and I have therefore only included a sum for nuclear research which corresponds to the expenditure per researcher in other branches of physics, and which roughly represents the contribution which the University itself makes towards the cost of the nuclear research. On this basis, the cost per research student is £400 a year. If to this is added £350 to represent the average maintenance grant of junior and senior workers, the total cost to the State of maintaining a research worker in the Cavendish Laboratory is £750 a year.

MAN'S ORGANS OF SPEECH

THE Huxley Memorial Lecture for 1947, under the auspices of the Royal Anthropological Institute, was delivered by Dr. W. L. H. Duckworth, reader emeritus in human anatomy in the University of Cambridge. The subject was "Some Complexities of Human Structure"*. The approach was frankly anatomical and was a meticulous and masterful analysis of the facts, anatomical and racial, relating to the organs of speech in man. Duckworth wasted no time on the classical definitions of anthropology ; he ignored the subdivisions of the subject and refused to be drawn into the finer distinctions of zoological anthropology, physical anthropology, social and cultural anthropology and ethnology. He kept clear of the pathological and avoided the theories of aphasia from Broca and Bastian to Henry Head. Here was the approach to the anatomical aspect as emphasized by Galen in his "Methodus Medendi" : "The magnitude of a disease is in proportion to its deviation from the healthy state ; and the extent of the deviation can be ascertained by him only who is perfectly acquainted with the healthy state". Hence the justification for the intensive study of normal structure and function in man as distinct from booksellers' notes about positive health and social medicine.

Duckworth dealt in turn with our present knowledge of the anatomy of the organs of speech, from lips, tongue, jaw, palate to the component parts of the larynx and finally the brain. To listen to so distinguished an anatomist, who is also the doyen of physical anthropologists, survey the field, much of his own ploughing and harrowing, was an intellectual feast. Rarely has a lecturer given facts and their history, as T. H. Huxley demanded, and yet exposed the gaps in our knowledge in both anatomy and physical anthropology. His survey of the work to be done provided bone and grist for many young workers. Here surely was God's plenty for the young anatomist in the laboratory and the young anthropologist in the field. The survey from Cuvier's postulate that articulate speech was the distinctive character of man to the vast modern demands of phonetics, linguistics and psychology was a criticism and yet a stimulus to the biological study of the organs of speech, emphasis being laid on the need for perfect acquaintance with the healthy normal anatomical structure.

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* Some Complexities of Human Structure. By Dr. W. L. H. Duckworth. (Huxley Memorial Lecture for 1947.) Pp. 12. (London: Royal Anthropological Institute, 1947.) 3*s.* 6*d.*

The description of the racial variation in the muscles of the lips in Australian, Negro, Chinese and White paid due credit to the careful dissections and theories of Huber in the United States and Lightoller in Australia. The gradual change from the coarsely bundled muscles of the bulky lip of the one to the finely bundled and more differentiated muscles of the smaller lip of the White was analysed both in terms of facial expression and speech. Duckworth insisted that the variety of movements accompanying the variety of structure are skilled, and saw no reason why they might not become more skilled in the future. It is interesting to note that this work of Lightoller's, ignored by most anatomists, was seized upon by Dr. E. W. Fish[1] to modify the technique of fitting artificial teeth in the aged. Fish expanded the dentures laterally so that their position was maintained by the modiolus or hub formed by the converging muscles lateral to the angle of the mouth. The utilitarian aspects of transcendental research are ever present, whether it be the grouping of relatively minute and insignificant muscles in the face or the Hertzian waves.

That strange amateur anatomist, F. O. Ward[2], in the middle of last century described the hyoid bone as "the only instance in the human body of a strictly solitary bone . . . supported in its position by the muscles and ligaments to which it gives insertion". The embryologist, immersed solely in the intricacies of the second and third branchial cartilages which contribute to the formation of the hyoid bone, has studied the early development of this bone. The possibility of changes in the structure of the hyoid bone with age, sex and vocal disability ranging from stammering to dumbness still awaits investigation. So far back as 1866, Huxley[3] described the larynx in his famous "Lessons in Elementary Physiology" as "perhaps the most singular motor apparatus in the body". Yet, in spite of Edison's invention of the phonograph in 1877, and the spread of the gramophone and wireless broadcasting in the twentieth century, the larynx has been but little studied by the modern anatomist and physiologist. As Duckworth pointed out, the outstanding contribution of recent years has been the "Mechanism of the Larynx" by Negus[7], a book "absolutely indispensable for every physical anthropologist, and for the purpose of any research in laryngology, whether normal or pathological".

In 1833 a French surgeon, Cavasse[4], pointed out that fracture of the thyroid cartilage, a result of garrotting, never takes place in the mid-line, because the two lateral parts of the cartilage unite by the intervention of a median cartilage, perfectly conscribed, which Rambaud and Regnault[5] called the vocal cartilage. It is visible by transillumination especially in young subjects, and gives attachment to the vocal cords. It is ossified from a separate centre, contains more elastic tissue in the young than the two lateral laminæ of the thyroid cartilage and affects the production of the voice. Yet Quain[6] in 1914 was content with the statement that "in the infant the isthmus of the thyroid cartilage differs from the two laminæ in being less opaque and more flexible". All other anatomical text-books have been dumb on this complexity of human structure, particularly the more recent ones.

In the second century A.D., Galen gave a detailed description of the larynx, and for eighteen centuries he eponym 'nerve of Galen' has been employed for he constant anastomotic branch between the superior and inferior laryngeal nerves. Moreover, Galen first reported the experimental proof of the function of the recurrent laryngeal nerve of the vagus by tying or dividing the nerve and thus weakening or destroying the voice of the animal. Surely, as Benjamin Franklin said, "all our knowledge . . . has been obtained by fragments, and our future acquisitions must be made in the same manner".

This brief and inadequate description of Dr. Duckworth's Huxley Lecture provokes the remark that editorial articles in *Nature* discussing the functions of universities have failed to mention one, namely, to provide for a green old age for scholars and men of science. Little note has been taken that such provision requires an atmosphere devoted to the maintenance of mental activity, cheerful disposition, simplicity of living on one hand, and absence of business urge, desire for wealth, and all tawdry ambitions of worldly importance on the other. At a time when the universities are in danger of being monopolized by the search for smaller atoms, bigger bombs, and diabolical and destructive enzyme poisons, it is well to re-echo Montaigne's last prayer "to know how to enjoy with loyalty our life". As Tocqueville and Lecky tried to make clear, this may be the very basis of anthropology.

H. A. Harris

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[1] Fish, E. W., "Principles of Full Denture Prosthesis" (London, 1933).

[2] Ward, F. O., "Outlines of Human Osteology" (London, 1838).

[3] Huxley, T. H., "Lessons in Elementary Physiology" (London, 1866).

[4] Cavasse, "Thèse sur les fractures traumatique du larynx" (Paris, 1833).

[5] Rambaud, A., et Regnault, Ch., "Origine et développement des Os" (Paris, 1861).

[6] Quain, "Elements of Anatomy". 11th Edit., 2, Pt. 2 (London, 1914).

[7] Negus, V. E., "The Mechanism of the Larynx" (London, 1929).

INTERACTION OF WATER AND POROUS MATERIALS

A GENERAL Discussion of the Faraday Society on "The Interaction of Water and Porous Materials" was held at University College, Southampton, during March 31–April 2. The four groups of papers on the programme were concerned with (*a*) fundamental, (*b*) botanical, (*c*) zoological, mainly entomological, and (*d*) industrial aspects of the penetration and movement of water in porous materials. They were well chosen to provide topics on which physical chemists, botanists, zoologists, agriculturists and those interested in fibrous materials such as textiles, wood and leather, could discuss problems common to two or more groups.

The factors governing the penetration of liquids into non-living capillary spaces, the diameter of which is greater than the range of molecular attraction, are fairly well understood. The penetration pressure, $P = 2\gamma \cos \theta/r$, where γ is surface tension, r is radius of the capillary considered as a cylinder, and θ is contact angle, determines the conditions of penetration; but the contact angle depends not only on the chemical nature of the solid and liquid, but also on the geometrical structure of the solid, and whether the liquid is advancing over a dry solid or receding from a wet one. The possible reasons for 'hysteresis of the contact angle', that is, the difference between the advancing and receding angles, received much attention; it was variously ascribed to roughness of the surface, overturning of the surface molecules, multi-molecular clusters of adsorbed water on the solid, films of air or other substances adhering to the solid before wetting, and soaking of the liquid into the solid, below the surface, on contact. Any circumstance which increases the adhesion of water to the solid necessarily decreases the contact angle; previous wetting would increase this adhesion, if any of the above mechanisms were present, except perhaps the first. Roughness certainly exaggerates hysteresis, but is perhaps less likely to be its usual cause. As Cassie showed in 1944, the contact angle on a fabric may be very large if there are regular gaps between hairs or yarns, even though the chemical proofing is one which, on a smooth surface, would give only a moderate contact angle. The feathers of ducks, the 'plastron' or air-retaining structure with which some sub-aquatic insects are provided on their outer surfaces, and leather surfaces, are peculiarly repellent to liquid water, but are freely permeable to vapour; they have this type of structure.

In pores the diameter of which is comparable with, or less than, the range of molecular attraction, such as those in zeolites, the finer pores of charcoal, and possibly also some pores in wood, transport of water takes place in the adsorbed film, that is, by surface diffusion within the range of molecular attraction. Further, solids which contain such small pores often come under severe stress when the quantity of liquid in the pores alters; when the pores fill, as in the sorption of vapours by charcoal, the solid expands; when they empty, as in the drying of wood, the strains set up may appear as severe warping, unless the drying is very carefully done. Adsorption hysteresis may be due to extremely narrow pores being wedged open beyond the range of molecular attraction on penetration of the adsorbed substance, so that they do not spontaneously close when the adsorbate is removed.

The state of the water in films adsorbed on a coal surface was discussed, and evidence presented that it is not precisely similar to bulk water, as indeed might have been foreseen. No sharp discontinuity in the volume, or dielectric constant, occurs as the temperature is decreased to − 70° C. The conclusion drawn is that the adsorbed water does not 'freeze'. It might, however, be considered at least partially frozen by the act of adsorption; the coal surface probably orients the first layer of adsorbed water molecules, subsequent adsorbed layers being more or less oriented by contact with the first oriented layer.

'Oleophobic' solid surfaces, which have a large contact angle with oil but are themselves of a hydrocarbon nature, have frequently been reported, but an explanation of their properties is difficult and even their genuine existence was challenged. If they really exist, the adhesion of such a solid surface to liquid paraffin must be substantially less than the adhesion of a liquid paraffin to itself, despite the close similarity in chemical constitution. It was tentatively suggested, in discussion, that the solid paraffin-like surfaces may have the terminal methyl groups, those most likely to be exposed at the surface, spaced apart so as to make the adhesion to liquid paraffin less than that from a liquid paraffin surface. It was also suggested that some instances of apparent oleophobic behaviour are due to the drop of oil dissolving, locally, part of the outer hydrocarbon layers on the solid, and being compressed laterally by the surface pressure of the film remaining on the rest of the surface. In such circumstances the oil drop would show a contact angle with the surface, but that could scarcely be taken as proof that the original surface had oleophobic properties.

A very lively discussion took place on how far the movement of water and dissolved substances in plants can be explained by mechanisms known to exist in non-living pores. R. D. Preston, in his introduction to the botanical section, cast doubt on the classical view that sap is pulled up a tree by tension set up at the top of long continuous columns of water, by the evaporation from the leaves: the columns may easily be broken by air, which will prevent the tension being exerted; and sap rises even if saw cuts are made so as to break every column parallel to the trunk.

In the phloem, ordinary diffusion through the bulk of the liquid (assumed stationary) in the pores appears much too slow a process to account for the speed and quantity of transport. It has been suggested that mass flow may occur, pressure differences being set up osmotically, and maintained by the synthesis of solutes with high osmotic pressure, required for assimilation by the cells, in one region, and their oxidation in another region of the plant.

Particular attention was given, in this discussion, to the possibility of accelerated diffusion along cell surfaces. Van den Honert has shown that a good spreading oil can be transported in ample quantity along a water surface, from a high surface concentration to a low, by a difference of spreading pressure in the two regions; but the not very abundant quantitative data on the rate of transport along *solid* surfaces suggest that this is very slow in comparison with the rate on liquid surfaces. Equilibrium spreading pressures on solids are no doubt considerable; and some mobility, at any rate when the adsorbed layers are held by van der Waals' forces, is usual; but generally the rate of spreading on solid surfaces does not seem nearly high enough. Bennet-Clark and Lundegårdh revived Engelmann's suggestion (1872) that electric endosmose may sometimes be a cause of rapid transport, the bio-electric potential of some tens of millivolts being a high potential gradient if exerted across a very thin membrane. Just possibly these potential differences are caused, and maintained, by differences in the redox potential in two regions. Such suggestions are rather speculative, and seem scarcely adequate to account for the frequent occurrence of accelerated diffusion and transport along cell surfaces. It still seems probable that special 'secretory' mechanisms, utilizing the energy of oxidative or other chemical processes, operate; the nature of such mechanisms is quite unknown at present. Accelerated surface diffusion, whether general or confined to certain specific physiologically important substances, may be properly termed 'secretion', since if powerful enough it could convey a substance from a low to high concentration. Can there be, on biological surfaces, a chemical 'ciliary' structure which propels molecules specifically, or non-specifically, in one direction, as visible cilia propel water *en masse* over some living surfaces?

Discussion in the zoological section was largely concerned with water-proofing. Crisp and Thorpe demonstrated that the spiracles of sub-aquatic insects are covered by a complicated set of minute hairs which exclude liquid water in a manner similar to that in which the duck's feathers keep the bird dry Many insects the normal habitat of which is a dry climate have a very thin layer of waxy material or their extreme outer surface, which greatly hinders the passage of water from the insect to the exterior if this is abraded, loss of water at once increases to a dangerous amount in fairly dry air. There seems no doubt that the cuticle of insects shows 'asymmetrical permeability', that is, moisture can pass more easily in one direction than in the other, across the cuticle. This is simply explained if the cuticle consists of two sides, one side having its permeability to water vapour decreased when in contact with a fairly high humidity, the other side being unaffected, or less affected. Such a complex membrane would pass water more easily from the less moisture-sensitive side than from the other side, because, when the higher humidity is on the side most affected by water, the permeability is decreased.

Cases of actual secretion of water into the body of an insect, from a humidity less than that in equilibrium with the interior of the insect, are not uncommon with *living* insects; one explanation which was suggested at the meeting, perhaps rather too crude to be correct, is that water is first condensed in capillaries so narrow that the meniscus on the top of the condensed column of water in the capillary is very sharply curved, so that condensation takes place below 100 per cent humidity; then the contents of the capillary tube are sucked into the insect's body from below. Very large suctions would have to be exerted.

Other subjects discussed included the behaviour of water in soils, textiles, coal and wood; also the determination of surface area by adsorption of gases, or the negative adsorption of inorganic ions in aqueous solution; and the estimation of pore size from the vapour pressure required for condensation, from the viscous resistance to flow through the porous material, or indirectly from the estimated internal surface of the solid.

The proceedings were pleasantly informal and friendly, as usual, despite the grievous loss the Society has suffered through the death of its honorary secretary, Mr. G. S. W. Marlow. Although the physico-chemical explanation of many of the phenomena which the biologists brought before the meeting remains very uncertain, and some seem to require 'biological' mechanisms much more complex than those found in non-living systems, the discussion was valuable in defining and clarifying some fundamental biological processes, as well as surveying the manner in which water interacts with several important industrial materials.

N. K. ADAM

AN EXPERIMENT IN MARINE FISH CULTIVATION

By L. H. N. COOPER and G. A. STEVEN

MANY stages of the food-cycle in the sea are much better known to-day than a quarter of a century ago. None the less, the synthesis of the scattered pieces of knowledge into a coherent whole and the assessment of the weight to be given to each has scarcely begun. An experiment in marine fish cultivation such as that of Gross, Orr, Marshall and Raymont[1] in Loch Craiglin, Argyllshire, during 1942–44, which has attempted this is therefore of outstanding importance and is worthy of a considered and vigorous criticism. The experiment suffered from many shortcomings which this group of able workers are the first to admit. The aim was set very high and the time that could be devoted to the project—mainly week-ends—under the severe stress of war conditions was inadequate. The experiment failed in its primary objective of demonstrating that marine fish cultivation can be made to pay. In the series of papers embodying the results, one senses that this failure—a failure on the heroic scale—has infected the authors with so great a feeling of disappointment that in the end they have not dared to draw from their data even those conclusions that their results would seem to justify.

One of us[2] has already stated his view that encouragement of fish growth in arms of the open sea such as the North Sea or English Channel by addition of nutrients can never be a paying concern. Indeed, in not so many years there well may be a call for means of recovering nutrients, particularly phosphorus, from the sea. None the less, he feels that the Loch Craiglin experiment shows that in selected basins and arms of the sea a satisfactory return on money expended is a definite possibility.

For the purpose of the experiments, Loch Craiglin is as unsuitable as any basin well could be; but this very unsuitability has thrown into high relief some of the adverse factors with which the marine pisciculturalist will always have to contend. The waters of the Loch were nearly always very strongly stratified. This stability was due not only to heating of the surface layer in summer but also to the presence of a chronic seal of brackish water, the salinity of which varied between 8 and $28\,{}^0/_{00}$. Even under unfertilized conditions, ventilation of the water by exchange of oxygen and carbon dioxide with the atmosphere must have been restricted. The addition of nutrients encouraged the phytoplankton further to strip the surface of carbon dioxide, the *p*H rising to more than 9. At the same time, at a depth of 3 metres in this very opaque stratified water, with Secchi disk readings averaging 2–3 metres, decomposition of the rain of organisms from above lowered the *p*H to 7·5. The corresponding partial pressures of carbon dioxide calculated from Buch's tables[3] would have been about 0·18 and 18×10^{-4} atmospheres, a range of one hundredfold. Animals and plants that can tolerate such a range of conditions are few. Healthy development of a balanced plant and animal community in a fertilized basin can occur only if vertical mixing and ventilation are adequate for the increased task. The authors seem to regard this ill-ventilation as an act of God about which nothing can be done. In Loch Craiglin this is probably so; but, for future development, the engineering problem of turn-over and ventilation is possibly the most important of all. Not only would improved turn-over revivify the bottom water and fertilize the surface water with carbon dioxide, but also it would circulate the added nutrients and iron to the upper layers where plants could re-use them immediately.

The water in Loch Craiglin had always a transparency far less than that of the open sea, Secchi disk readings averaging 2–3 metres, compared with the 10–15 metres in the English Channel; and the extinction coefficient for green light ranged from 0·5 to 14 (coastal water 0·2–0·3). This means that the range of depths well suited to active photosynthesis must have been measured in centimetres rather than metres. Much of the turbidity arose from biological activity within the Loch—activity that must be better understood if a way of dealing with it successfully is to be devised.

The problem of 'weeding' also arose in an acute form. When a field is infected with even such a persistent weed as charlock, a farmer has ways of dealing with it. If he does not, he will not succeed as a farmer for long. In Loch Craiglin, bottom-living plants such as *Enteromorpha*, *Cladophora*, *Zostera* and *Ruppia* took the first large share of the added nutrients. They were weeds and needed to be treated as such, although it is hard to see how this could have been attempted with any great hope of success.

Microflagellates were richer than normal; but no clear-cut dependence on single fertilizations, light or hydrographical factors could be detected. Their growth requirements and physiology are still too little understood.

On the bottom fauna the effect of fertilization was remarkable. By the summer of 1943, sampling and computation indicated that the population density of the bottom fauna in the whole Loch had increased by an average of about 750 per cent over the pre-fertilization value; this despite heavy feeding by the large number of introduced fishes. This high value declined, however, until, in the winter of 1944, it reached a fairly stable level about 300 per cent above the corresponding pre-fertilization winter density of 1942. This increased population density produced an increase of several hundred per cent in total dry organic weight. These increases applied not to one but to all the common species useful as food. For some unexplained reason the chief two invertebrate 'competitor' species, *Anemonia* and *Ciona*, suffered a diminution in numbers. This did not apply to gobies and sticklebacks, which multiplied and flourished to such an extent that in one day, in August, they are computed to have eaten no less than eighteen times as much food as the total population of 'economic' flatfishes.

Too much weight must not be attached to the actual figures; the important point is that they undoubtedly reveal a very large increase in the invertebrate bottom fauna of the Loch due to artificial fertilization. This probably explains, in part at least, the rather unexpected finding that flatfishes in Loch Craiglin continued to feed heavily and even to grow throughout the winter.

The growth-rates of the flatfishes were investigated by means of marking experiments. These were not very successful; the marks became entangled in bottom weed and eelgrass, or inflammation of the wound interfered with growth. There was evidence, however, that unmarked plaice made the equivalent of two years ordinary growth in one year. But most work had to be done with flounders, mainly unmarked. In one year many of these showed weight increases up to about eighteen times that of the normal increment for this species in average natural conditions.

These high growth increments in large numbers of fish were not maintained. In 1943 the flatfish population was as much as 1,000 per acre (2,500 per hectare), but during the year it was very largely wiped out by cormorants, herons and at least one otter. Nevertheless, in spite of failures such as this, these experiments have demonstrated most convincingly that by the application of fertilizers Loch Craiglin, in spite of its 'dirty' bottom and unfavourable hydrographical conditions, was rapidly converted into a feeding ground approaching the richest natural feeding ground known. Although the authors have hesitated to say so, it is reasonable to believe that, if certain salient features could be dealt with, such an enclosed loch might be made far richer in fish production than anything known in Nature. These are:

(1) *Ventilation.* The addition of fertilizers must exacerbate the unbalance of carbon dioxide and pH that always develops in stratified water—and stratification is inevitable in summer or after heavy rainfall. Natural processes of vertical mixing need to be assisted. Here the engineer must be called in to devise some pumping or other mechanism for spreading bottom water on the surface in sufficient quantity to break down the stratification. Could wind power be used to keep the cost within economic limits?

(2) *Fixed plants.* These will thrive less well in deeper water, but are always likely to take toll of added nutrients. Their control provides a problem for research. In the absence of useful fish food-animals that can be encouraged to eat them, an economic outlet must be sought for the seaweeds and eelgrass which would make it worth while to harvest them. This would also reduce their drain on the nutrients.

(3) *Nature of the bottom and fishing gear.* The muddy bottom of Loch Craiglin was in many ways an adverse factor. In particular, catching the fish was undesirably laborious and less successful than it need be. Either special catching gear, perhaps traps, is called for, or a sandy bottom is essential.

(4) *Opacity of the water.* As much as possible of the daylight penetrating into the water needs to be available for photosynthesis. In physical terms, high quantum efficiency of photosynthesis is required. Intensive production of living material in the sea leads everywhere to production of matter, possibly dead plant pigments, that seem to be resistant to breakdown. Their presence restricts absorption of light by the pigments associated with living plant cells. Much more needs to be learned about the chemical substances which bring about light absorption and scattering in 'old water' and how they could be destroyed or turned to account.

Always when discussing marine fish cultivation, it is assumed that nutrients from terrestrial stocks are to be added to the sea. Yet the very great richness of Antarctic water in nutrient salts has come about by a process of concentration within the sea. Current systems, both horizontal and vertical, are such that the loss of nutrients caused by the rain of organic matter falling towards the bottom from the photic zone south of the Antarctic convergence is more than made up by upwelling of deeper and richer water. By contrast, in the Straits of Gibraltar, the relatively rich deep water flows out from the Mediterranean over the sill and is replaced by poorer Atlantic surface water. The net result of the exchange is an impoverishment in nutrients of this great Sea, and consequent poor fisheries. Cannot something be learned from these natural events that could be applied, for example, to a large tidal sea loch with a narrow deep entrance that could be easily dammed? Let it have two sluices, one at the foot of the dam, opened to allow deep nutrient-rich water to enter on the rising tide, the other at tide level to allow surface water, stripped of nutrients, especially in summer, to escape on the falling tide. In time, a concentration of nutrients would build up (as in the Antarctic) higher than would ever be found in the adjacent open sea, and should open up great possibilities of successful fish farming. Under these conditions it would be worth while to remove unwanted fixed plants for use as field dressings.

The cost of building such a dam solely for purposes of an artificial fishery would no doubt prove prohibitive. Equally the construction of such dams to convert tidal energy into electric power has also been burked on the grounds of cost. There should be no loss of hydrostatic height involved in leading the water from the foot of the dam by way of a siphon through a turbine rather than from the incoming surface water, as would normally be done. The combination of simultaneous production of power and fish from the one investment might prove economic. This is another matter for consideration by engineers. In short, this unique experiment has provided such a mass of interesting and important facts as will stimulate academic research and practical endeavour in many parts of the world.

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[1] *Proc. Roy. Soc., Edinburgh*, **63** (1947). An Experiment in Marine Fish Cultivation. No. 1. Introduction. By Dr. F. Gross. 1*s*. No. 2. Some Physical and Chemical Conditions in a Fertilized Sea-Loch (Loch Craiglin, Argyll) by Dr. A. P. Orr. 3*s*. No. 3. The Plankton of a Fertilized Loch. By Dr. S. M. Marshall. 2*s*. 2*d*. No. 4. The Bottom Fauna and the Food of Flatfishes in a Fertilized Sea-Loch (Loch Craiglin). By J. E. G. Raymont. 3*s*. 8*d*. No. 5. Fish Growth in a Fertilized Sea-Loch (Loch Craiglin). By Dr. F. Gross. 7*s*. 8*d*. See also *Nature*, **153**, 483 (1944); **158**, 187 (1946).

[2] Cooper, L. H. N., *J. Mar. Biol. Assoc.*, **27**, 326 (1948).

[3] Buch, K., "Der Borsäuregehalt des Meerwassers und seine Bedeutung bei der Berechnung des Kohlensäuresystems im Meerwasser". *Cons. perm. int. pour l'explor. de la mer, Rapp. et Proc.-verb.*, **85**, 71 (1933).

OBITUARIES

Prof. Alexander Ogg

For more than forty years Alexander Ogg, who died on February 23, had been by common consent the much-loved leader in his subject of physics in South Africa. A Scotsman by birth, he graduated in the University of Aberdeen under Prof. Niven and afterwards obtained his doctorate as an 1851 Exhibitioner under Nernst in Göttingen. His interest in thermodynamics arose during this period, and led to his well-known English translation of Planck's classic work on the subject. After this, he was for a time a lecturer at Aberdeen, which he left to become a master in the Royal Naval Engineering College, Devonport. In 1905 he migrated to South Africa to be the first occupant of the chair of physics and applied mathematics at Rhodes University College, Grahamstown. In so doing he became by no means the least illustrious of that band of Scottish teachers who have contributed so much to South Africa.

Ogg's new department at Rhodes College was housed in part of the old military barracks and bore the inscription "Sergeants' Mess" over its door. He set to work with great vigour and in the face of many difficulties to convert it with his own hands into a physics laboratory which would be not only the best in the country but also bear comparison with any overseas. He soon became acknowledged as an inspiring teacher and attracted to his honours courses the best brains of the College, whether they intended to become physicists or not. Year after year, in regular succession, the senior overseas scientific scholarship in the Union was won by one of Ogg's students, all of whom to-day occupy leading positions in the life of the country.

In 1917, after assisting Sir William Bragg for a time in England in military research, he moved to the University of the Witwatersrand, and in 1920 to that of Cape Town, where he remained until his retirement in 1936. When the University of Cape Town moved to Groote Schuur, he planned and fitted up the new de Beers Physical Laboratories, devoting his spare time to making them an outstanding monument to his wide experience and skill.

During his time in Cape Town, Ogg became interested in terrestrial magnetism, and when he retired from university life at the age of sixty-five he began a new one as director of the Government Magnetic Observatory, Hermanus, which again he planned and fitted up himself. Under his direction the Observatory has become well known internationally not only for its observations, which are considered to be among the most accurate in the world, but also for Ogg's papers on K indices of magnetic activity and on magnetic disturbances. He retired from the directorship in 1946, but maintained an active interest in the Observatory, as in all physical research in the Union, up to the time of his death.

The high standing of the subject of physics in South Africa is very largely due to Ogg's own high standards as a teacher and examiner. His students have become members of the staff of practically every university in the country, and his scholarly influence remains imprinted on both schools and universities. His time and energy, particularly in his early period, were so fully occupied with building up his departments that he had little available for research, though some valuable work on X-ray diffraction and crystal structure was done by him in Cape Town.

He was a fellow of the Royal Society of South Africa and its president for five years, a fellow of the Institute of Physics, the Physical Society, the Royal Microscopical Society and the Faraday Society. The University of Cape Town conferred on him the honorary degree of D.Sc. in 1936, and the University of Aberdeen that of LL.D. in the same year.

As a man, Ogg will be remembered for his kindliness and humour, his strict sense of justice and the great personal interest he took in his students. He always exercised an important influence on university affairs, an influence which was all the more effective because of his unassuming integrity.

B. F. J. Schonland

Mr. Harry Price

Through the death of Mr. Harry Price on March 29, psychical research has lost its most distinguished journalist and writer of popular descriptive accounts of adventures with the unknown. He was born in 1881, and from an early age was keenly interested in conjuring and magic, which soon led him to a desire to inquire more fully into the alleged physical phenomena of mediumship. An opportunity was given him in 1922 to visit Munich in order to be present at some sittings with the famous medium Willi Schneider, with whom the late Baron von Schrenck was at that time experimenting. From that period until the day of his death his interest in the problems of mediumship never weakened.

After the first properly equipped séance room had been built and opened by the Society for Psychical Research in February 1924, Mr. Price followed suit, and in December 1925 he opened what he called the National Laboratory of Psychical Research, with premises in the house of the London Spiritualist Alliance in South Kensington. From that date he pursued his inquiries and published his results with unremitting zeal and enthusiasm. His books and magazine articles were written in popular and colloquial style, and it was through them that many people became acquainted with psychical research who would otherwise have taken but little interest in the subject.

Mr. Price had a wide knowledge of his subject, and in course of time accumulated what is undoubtedly the finest collection of books on conjuring and allied arts that exists. This library he placed on permanent loan in the University of London, with the intention of bequeathing the entire collection, together with a sum of money for its maintenance, to the University. He had long hoped that a department for psychical research might be established in the University of London or elsewhere, and the negotiations in connexion with this project were long and protracted but never came to fruition. One of the reasons for this was that Mr. Price's interest in psychical research was much more that of a brilliant journalist seeking sensational copy than that of a sober man of science studying obscure phenomena away from the glitter of *klieg* lights and the hubbub of Press conferences. It was thus that many of his results were greeted with some suspicion, especially as some of the accounts of his own experiences were unverified and in many cases unverifiable. Yet his influence on contemporary psychical research was considerable, and his position in the field he made his own is not likely to be challenged for many years.

WE regret to announce the following deaths:

Sir Franklin Sibly, K.B.E., vice-chancellor of the University of Reading from 1929 until 1946, on April 13, aged sixty-four.

The Rev. Thomas Stephenson, a well-known amateur field botanist, on April 15, aged eighty-two.

NEWS and VIEWS

Félix Vicq d'Azyr (1748–94)

FÉLIX VICQ D'AZYR, who was born at Valognes in Normandy two hundred years ago on April 23, 1748, may properly be styled the greatest comparative anatomist of the eighteenth century before Cuvier. At the wish of his father, a doctor, he went to Paris at the age of seventeen to study medicine, remaining in the capital all his life. His social success and rapid rise to fame he is said to have owed to the French naturalist, Louis Jean Martin Daubenton, whose niece he married. He became permanent secretary to the newly founded Paris Academy of Medicine and succeeded Buffon in the French Academy. He was also consulting physician to the Queen. While his name is specifically immortalized in the 'band of Vicq d'Azyr' (also described by Gennari in 1782) and in the 'bundle of Vicq d'Azyr' (fasciculus mammillo-thalamicus), he made numerous exceedingly distinguished contributions to comparative and to human anatomy. Of particular importance is his comparative study of the limbs of man and animals, which stresses the correspondence between the flexor and extensor muscles of the legs and arms. In the troubled times in which his last years were spent he frequently risked death by attending patients on the proscribed list. He is believed to have caught a chill while watching the burning of the allegorical figure of atheism, and he died on June 20, 1794, at the early age of forty-six. Vicq d'Azyr's writings were published after his death by Moreau de la Sarthe under the title "Oeuvres de Vicq d'Azyr" (6 volumes), Paris, 1805.

Fuel Efficiency Committees

WHEN he opened the Wolverhampton Industrial Centenary Exhibition, Mr. Hugh Gaitskell, Minister of Fuel and Power, announced that he had reconstituted the Fuel Efficiency Committee organisation of the Ministry. This organisation consists of a central Fuel Efficiency Committee and a Fuel Efficiency Committee in each Region. The Fuel Efficiency Committee was first set up in September 1941, under the chairmanship of Dr. E. S. Grumell, who will continue as chairman. As now reconstituted, it will have the following terms of reference: "To advise on the application of measures promoting economy and efficiency in the use and consumption of fuel and power; to survey the progress of the organisations established for this purpose; to report the problems arising from these surveys which appear to require scientific investigation; to advise generally as to the lines on which a policy designed to raise the standards of utilization of fuel and power can best be implemented".

Many members of the previous committees have consented to serve on the new body. Other experts in different branches of fuel technology, and additional representatives of both domestic and industrial consumers have been invited to join. Liaison with both sides of industry will be ensured by the nomination of members of employers' and trade union organisations, and also with the Industrial and Domestic Coal Consumers' Councils, through their chairmen. The Regional Fuel Efficiency Committees are being reconstituted on similar lines, and their chairmen will be *ex officio* members of the main Committee. The committees consist entirely of voluntary unpaid workers.

Grants for Scientific Research in Belgium

THE annual report for 1946 of the Institute for the Encouragement of Scientific Research in Industry and Agriculture, Exercice, Brussels, details the twenty-nine projects for which subsidies were granted in 1946. The largest of these, 2,800,000 francs, was to the Electrical Construction Works of Charleroi, for research on electronic tubes and their applications; a grant of 2,458,000 francs was made to the Foundation for Potato Research for investigations on the breeding of varieties resistant to virus disease, and one of 2,000,000 francs to the Belgian Institute for High Pressures for static and dynamic researches in the field of high pressures, the development of methods for determining the quality of powders and explosives and the study of the metrology of high pressures. A further grant of 1,900,000 francs was made to the Electrical Construction Works of Charleroi for the continuation and extension of research on the mercury vapour arc, while the Belgian Institute for the Improvement of the Beetroot received 1,890,000 francs for continuing agronomic, chemical, biological and mechanical investigations on the improvement of the sugar-beet. To the Union of Belgian Artificial Textile Manufacturers, "Fabelta", 992,000 francs were granted for investigations on the determination of the properties of viscose filaments, and on the deformation of threads of regenerated cellulose. A grant of 891,000 francs was made to the National Research Centre for the Study of Animals Harmful or Useful to Agriculture, for the initiation of a study of the fauna, of means of controlling indigenous pests and nematode phytoparasites, as well as of biological control of agricultural pests. The Colonial Centre for Documentation and Co-ordination of Chemical Research received 844,400 francs for research in medicinal plants and insecticides in the Belgian Congo, while the Belgian Society of Optics and Precision Instruments received 800,000 francs for scientific and technical research on the improvement of optical surfaces, the study of optical systems corresponding with a new range of instruments and on the introduction of rational methods of manufacture into optics. Smaller grants, including 263,000 francs to the Centre for Ecological and Phytosociological Research and 162,500 francs for research on penicillin, brought the grand total to 20,801,300 francs.

Pulse-Counting Photometer

THE January issue of *Sky and Telescope* describes a new photo-electric photometer which counts the number of light pulses coming in from a star. The apparatus, known as the *RCA* 1*P*21 photo-multiplier tube, furnishes a strong pulse which can be amplified to operate special counters supplied by the Radio Corporation of America. In the 1*P*21 tube, each electron emitted when photons strike the light-sensitive surface in turn releases two to five secondary electrons from the first dynode, and repetition of this process through nine stages means that a single photon can be responsible for the emission of a million or more electrons from the last dynode. The addition of an *RCA* precision time-interval counter makes the work automatic; the observer merely sets a time-interval into a predeterminer, and the electronic devices then expose the counter to the output of the photomultiplier for a predetermined time. The number of pulses received in the interval is proportional to the light intensity of the star. Stars as faint as mag. 11·5 have been measured with the new apparatus attached to the 18-in. refractor of the Flower Observatory, and improvements now in progress may extend this by two magnitudes.

Head Wounds: Treatment and Rehabilitation

"WAR SURGERY SUPPLEMENT No. 1" of the *British Journal of Surgery*, with the subtitle "Wounds of the Head" (Bristol: John Wright and Sons, 1947. 30*s*. net), is not only a good record of surgical skill and achievement but also a fine example of British printing and publishing. Liberally illustrated by drawings and photographs, it should be a valuable work of surgical reference. There are twenty-two articles on various aspects of war wounds of the head. The first is by Geoffrey Jefferson, on "Head Wounds and Infections in Two Wars", the second by Sir Hugh Cairns on "Neuro Surgery in the British Army, 1939–45", and the third a remarkable "Atlas of Head Wounds", illustrating in colour standard operative techniques for their treatment. The remaining articles deal with other aspects of this important field of work and there are also notes on rare or obscure cases and a valuable bibliography of "Gunshot Wounds of the Head". Surgeons especially, but also bacteriologists, neurologists and others who are interested in the treatment and in rehabilitation of the patient after severe head injuries will certainly find the experience collected in this volume of very great value. They will look forward with great interest to the appearance of the three other war supplements which are being prepared. No. 2 of these will deal with Abdomino-thoracic Wounds, No. 3 with Wounds of the Extremities, and No. 4 with Plastic Surgery, including Facio-Maxillary Injuries.

Textile Institute

ACCORDING to the annual report of the Textile Institute, presented at the annual general meeting on April 21, membership increased during 1947 by more than 20 per cent, to 3,728; this is more than twice the 1943 total. Correspondingly, there has been a big increase in activity. Further new branches of the Lancashire Section were formed at Oldham and Burnley; sections and branches held more than a hundred meetings. Besides the very successful annual conference held at Portrush, two one-day conferences were held to consider "Modern Methods of Single Fibre Testing" and "End Breakages in Cotton Ring Spinning". Two scholarships were awarded, to Mr. G. H. Ewins and Mr. J. E. Booth, both of Bolton, who have now commenced degree courses in textiles at the Manchester College of Technology. The decision to award a new scholarship of a maximum value of £1,000, to be available to students in all branches of textiles, was also announced. It is hoped that the Institute will be able to ensure "the general recognition and application of technical skill and scientific knowledge within the textile industry on a scale adequate to enable the industry to maintain its place in the increasingly complex economy of a rapidly developing world. The Textile Institute must achieve the status and capacity which is required if textile technology, of which the Institute is the guardian, is adequately to meet the needs of modern times."

Health Education in Guildford

AN earnest attempt to combat infection of food and drink has recently been begun by the Guildford Health Committee and food traders of the town (*Health Educ J.*, 6, No. 1; January 1948). A preliminary survey of 317 food premises carried out in November 1946 by health officials showed that many premises were faulty in structure and had inadequate washing and cleaning facilities and were staffed by men and women who were daily committing unhygienic practices. Instead of using legislative powers to tackle the problem it was decided to gain the willing co-operation of the manufacturers and food handlers. A Guildford Hygienic Food Traders Guild was set up to improve the sanitary arrangements in food-handling premises and to ensure that the statutory standards of food hygiene are observed, as well as to establish codes of practice for different trades which would be voluntarily accepted and applied by member firms of the food trades guild. Time was given for the necessary alterations and improvements to premises to be made, and the scheme took effect from March 1. The support and co-operation of the housewife has been sought by educational propaganda.

Plant Collecting in the Far East

DR. GEORGE TAYLOR joined Frank Ludlow and George Sherriff in 1938 for an expedition to south-eastern Tibet, and an account of the journey has recently appeared (*J. Roy. Hort. Soc.*, **72**, Pts. 4 and 5, April and May 1947), with illustrations (several in colour) of some of the plants of significant horticultural beauty brought to Great Britain. Part of the collection is still unidentified; but the account seeks rather to portray those species which might attract British gardeners. The genus *Meconopsis* is perhaps most strongly represented, followed closely by *Gentiana*, but many other genera are mentioned. Mr. F. Kingdon Ward has also a recent short paper on his war-time explorations in Manipur (*J. Roy. Hort. Soc.*, **73**, Pt. 2, Feb. 1948). He noted many interesting plants and confirmed several earlier records by Watts and Clarke.

Natural History of Butterflies

A 20-page booklet on "Butterfly Migration" by Dr. C. B. Williams, in the "Young Britain" Educational Series of the *Daily Mail*, has recently come to hand. Simply but effectively written and attractively illustrated, it is a publication with an immediate appeal to young naturalists, if not to older ones also. The photographs of the living insects by S. Beaufoy add to its merits, and the chief facts relative to butterfly migration and what to look for in this field of natural history are clearly presented. Details regarding the various publications in the series are to be obtained from the *Daily Mail* School-Aid Department, New Carmelite House, London, E.C.4. The present booklet and many of the others are priced at 1*s.*; some cost a little more, but are excellent value at this low figure.

Archæology of the Missouri Valley

The Government of the United States is undertaking a large flood control and development programme in the Missouri Valley, and this will result in the destruction or submergence of many archæological sites which badly need study. Work in the area is a race against time, and "Prehistory and the Missouri Development Program", by W. R. Wedel (*Smithsonian Misc. Coll.*, **107**, No. 6), is a summary of what is already known about the archæology, together with an account of a preliminary survey, under the auspices of the Smithsonian Institution, done during the field season of 1946, in order to determine which sites ought to be excavated before they are overwhelmed.

A New Mathematical Journal

The Institute for Mathematics and Mechanics of New York University, of which the director is Prof. R. Courant, has now undertaken the production of a new journal entitled *Communications on Applied Mathematics*, which will appear quarterly. The publishers are Interscience Publishers, New York and London, and the subscription is eight dollars a year. The first number, dated January 1948, contains 99 well-printed pages, on good paper, with several diagrams. Most of it consists of an elaborate investigation of non-linear wave propagation in shallow water and open channels by J. J. Stoker. There is also a shorter paper on free boundaries of an ideal fluid by M. Shiffman. The second number will contain other papers on water waves. It is not intended that the new journal shall deal only with hydrodynamics; later numbers will cover a great variety of topics, including quantum theory, elasticity, aerodynamics, combustion, kinetic theory of gases, and the numerical solution of non-linear partial differential equations. Most of the papers will originate from the Institute for Mathematics and Mechanics of New York University.

International Society of Hematology

The International Society of Hematology will hold its bi-annual meeting in Buffalo, New York, during August 23–26. The provisional time-table allows for half-day sessions as follow: general subjects, including radioactive and stable isotopes in hæmatology; problems and diseases related to the red cells; problems and diseases related to the white cells; immunohæmatology, ***Rh–Hr*** (*CDE–cde*) antigens and antibodies, and hæmolytic anæmias (two sessions); coagulation problems and hæmorrhagic diseases. The chairman of the Programme Committee is Dr. Ernest Witebsky, Buffalo General Hospital, Buffalo, New York. Dr. Eduardo Uribe Guerola, Leibnitz 212, Nueva Colonia Anzurez, Mexico, D.F., is responsible for programme arrangements from South and Central America, and Sir Lionel Whitby, University of Cambridge, for papers from Europe. All scientific sessions and exhibits will be open to those interested in hæmatology. The secretary of the Society is Dr. Sol Haberman, William Buchanan Blood Centre, Baylor Hospital, Dallas, Texas, from whom further particulars can be obtained.

International Rheological Congress

An International Rheological Congress will be held at Scheveningen (The Hague) during September 21–24. The Congress will consider theoretical problems; fundamental experimental methods; rheological properties of various systems; rheological problems in biology; and industrial applications. The plasticity of crystallized materials, soil mechanics and geophysical problems will be excluded, since other international congresses will give attention to these subjects during the year. Sectional meetings for the discussion of special subjects will be a feature of the meeting; at these meetings, every speaker will give only a short account of his paper, so that ample time will be available for discussion. Manuscripts in English or French must be received before May 1. The maximum space for a paper is 2,500 words including formulæ and diagrams, since the *Proceedings* must be limited to 500 pages. Preprints of all papers will be available at least a month in advance of the meeting. Owing to generous support from Dutch industry and scientific societies, the congress fee will be 15 florins (about £1 8*s.*); this will cover the cost of preprints, but not the *Proceedings*. The Organising Committee will help participants in obtaining accommodation at Scheveningen. The secretary of the Committee is Ir. H. C. den Daas, Julianalaan 134 (Postbox 66), Delft.

Summer School in the Physics of Solids

A Summer School in the Physics of Solids, with particular reference to the properties of ionic solids, will be held in the H. H. Wills Physical Laboratory of the University of Bristol during September 8–15. Lectures will be given by Prof. N. F. Mott, Dr. J. W. Mitchell and other members of the staff of the Laboratory. A purely theoretical course on the electrical properties of ionic solids was held in 1946. The present course is intended for members of the staffs of Government and industrial laboratories who wish to familiarize themselves with both experimental and theoretical work on the properties of ionic solids, particularly in fields beyond those with which they are directly concerned. For each branch of the subject, parallel lectures will be given on the experimental side and on the theoretical side. Accommodation can be arranged at the University Hall of

Residence, Clifton Hill House. Inquiries should be addressed to the Director of the Department of Adult Education, W. E. Salt, University, Bristol 8; completed application forms should be returned by June 15.

Summer School in Metal Physics

A Summer School in Metal Physics will be held in the Cavendish Laboratory, Cambridge, during August 23–September 3. The School will provide an introduction to the application of physical methods to the examination and utilization of metals, and is intended for those whose researches require a more fundamentally physical approach than is usual in ordinary metallurgical and engineering practice. The lectures and demonstrations will deal with (*a*) application of X-ray methods in the examination of metals, (*b*) physical and mechanical properties of metals. Both parts will be taken by all attending the School, and for Part (*a*) an elementary knowledge of X-ray diffraction methods and of crystal symmetry will be assumed. A detailed syllabus and form of application for admission can be obtained from G. F. Hickson, Secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge, to whom the completed application form should be returned not later than June 1.

University of London: Appointments

The following appointments in the University of London have been announced: Prof. A. C. Offord, professor of mathematics at King's College, Newcastle-upon-Tyne, since 1945, to the University chair of mathematics tenable at Birkbeck College as from October 1; Dr. R. E. M. Wheeler, director-general of archæology in India since 1944, to the chair of the archæology of the Roman Provinces tenable at the Institute of Archæology as from October 1; Miss Mary Barber, lecturer in bacteriology in the British Postgraduate Medical School, to the University readership in bacteriology tenable at St. Thomas's Hospital Medical School as from October 1; Dr. H. E. Rose, lecturer in mechanical engineering at King's College, to the University readership in mechanical engineering tenable at the College as from October 1.

The following titles have been conferred: professor of geology in the University on Dr. Leonard Hawkes (Bedford College); reader in organic chemistry in the University on Dr. A. H. Cook (Imperial College of Science and Technology); reader in chemistry in the University on Dr. H. G. Poole (University College); reader in agricultural chemistry in the University on Dr. R. L. Wain (Wye College).

The degree of D.Sc. has been conferred on Franz Bergel (Lister Institute of Preventive Medicine).

Colonial Service Appointments

The following appointments in the Colonial Service have been announced: J. L. Fleure, survey probationer, Malaya; R. W. Butler, veterinary officer, Tanganyika; R. M. S. Neave, veterinary officer, Kenya; D. Bradwell, analyst, Medical Department, Cyprus; R. L. Hartley, agricultural education officer, Fiji; C. W. D. Kermode, assistant conservator of forests, Tanganyika; J. P. Oliver, agricultural officer, Falkland Islands; L. Ross, assistant meteorologist, Nigeria; A. J. Willis, assistant meteorologist, Nigeria; E. W. Leach (deputy director of agriculture, Trinidad), director of agriculture, Trinidad; W. C. Muir (director of agriculture, Trinidad), director of agriculture, Tanganyika; F. W. Toovey (principal research officer, Oil Palm Research Station, Nigeria), officer-in-charge, Oil Palm Research Station, Nigeria; H. Fraser (assistant conservator of forests, Tanganyika), senior assistant conservator of forests, Tanganyika; H. R. Herring (assistant conservator of forests, Tanganyika), senior assistant conservator of forests, Tanganyika; A. L. C. Thorne (veterinary officer, Gold Coast), veterinary education officer, Nigeria; J. Y. Moggridge (entomologist, Tsetse Research Department, Tanganyika), director, Tsetse Research Control Department, Tanganyika; H. C. Smith (senior assistant livestock officer, Tanganyika), livestock officer, Tanganyika; J. F. B. Watling (senior inspector of produce, Nigeria), principal produce inspector, Nigeria.

New Satellite of Uranus

It is reported from the McDonald Observatory, Texas, that a new satellite of magnitude 17 to the planet Uranus was found on a plate taken on February 15, at the Cassegrain focus of the 82-in. telescope. Two other plates taken on March 1 confirmed the new discovery. Its distance from the planet is about 0·00082 astronomical unit, or 76,500 miles, which implies that its period of revolution is about 31 hours.

Acetylation of Sugars

Referring to the communication by S. D. Nicholas and Dr. F. Smith entitled "Acetylation of Sugars" (*Nature*, March 6, p. 349), Dr. P. H. Plesch, Chemistry Department, University of Manchester, remarks that the use of perchloric acid as catalyst in the acetylation of sugars is by no means new; it has been discussed in some detail by D. Krueger and W. Roman (*Berichte*, **69**, 1830 (1936) and *Angew. Chem.*, **47**, 58 (1934)).

Announcements

Mr. Norris E. Dodd, Under-Secretary of Agriculture in the United States, has been appointed director-general of the United Nations Food and Agriculture Organisation, in succession to Sir John Boyd Orr, who has retired. The British Minister of Food has agreed to release Sir Herbert Broadley, deputy secretary, Ministry of Food, for appointment as deputy director general of the Organisation.

The Fison Lectures of the Animal Health Trust will be delivered by Prof. L. Seekles, of the Veterinary Biochemical School of the University of Utrecht, at the Kingsway Hall, London, on May 10 and 12. He will discuss mineral disturbances in cattle, gastro-intestinal autointoxication in cattle and horses, and conditional deficiencies of trace elements in cattle. Further particulars may be obtained from the Animal Health Trust, 232–235 Abbey House, Victoria Street, London, S.W.1.

The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland propose to award, for the next academic year, a limited number of postgraduate scholarships in husbandry, agricultural economics, statistics and agricultural and dairy engineering. Particulars may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 2 Cambridge Terrace, Regent's Park, London, N.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.

Erratum. In the note on "American Summer Scholarships for European Students" (*Nature*, April 17, p. 593), it should have been stated that applicants must be *less than* thirty-five years of age.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Purification of Anti-pernicious Anæmia Factors from Liver

We have now prepared from ox liver two red pigments both highly active in pernicious anæmia. The crude extract was purified by the methods employed by Emery and Parker[1] and then by repeated chromatography. Full details of these techniques will be offered for publication later. Recently we have used as starting material a proteolysed liver extract made on a manufacturing scale; this has given better yields of a product differing slightly in chromatographic behaviour, and of higher activity. Some preparations of both types have been separated by partition chromatography into two red fractions; the proportions suggest that one arises from the other by proteolysis.

The development of fractionation methods was made possible by the collaboration of Dr. C. C. Ungley, who carried out more than eighty clinical tests on our materials. After it became clear that activity and colour are inseparable, this property was used as a guide in cutting chromatograms. With the invaluable assistance of Mr. L. F. J. Parker, four tons of liver have to date been fully processed, yielding barely a gram of red materials from six separate lots of liver. The minimum effective single dose for the best four preparations from non-proteolysed liver are assessed at about 0·6 mgm., while proteolysed liver has yielded one preparation L.E.445 effective at 0·3 mgm. though not fully purified. It was also effective in three cases of subacute combined degeneration of the spinal cord. A recovery of about 25 per cent of the original clinical activity was achieved in this purification. Ten batches of red materials have all proved clinically active (twenty-six cases in all).

A recent preparation, which appeared to have reached the limit of purification by chromatography, was shown by electrophoresis on the Tiselius apparatus to be still not homogeneous. After the action of mixed bacteria, it was susceptible to further chromatographic purification. The resulting product had eight times the intensity of colour of L.E.445. It has not yet been tested clinically; if activity remains proportional to colour, it should be effective at 0·04 mgm.

The products are amorphous solids having about the colour of cobalt salts, but they show only general absorption of visible and ultra-violet light with very slight steps at 505 and 275 mμ. The low intensity of absorption precludes the presence of more than a few per cent of such bodies as folic acid or xanthopterin. Ultra-violet light produces a very faint blue fluorescence (probably due to a trace of impurity); this is abolished by hydrosulphite, while the colour shows only a slight change of shade. Dr. R. A. Kekwick at the Lister Institute kindly examined a sample in the ultra-centrifuge and reported no sedimentation boundary even at 250,000 *g*, suggesting a molecular weight well below 10,000. The diffusion method has indicated molecular weights of about 3,000 for the pigments from both proteolysed and non-proteolysed liver. We are indebted to Dr. J. E. Page for these determinations and also for polarographic examination and electrometric titration, neither of which revealed any characteristic steps. The optical rotation of various imperfectly purified specimens has ranged from $[\alpha]_D - 150°$ to $-200°$. There is a gradual change in colour from red to orange on exposure to daylight, accompanied by a marked change in chromatographic behaviour.

Our products are exceedingly soluble in water and not readily salted out; they are also soluble in nearly anhydrous alcohol, in acetone containing only a few per cent of water, and in glacial acetic acid; but not in ether, chloroform or non-polar solvents.

Chemical examination has not proceeded very far. Various lots have contained 11·7–13·9 per cent nitrogen. Washing a solution in phenol with dilute acid removed calcium and a little sodium; the phenol solution left a negligible ash. Amorphous precipitates are given by Reinecke acid, rhodanilic acid and phosphotungstic acid. Warm dilute alkali has no effect on the colour, but boiling normal soda quickly destroys it. On the other hand, the colour is remarkably resistant to acid hydrolysis and partially survives boiling with 6 *N* hydrochloric acid for twenty-four hours. After boiling with *N* hydrochloric acid for one hour the pigment is very readily extractable by *n*-butanol. From 23 to 50 per cent of the original weight appeared in the butanol extract, depending on the purity of the preparation. It appears to contain two pigments, one acidic and readily extractable from the butanol with aqueous alkali, the other neutral; the latter is readily soluble in chloroform, the former only slightly; both are insoluble in ether; neither is identical with the photolysed product. These substances have not as yet been examined further.

The residual aqueous acid layers have contained peptides; after further acid hydrolysis these have been examined by Mr. G. A. Childs and Dr. W. F. J. Cuthbertson, by chromatography on paper and (after acetylation) on silica, and by microbiological assay, respectively. Proline, hydroxyproline, leucine, serine, glutamic acid, and *p*-aminobenzoic acid have been detected; but differences in the results for different preparations make it probable that some of the amino-acids arise from peptide impurities.

The following conclusions appear warranted. Our two pigments are differing forms of the classical liver factor first postulated by Minot and Murphy twenty-two years ago[2], and not some incomplete substitute, such as folic acid or thymine. Whatever deficiencies may be found with other macrocytic anæmias, true pernicious anæmia and its associated neurological disturbances do not require a multiplicity of factors as postulated by Jacobson and SubbaRow[3] and others, but respond to a single factor. With an effective dose equivalent to some 20 μgm. daily (possibly 2·5 μgm. only) this is one of the most potent of known physiologically active substances.

Addendum. Since this letter was written, we were privileged, through the courtesy of a confidential disclosure by Dr. R. T. Major of Merck and Co., Inc., Rahway, New Jersey, to read prior to publication the paper by E. L. Rickes, N. G. Brink, F. R. Koniuszy, T. R. Wood and K. Folkers (*Science*;

in press), on the isolation of crystalline vitamin B_{12}, which appears to be the pure anti-pernicious anæmia factor.

E. LESTER SMITH

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Greenford.
April 9.

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[3] Jacobson, B. M., and SubbaRow, Y., *J. Clin. Invest.*, **16**, 573 (1937).

A New Extraction Procedure for the Preparation of Heparin

THE usual method of preparing heparin, due to Charles and Scott[1], involves rough extraction of tissues with alkali and subsequent tryptic digestion of the protein precipitate.

Special investigations, which will be reported elsewhere, made it highly desirable to prepare heparin by means of milder extraction methods avoiding the use of alkali. For this purpose, a number of salt solutions of different concentrations were tested. A 10 per cent calcium chloride solution, as used by Meyer *et al.*[2] for the extraction of chondroitin sulphuric acid, proved to be ineffective, and so did several other salt solutions. It was found that solutions of potassium thiocyanate exert a pronounced power of extracting fairly quickly and completely the mast cell granular substance from various tissues (liver and skin). Using *M* potassium thiocyanate solution for twenty-four hours, we obtained about 90 per cent extraction of the metachromatic material in ox liver. Histochemical examination of the tissue residues (cf. Sylvén[3]) showed only insignificant amounts of metachromatic substances left after such extraction. Metachromatic material was not found to adhere to other constituents, such as collagen, as it often does when previous methods are used.

After the extraction, the potassium thiocyanate was readily removed by dialysis. The following fractions then remained to be analysed: tissue residue, precipitate, supernatant and dialysate. The different fractions were treated by tryptic digestion according to Charles and Scott, and the heparin contents were assayed by estimating the anticoagulating effect by means of the thrombin method according to Jaques and Charles[4]. The following amounts of heparin expressed in mgm. 'standard heparin' according to Jorpes[5] were found:

	Amount of heparin obtained from ox liver
Tissue residue	5·5 mgm./kgm.
Precipitate	56·3 ,,
Supernatant	0 ,,
Dialysate	0 ,,
	Total 61·8 ,,

Obviously, the extracted substances displaying heparin activity were precipitated following the removal of thiocyanate. The heparin precipitated during dialysis seems to be bound to proteins. The complex is split by trypsin treatment, and afterwards almost all the heparin can be recovered. The collected yield tallies well with that reported by Wilander[6] (56–75 mgm./kgm. ox liver).

The properties of heparin prepared in this way will be described elsewhere.

We wish to express our thanks to the Consul General, Axel Ax:son Johnson, Stockholm, for financial support.

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ROBERT JENSEN
BENGT SYLVÉN

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Jan. 10.

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Effect of Thyroid Deficiency on the Level of Pseudo-Cholinesterase in the Plasma of Rats

THE effect of thyroid deficiency on the level of pseudo-cholinesterase in rat plasma has been examined in the following experiments.

Adult male Wistar rats (200–400 gm.) were used. They were maintained on a diet of chow ('Purina') which has been shown to be adequate for normal growth in the rat colony. All animals were killed by exsanguination through the jugular vein, and plasma from the oxalated blood was used for estimating pseudo-cholinesterase activity. The determinations were carried out by the method previously described[1]. Group I consisted of twenty-seven normal animals which served as controls. Group II was made up of sixteen animals which survived thyroidectomy. In this operation the removal of varying amounts of parathyroid tissue could not be avoided. To offset the effects of parathyroidectomy, daily subcutaneous injections of 2 ml. of a 5 per cent calcium gluconate solution were given for a period of seven days. The animals were killed fourteen days after operation; this time interval seems sufficient for the recovery of the level of pseudo-cholinesterase from the transient decline resulting from surgical intervention[2]. To exclude the possibility that the effects observed were due to parathyroidectomy rather than thyroidectomy, a third group of fifteen rats was treated with thiouracil. These rats received for a period of 23–27 days a water ration containing 0·06 per cent thiouracil. With an average daily intake of 20 ml. of water, the thiouracil consumed by each rat was thus in the neighbourhood of 12 mgm. a day.

It will be seen from the figures in the accompanying table that thyroidectomy and treatment with thiouracil cause an increase in the level of the pseudo-cholinesterase of the plasma.

LEVEL OF ACTIVITY* OF PSEUDO-CHOLINESTERASE IN THE PLASMA OF MALE RATS

Group	Normal I	Thyroidectomized II	Thiouracil-treated III
Number of animals	27	16	15
Average activity	41·0	97·1	117·3
Standard error	2·3	8·7	10·6

* µl. Carbon dioxide evolved by 1 ml. plasma in 20 minutes. Substrate: benzoylcholine chloride (0·006 *M*).

A statistical analysis of the results obtained reveals that the probabilities for the differences in pseudo-cholinesterase activity arising on a basis of pure chance are: for Groups I and II, $2 \cdot 0 \times 10^{-9}$; for Groups I and III, $2 \cdot 6 \times 10^{-12}$; and for Groups II and III, $1 \cdot 3 \times 10^{-1}$. Thus the differences between the levels of pseudo-cholinesterase in the plasma of normal and thyroidectomized and of normal and thiouracil-treated animals are highly significant, whereas the difference between the effect of thyroidectomy and treatment with thiouracil is of doubtful significance.

Since the physiological function of the pseudo-cholinesterase is still obscure, any attempt to interpret the results outlined above would seem premature. This investigation is being continued and the experimental findings will be discussed in greater detail elsewhere.

This research was aided by a grant from the Banting Research Foundation to one of us (M. N.).

R. D. Hawkins
B. Mendel
M. Nishikawara

Banting and Best Department
of Medical Research,
Banting Institute,
University of Toronto.
Jan. 9.

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Phase Memory of the Ear: a Proof of the Resonance Hypothesis

No experiment has hitherto been recorded which is decisive for or against the resonance hypothesis. The properties of the ear are such that it is difficult to construct an experiment of which the result is neither obscured by an unavoidable margin of error nor capable of alternative interpretations. We believe that the following experiment is unobjectionable on either of these grounds and constitutes a valid proof that the resonance hypothesis is true, and that the resonators of the ear (at all but the lowest audible frequencies) are only lightly damped.

We present to the ear of an observer two alternative stimuli. One stimulus consists of a train of oscillatory pulses of sound, each pulse of the form $F \sin 2\pi ft$ and n cycles duration separated from the next by a silent interval of length corresponding to m cycles, n and m being integers. The other stimulus, which can be substituted for the first by the operation of a single switch, is identical in all respects save that the phase of alternate pulses is reversed. Precautions are taken to ensure that the wave-form of the sound in air corresponds with high accuracy to the intended wave-form. If the observer can distinguish between the two stimuli, it follows that the oscillations in the ear initiated by each pulse have not died down to insignificance at the onset of the next, for the energy of every pulse of both stimuli is identical in magnitude and spectral distribution. No frequency analyser could distinguish between the two stimuli unless its oscillatory time constants were so large that phase was 'remembered' across the silent interval.

We find, for example, that at a frequency, f, of 5 kc./s., an intensity of about 20 db. above threshold and n approximately 10 (the value of n is not critical), the stimuli are readily distinguished provided that m is not much greater than 30. The energy in a resonator decays at the rate of $\frac{20\pi}{Q} \log_{10} e$ db. per cycle ($\doteqdot \frac{27}{Q}$ db. per cycle), where Q defines the degree of resonance in the usual way. It is evident that if Q were low, say, 10, the residual energy at the end of a silent period of 30 cycles would be insignificant (40 db. below threshold). The only explanation of the result is that at this frequency the value of Q must be so high that the residual energy at the end of the silent period is a significant fraction of the energy available from the next pulse. This indicates a value for Q of at least 100 and probably substantially more.

We have published[1] an estimate of Q for the resonators of the ear by a different method, giving a value of about 250 at 5 kc./s. The experiment described above constitutes a proof that our previous interpretation was correct, and that in fact it was the Q of the resonant elements which we determined and not, as has been suggested, a time constant associated with some subsequent process in the chain which results ultimately in a sensation in consciousness. It also strongly supports the conclusion that, in essence, Helmholtz's interpretation of the structure of the ear was correct[2]. Consequently the results of experiments which have been interpreted as indications that the resonators of the ear were highly damped must be re-examined. So far as we can see, an alternative explanation consistent with the resonance hypothesis is in every case the probable one.

One of us (T. G.) was assisted by a grant from the Medical Research Council.

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T. Gold

Zoological Laboratory,
Cambridge.
Jan. 17.

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[2] Helmholtz, "Tonempfindung" (1862).

Osmotic Work Performed by the Renal Tubules

A method for the derivation of an 'index of renal tubular activity' has recently been suggested by Barclay and Kenney[1]. An alternative method of deriving this index, which is suggested in this note, lends support to Barclay and Kenney's claim that their ratio represents tubular activity.

Consider a small region of the tubule, where the concentration of the solute in the tubular urine exceeds the concentration of the same solute in the plasma by a small amount, dC'. Let the osmotic pressure difference between the plasma and the tubular urine in this region be equal to p', for this particular constituent solute.

Then:

$$p' = RT.dC',$$

where R is the gas constant, and T the absolute temperature.

Now the work performed in withdrawing a volume of water, dv, against this osmotic pressure, p', is

$$w' = RT.dC'.dv.$$

To obtain the total work performed along the whole length of the tubule, we can take the sum of the work done in the regions from the glomerulus to the end of the tubule: that is, from the region where $dC' = 0$, to the region where $dC' = (U' - P')$, U' and P' being the concentrations of the substance in the urine and plasma, respectively.

If the work done along the whole length of the tubule is summed, the value of dv may be written as a constant, k; and dC' becomes $(U' - P')$. If this value for the work along the whole length of the tubule is referred to a constant rate of filtration of the solute under consideration, we can obtain an expression for the total work, per mole of the solute filtered :

$$W_0' = RT.k.(U' - P')/G.P', \qquad (1)$$

where G represents the glomerular filtration-rate.

Similarly, for a second solute :

$$W_0 = RT.k.(U - P)/G.P. \qquad (2)$$

Therefore the ratio of the osmotic work performed in withdrawing water against the osmotic pressure of the second solute to that performed in withdrawing water against the osmotic pressure of the first is given by :

$$W_0/W_0' = P.P'(c - 1)/P'.P(c' - 1),$$

where $c = U/P$ and $c' = U'/P'$.

$$\text{Hence } W_0/W_0' = (c - 1)/(c' - 1). \qquad (3)$$

Where the 'reference solute', represented above by U', P', etc., is a substance which is neither excreted nor reabsorbed by the tubule cells, this ratio becomes identical with that proposed by Barclay and Kenney.

The above equations hold in the case of non-electrolytes. For electrolytes we must consider the activity coefficient. For two electrolytes having the same values for activity and dissociation, equation (3) above will hold. If we consider any electrolyte, and compare it with a reference solute, such as inulin, we are fulfilling the conditions under which the index of Barclay and Kenney is applied.

This would indicate that the index, E, referred to above, represents the ratio of the osmotic work performed in withdrawing water against the osmotic pressure of a particular solute, to that performed in withdrawing water against the osmotic pressure of a solute which is neither excreted nor reabsorbed by the renal tubules.

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[1] Barclay, J. A., and Kenney, R. A., *Acta Med. Scand.*, **125**, 386 (1946).

White-eyed Mutants of Diptera

RECENTLY, Sturtevant[1] has criticized work on white-eyed mutants of *Culex*[2], *Calliphora*[3] and *Phormica* (= *Phormia*)[4], on the grounds that such mutations are not comparable with white-eyed types in *Drosophila*. Sturtevant claims that while there are two pigments, a red and a brown, in the wild-type eye of *Drosophila*, there is only one pigment, a brown, in *Calliphora*, and that this is the usual condition in insects. Thus, the wild-type eye of *Calliphora* would be like the brown mutant of *Drosophila* in which red pigment is absent ; and, moreover, in that case it would not be possible to distinguish morphologically white, vermilion, cinnabar and scarlet mutants in *Calliphora* or in other Diptera in which red pigment is not present in the wild-type eye. In support of this view, Sturtevant quotes the work of Becker[5] on the eye-pigments of Arthropods.

Microscopical examination of the wild-type eye of *Culex pipiens* confirms the absence of red pigment granules in this species ; but it is only necessary to tease out in saline and examine microscopically an adult wild-type eye of *Calliphora erythrocephala* to prove conclusively that abundant red pigment granules are present. In a paper now in the press[6], I have shown that during pupal life the sequence of pigment formation in *C. erythrocephala* is yellow, brown and red. Moreover, there is a close parallelism between *Drosophila* and *Calliphora* both in the sequence of development of pigment granules and in the distribution of the different types of granules in the various pigment cells of wild-type eyes, except that in *Calliphora* the late-phase deposition of pigment and the appearance of red granules do not occur until a few hours before the emergence of the adult fly (at 24° C.). In the mature wild-type eye of *C. erythrocephala*, red pigment granules are present in the basal regions of the primary pigment cells and are densely packed throughout the body and fringes of the secondary pigment cells. Brown pigment granules are densely packed throughout the primary pigment cells except for their basal regions, but occur only in the distal tips of the secondary pigment cells.

I have shown[7] previously that the nature and location of the red and brown pigments in *Calliphora* render possible the occurrence of 'red' mutants as in *Drosophila* ; but this paper, which followed that in which the white-eyed mutant of *Calliphora* was described[3], apparently has been overlooked by Sturtevant. It was shown that, in certain circumstances, namely, keeping developing pupæ at about 4° C., it is sometimes possible to induce the formation of red pigment granules in the eyes of white-eyed mutant females of *Calliphora*. In such cases red is present in the absence of brown pigment, and the eye of the adult female is 'pink' or 'red'. This shows that potentially the 'red' series of mutants is possible in *Calliphora* in the absence of brown pigment ; and, presumably, in the absence of 'red', a series of brown mutants could appear. Finally, the absence of *both* red and brown pigments gives the white-eyed mutant.

It can be concluded, therefore, that in the wild-type eye of *Calliphora erythrocephala* both red and brown pigment granules are present. In mutant forms the red pigment may be present in the absence of brown. In the white-eyed mutant both red and brown pigments are absent. There is a close parallelism between the type, development and distribution of pigment granules in wild-type eyes of *Drosophila* and of *Calliphora*.

There is thus no basis for the contention of Sturtevant that the white-eyed mutation which I have described in *Calliphora erythrocephala* is not comparable with white-eyed types in *Drosophila*. The main interest, however, of the white-eyed mutant of *Calliphora*, as I emphasized in previous papers, is that, in spite of the similarity to *Drosophila* in details of type and distribution of pigment granules and in the location of the mutant gene in the X-chromosome, there is a fundamental difference in the mode of inheritance of the mutant gene in *Calliphora*. The white-eyed gene in *Calliphora* is sex-linked, as in *Drosophila* ; but, as I have shown[3], it is unique among known eye-mutants of *Diptera* in being sex-limited and appearing only in the double recessive female. This sex-limitation is due to the presence of an allelomorph for wild-type eye in the Y-chromosome, which is dominant over the recessive mutant gene in the X-chromosome. The male *Calliphora*, therefore, never manifests the white-eyed character even when it carries the mutant gene in the X-chromosome of the XY pair in this sex. In Diptera the only other comparable cases of sex-limitation of mutant genes, caused by the presence of normal allelomorphs in the *Y*-chromosome, are the mutant 'bobbed' described by Mohr[8] in *Drosophila melanogaster* in 1923 and the 'lethal' described by Schubel[9] in 1934 in the same species.

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Molteno Institute,
Cambridge. Jan. 15.

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Action of Heating on *Rh*-Positive Human Red Cells

Lubinski and Portnuff[1] have demonstrated that heating at 56° reduces or destroys the agglutinability of *Rh*-positive cells by anti-*Rh* sera. They have studied also the action of diluted formalin, which seems to be somewhat similar. Many workers have observed that preservation in saline affects the *Rh*-positive cells in the same way and recommend the use of fresh suspensions when performing *Rh*-testing.

These facts lead to the idea that the *Rh* receptor is probably more superficial or fragile than the *A* and *B* receptors, for example. We have tested this idea by the following experiment: 1 ml. of *O Rh*+ (*CDe, cDE*) cells are washed three times and suspended in an equal volume of saline adjusted to *p*H 7·2. The mixture is heated for fifteen to twenty minutes in a water-bath at 56° C., and the cells separated from the medium by centrifuging. The cells are washed three times and distributed in a series of titrations with a powerful anti-*Rh* (anti-*D*) serum. Controls are made with unheated *Rh*+ and *Rh*− (*cde, cde*) cells and with heated *Rh*− cells. It is easily verified that heating abolishes the agglutinability of the *Rh*-positive cells. The supernatant fluid to both *Rh*+ and *Rh*− heated cells is mixed with an equal volume of anti-*Rh* serum and allowed to stand at room temperature for half an hour. The two mixtures are then titrated in saline with fresh *Rh*-positive cells. In these conditions, a marked inhibition effect takes place in the first series (supernatant fluid of *Rh*+ cells), while the second shows no evident change in the anti-*Rh* titre.

This experiment was performed with several anti-*Rh* sera, and the same results were obtained.

It appears that heating at 56° C. affects the agglutinability of *Rh*-positive cells by splitting off from the surface of the cell a substance which diffuses in the medium; this may prove to be the *Rh*-receptor.

We are indebted to Dr. R. R. Race and A. E. Mourant for having given us the test-sera used in the genotype determination.

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A Method for Estimating Percentage Germination of Fungal Spores

METHODS previously used for estimating the percentage germination of fungal spores have involved hanging-drop or slide cultures. The environmental conditions, when using these methods, have always been difficult to standardize, though it may be argued that for pathological work they simulate those existing on the surface of fruits and leaves.

We have evolved, during fermentation studies, a method which could be applied to fundamental investigation of the physiology and biochemistry of spore-germination. This method possesses the following advantages: (*a*) conditions are readily standardized; (*b*) it is rapid and easily operated; (*c*) large serial samples can be taken from the same population; (*d*) the samples can be kept for further reference.

The technique involves addition of spores to a liquid nutrient medium contained in a plugged vessel so that the final concentration is not less than 1×10^6 spores per ml. of medium. The vessel is shaken on a rotary or reciprocal shaking machine at a known temperature, and samples are taken at intervals. The spores in the samples are fixed and afterwards examined as convenient.

The degree of accuracy of this method is illustrated by the results of the following typical experiment. Conidia of *Penicillium chrysogenum Q* 176 were used. Each of eight 750-ml. conical flasks containing 100 ml. of a nutrient medium was inoculated with 1×10^8 conidia. The flasks were maintained at 24° C., on a rotary shaker. Later, when germination was about 50 per cent, three samples were taken from each flask and fixed in 10 per cent formalin. Three counts per sample, each of about 500 spores, were made.

A statistical analysis of the results showed that no significant variation existed between the repeat samples from the flasks, the repeat counts per sample and the mean count from flask to flask. The variation between the nine counts within each flask was not greater than the theoretical error of counting[1]. The conidial suspension was thus uniform, was capable of accurate sampling and remained stable. The theoretical standard error of percentage germination is $100\sqrt{n(N-n)/N^3}$, where N is the total number of spores counted and n is the number germinated. For the results of this series, this was approximately 2·2 per cent actual.

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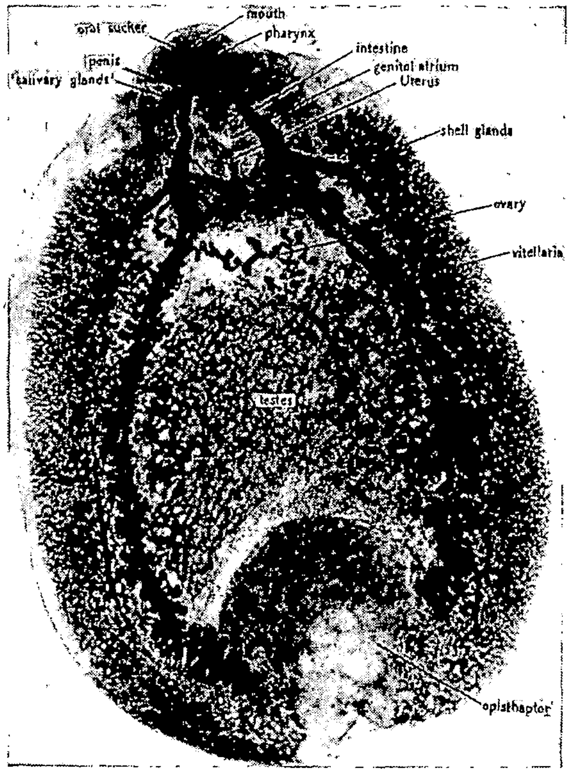
A Rare Cœlom-Dwelling Trematode

CŒLOM-dwelling trematodes are very rare. The only monogenetic form ever found in the cœlom of a vertebrate is *Dictyocotyle cœliaca* Nybelin, 1941. A solitary specimen was found at Göteborg on April 1, 1940, attached to the surface of the liver in a ray (*Raja lintea* Fries) caught the previous day near Skagen. At first sight the trematode was mistaken for the well-known cloacal parasite *Calicotyle kroyeri*, but closer inspection revealed several distinctive characters, notably the irregular arrangement of numerous



Calicotyle cœliaca; FIRST SPECIMEN. NEGATIVE PREPARED BY MESSRS. H. MALIES AND M. V. SALMON; PRINT BY WALLACE HEATON, LTD.

shallow loculi on the posterior disk (opisthaptor), which was devoid of hooks, the reticular nature of the testes and the five finger-like terminations of the filiform ovary[1]. In contrast, the opisthaptor of *Calicotyle* has one central loculus and seven peripheral loculi and bears one pair of hooks with recurved points, the testes are diffuse and follicular and the ovary terminates in a single lobe.

A second specimen was afterwards found among specimens of *Calicotyle kroyeri* in the Natural History Museum, Göteborg. It had been found by Swenander thirty-five years earlier in the cœlom of a starry ray (*Raja radiata* Donovan) caught near Trondhjem, and was somewhat deformed. Three specimens found several years later at Cambridge on the liver of a young skate (*Raja* sp.) obtained from Plymouth were mature but mutilated, each of them having lost the opisthaptor[2]. Thus, until the present time, only one good specimen of this species was known.

In my recent book[3] I commented on the difficulty of resolving the taxonomic status of *Dictyocotyle cœliaca*, which I chose to regard as an abnormal form of a species of *Calicotyle*, probably *C. kroyeri*, which had entered the cœlom of the host by way of one ot the abdominal canals and had either failed to perfecf the larval haptor normally or else regenerated an abnormal haptor after losing the normal one. In the absence of young forms we cannot improve on these speculations; but as two new adult specimens have turned up in Britain, some further comments are called for. The specimens came to me as stained whole mounts through the courtesy of Mr. Eric B. Francis, from the Zoological Laboratory, University of Sheffield. They were found on the outside of the stomach in a thornback ray (*Raja clavata* L.) during the course of a dissection. About twenty other rays of the same batch (believed to have been landed at Brixham) were examined for similar parasites, but without success.

Both specimens are somewhat larger than Nybelin's specimen *A*, being 8·3 mm. and 8·1 mm. long and 6·3 mm. and 6·0 mm. broad (0·76 and 0·73 body-length), but smaller than his specimen *B* which, to judge from a figure and scale, must have exceeded 11 mm. in length. The unarmed, multiloculate opisthaptor is about 2·5 mm. in diameter (0·3 body-length) in each specimen, that is, relatively large, and the oral sucker is about 1·0 mm. broad and 0·7 mm. long. In other respects the specimens display the distinctive characters described by Nybelin; the reticular testes occupy most of the space available in the mid-body, and in front of them is seen the thread-like ovary with its five almost spherical terminations, each about 0·1 mm. in diameter (see reproduction). Other characters include well-developed glands associated with the base of the pharynx, the mean size of which is 0·42 mm. × 0·37 mm., intestinal crura with short and simple diverticula and also larger, compound outgrowths in the posterior region, well-developed vitellaria and shell glands, a common genital atrium and pore, complicated male genital organs—including a cuticularized penis—and a pair of vaginæ. What is almost certainly an extruded egg is caught on a fold of the body margin in one specimen; it is pyriform, measures 0·186 mm. × 0·100 mm. and has a single polar filament 0·019 mm. long.

With this confirmation of Nybelin's observations on the cœlom-dwelling trematode from rays captured in the Skager Rak, the North Sea and the English Channel comes the conviction that it deserves the status of a species, but is a species of *Calicotyle*, namely, *C. cœliaca* (Nybelin, 1941). The location in the host indicates only deeper penetration, for *C. kroyeri* and *C. affinis* enter the rectum and rectal gland of *Chimæra monstrosa*, *C. stossichi* enters the rectum of *Mustelus lævis* and *C. inermis* and lives in the oviducts of *Pristiophorus cirratus*. The absence of hooks on the opisthaptor is also a character of the last-named species. Little can be said at present about the loculi on the opisthaptor, except that they number about one hundred and vary in degree of development (see reproduction).

For further study of this obscure and interesting trematode new specimens are needed, particularly young forms, and I hope that a look-out will be kept for them not only in the cœlom, but also in locations such as the rectum and the oviducts, in laboratories where skates and rays are dissected.

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Interspecific Fertilization in Ascidians

THE only experimental work on interspecific fertilization in Ascidians known to me is that of Reverberi[1], who succeeded in fertilizing *Ciona intestinalis* eggs with *Phallusia mamillata* sperms after removal of the egg membranes. He availed himself of Morgan's observation that in *Ciona* only the egg membranes oppose self-fertilization.

Following Prof. Reverberi's suggestions, interspecific crosses have been tried between eggs and sperms of five species of Ascidians : *Ciona intestinalis* (Lin.) ; *Phallusia mamillata* (Cuv.) ; *Ascidia malaca* (Traust.) ; *Ascidia mentula* (O. F. Müller) ; *Ascidiella aspersa* (O. F. Müller). The experiments were carried out during September–December, 1947, at the Zoological Station of Naples.

Egg membranes were removed by means of steel needles ; chemical methods (such as digestion by enzymes from Decapod hepatopancreas) were avoided in order not to modify the egg cortex. The preliminary results may be summarized as follows.

Fertilization with heterospecific sperms succeeded in every case, except where *Ascidiella* sperms were used : it was observed that these sperms very rarely fertilize eggs of their own species after removal of the egg membranes. Probably this result is connected with the fact that *Ascidiella* eggs, which normally are buoyant, sink when their membranes are removed. The percentage of fertilized eggs varied considerably in the different kinds of crosses, but was fairly constant in experiments with the same cross. The lowest percentage was obtained with *Ciona* sperms.

In no case did interspecific fertilization succeed with eggs still inside their membranes, in spite of the fact that in certain species (*Phallusia* ; *Ascidia mentula*), unlike *Ciona*, self-fertilization is a normal process.

Time intervals between sperm addition and actual fertilization varied widely, even in the same experiment (from a few minutes, as normal, to more than twenty-four hours). This result is perhaps correlated with enzymatic activity of the sperms. Sperms of the same *Ascidiella* specimen clotted constantly around the eggs of certain species (*Phallusia* ; *Ascidia malaca*), but not of others (*Ascidia mentula*).

In a high percentage of cases fertilized eggs developed. In the following cases normal tadpoles were obtained : ♀ *Phallusia* × ♂ *A. mentula* (27 per cent) ; ♀ *A. malaca* × ♂ *Ciona* (7·7 per cent) ; ♀ *A. malaca* × ♂ *Phallusia* (68·5 per cent) ; ♀ *A. malaca* × ♂ *A. mentula* (83 per cent) ; ♀ *A. mentula* × ♂ *Phallusia* (11 per cent). These larvæ showed only maternal characters. The development-rate was always that characteristic of the maternal species. The larvæ did not metamorphose, probably due to culture conditions ; but sometimes tail resorption occurred.

In the other cases, a tadpole stage was not reached. But gastrulation took place (apart from ♀ *A. mentula* × ♂ *Ciona*, where the eggs were only abnormally activated), and in a few cases some differentiation was observed (testal membrane, superficial pigment spots).

Cytological study of the material has not yet been made, so it is not possible to decide whether true hybrids were obtained or development was parthenogenetic. In most cases two polar bodies were extruded, and in some the conjugation of pronuclei was actually observed.

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Toxicity of Azo-Compounds and Other Substances to the Fruit Tree Red Spider Mite

LITTLE is known of the susceptibility to synthetic organic substances of the summer stages of the fruit tree red spider mite, *Metatetranychus ulmi* (Koch) (syn. *Paratetranychus pilosus* C. and F.), although recent work on this pest[1], and on the related mite *Tetranychus telarius* L.[2-5], has suggested that azobenzene is appreciably toxic. Consequently, we have recently examined in the laboratory, using *M. ulmi* as a test-organism, a series of compounds related to azobenzene, with the view of investigating the relation between toxicity and chemical structure.

A group of twenty-eight compounds was tested against the summer eggs on one hand and the adult female stage on the other; and, on arranging the compounds in order of toxicity, no well-defined parallelism was evident between the two series. There are, however, individual exceptions to this : notably, azobenzene, azoxybenzene and benzyl benzoate appear appreciably toxic to both stages, whereas 4-hydroxy-azobenzene, 4-amino-azobenzene, benzene-azo-*o*-cresol, diphenyl urea and diphenyl thiourea have little effect on either stage. The effect of substitution in the benzene nuclei has not yet been investigated in detail, but in the few cases examined such substitution products are less toxic than the parent compound. Thus, 4-amino-azobenzene, 4-hydroxy-azobenzene, 3 : 3′-dimethyl-azobenzene and benzene-azo-*o*-cresol are far less toxic than azobenzene, while 4 : 4′-diamino-diphenyl and benzaldehyde 2 : 4-dinitrophenylhydrazone are less toxic than diphenyl and benzaldehyde phenylhydrazone.

The azo-group does not appear to be essential to toxicity, since it may be replaced without loss by a variety of other atomic groupings. On the other hand, there is evidence that the precise nature of the grouping is of importance, and the accompanying table shows the toxic effect of compounds containing various alternative linkages between the two benzene nuclei.

EFFECT ON TOXICITY OF ALTERING THE BRIDGING GROUP BETWEEN TWO BENZENE NUCLEI

Toxicity	Alternative bridging group	
	Summer egg	Adult female
As toxic as azobenzene	$-CO-O-CH_2-$ $-\overset{\overset{O}{\|}}{N}=N-$ $-SO_2-$ $-\overset{\overset{NO}{\vert}}{N}-$ $-NH-NH-$	$-CO-O-CH_2-$ $-\overset{\overset{O}{\|}}{N}=N-$ $-CH=N-NH-$
Somewhat less toxic	$-CH_2-NH-CH_2-$ $-CH=CH-$ $-CO-O-$ $-CH_2-CH_2-$ $-NH-$	$-CH_2-NH-CH_2-$ $-NH-NH-$ $-CO-CO-$
Appreciably less toxic	$-CH=CH-CO-$ $-O-$ $-CH=N-NH-$ $-N=N-NH-$ No bridging group (diphenyl)	$-CH=CH-CO-$ $-O-$ $-NH-$ $-CO-O-$ $-CH=CH-$ $-\overset{\overset{NO}{\vert}}{N}-$ $-CH_2-CH_2-$ $-SO_2-$ $-CH(OH)-CO-$
Much less toxic	$-CO-CO-$ $-CH(OH)-CO-$ $-NH-CO-NH-$ $-NH-CS-NH-$	No bridging group (diphenyl) $-N=N-NH-$ $-NH-CO-NH-$ $-NH-CS-NH-$

It will be noted that, under the conditions of our tests, azoxybenzene and benzyl benzoate were the only compounds with toxicity to both summer eggs and adult females comparable to that of azobenzene. Diphenyl sulphone was more toxic to the egg stage than any of the other compounds tested.

Further details of this and related work will be published elsewhere.

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Height of Meson Formation

In an earlier publication[1], it was reported that the intensity of cosmic rays appears to be closely related with the height of the 7·5-cm. mercury pressure-level. It was found that the correlation of cosmic-ray intensity at constant atmospheric pressure with the height of lower pressure-levels is rather low, though gradually increasing with height. When the 7·5-cm. pressure-level is chosen—the highest for which sufficient meteorological data were then available—this correlation reaches the value − 0·67. On the basis of the instability of the meson and by assuming that the bulk of the penetrating component originates at this presure-level, the value 18·6 km. was obtained for the mean range of mesons. In support of this hypothesis is the fact that if we take for the mass 180 m_e and for the average momentum of the mesons along their path down to sea-level the value 2,800 MeV./c. given by Rossi[2], then we have for the rest-life the value $2 \cdot 04 \times 10^{-6}$ sec., which agrees with the one generally accepted.

A study of the results obtained for the effect of ground temperature on cosmic-ray intensity in different parts of the world has now been made. It appears from this study that the mean value of the temperature coefficient α_1 obtained by using variations from day to day is about half the value, α_2, obtained by the use of variations from month to month. In addition to this it is known that α_1 shows a marked seasonal change[4].

Using upper-air data kindly supplied by the Meteorological Office, I have found that the difference between α_1 and α_2, as well as the seasonal change of α_1, for which so far as I know no explanation has been offered, can be accounted for as an effect of meson decay if we assume as before that mesons originate at the 7·5-cm. pressure-level, and take 18·6 km. for the mean range. The twelve-monthly variation in cosmic-ray intensity as obtained by Forbush[5] appears to be fairly well explained also by the same hypothesis.

We might therefore conclude from these results that the bulk of mesons is generated at the 7·5-cm. mercury pressure-level.

To see, however, what the results would be if a higher pressure-level had been assumed for the layer of meson formation, I have taken the 3-cm. pressure-level, the highest for which sufficient meteorological data are now available.

	α_1	α_2	12-monthly variation amplitude
Observed values . . .	−0·10%	−0·18%	1·43%
From 7·5 cm. Hg pressure-level .	−0·10	−0·24	1·65
,, 3·0 ,, ,, ,, .	−0·15	−0·43	2·40

The accompanying table compares the results so obtained with the previous results.

It can be seen that the hypothesis of meson formation at the 3-cm. pressure-level leads to values which are roughly fifty per cent higher than those for the 7·5 cm. mercury pressure-level. To reconcile them with the experimental results, we should clearly have to take for the mean range of mesons a value of 28 km., a fifty per cent increase; but this value, together with the fact that in this case we should have to take for the average momentum of the mesons along their path[6] 2,100 MeV./c., would lead to a rest-life of $4 \cdot 0 \times 10^{-6}$ sec., a 100 per cent increase over the accepted value.

The conclusion appears, therefore, to be that the bulk of mesons is generated at, or little above, the 7·5-cm. pressure-level, at the height of the maximum of the Pfotzer curve for the intensity of the total radiation.

If the average layer for meson formation lies at that height, it follows that the intensity of the meson component should be decreasing at the 3-cm. mercury pressure-level (22 km.). On the other hand, the experimental result of Schein, Jesse and Wollan[7] shows that the hard component increases gradually up to the height of 2 cm. mercury pressure reached in their experiment. The two results, however, are not necessarily mutually exclusive if, as generally supposed, the mesons are formed by primary protons the penetrating power of which is not too different from that of the hard component. The intensity of the primary protons should increase gradually with height.

A complete account of this investigation is being sent to the Physical Society of London.

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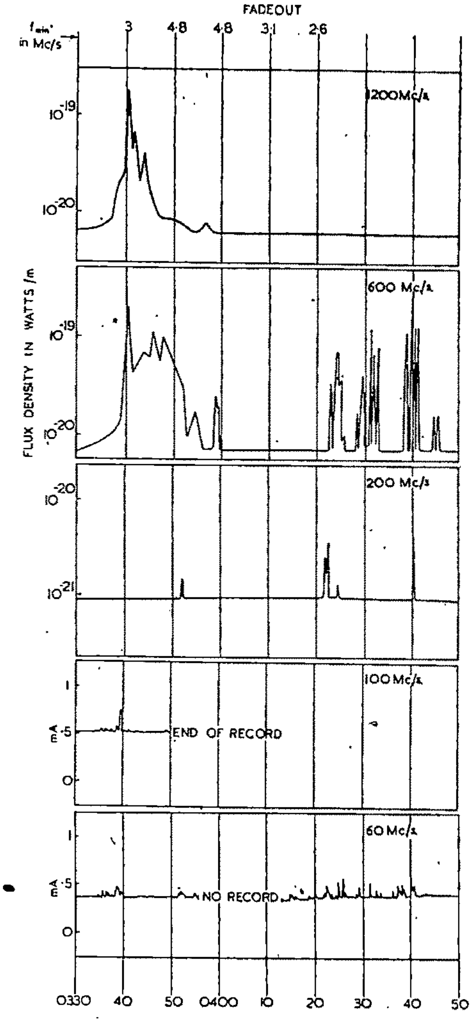
A Solar Noise Outburst at 600 Mc./s. and 1,200 Mc./s.

Simultaneous records of solar radiation at 200 Mc./s., 600 Mc./s. and 1,200 Mc./s. have been made at this laboratory for approximately two hours per day since August 18, 1947. In general, the 200 Mc./s. radiation is similar in character to that described by McCready, Pawsey and Payne-Scott[1], showing a considerable number of short bursts and an increase in general level as some sun-spots cross the meridian. The 600 and 1,200 Mc./s. records, on the other hand, show almost a complete absence of bursts, the level remaining fairly constant for any one day. The radiation received when the sun is almost free from sunspots corresponds to a solar black-body temperature of 0·5 million degrees



Kelvin at 600 Mc./s. and 0·1 million degrees Kelvin at 1,200 Mc./s. and is almost certainly thermal in origin. As sunspots appear, the temperatures rise gradually and show close correlation with sunspot area. The maximum steady levels recorded to date are 1·0 million degrees at 600 Mc./s. and 0·2 million degrees at 1,200 Mc./s. The absence of rapid changes in level suggests that the radiation is still thermal in character, and it is thought that the increase is due to the magnetic field of the sunspots raising parts of the effective radiating shells into the corona[2], which is at a temperature of at least 1 million degrees.

An isolated exception to the above general behaviour occurred on October 4, when there was an outburst of radiation on 600 Mc./s. and 1,200 Mc./s. Both levels increased to thirty times their normal value and remained high for approximately ten minutes, showing the typical characteristics of an outburst. A radio fadeout was reported by the Mount Stromlo ionospheric recording station at the same time. On 600 Mc./s. another disturbed period characterized by a series of bursts began twenty minutes later. The 200 Mc./s. record was that of a quiet sun with only a few isolated bursts. For part of this period records are also available on 60 Mc./s. and 100 Mc./s. On these frequencies no outburst occurred, but a group of bursts coincided with the commencement of the outburst at the higher frequencies. The records are shown in the accompanying figure.

The 200 Mc./s., 600 Mc./s. and 1,200 Mc./s. levels are plotted in terms of flux density. If this were done for the 60 Mc./s. and 100 Mc./s. records, even small bursts would appear as large increases in flux density and a false emphasis of relative solar activity would result. Consequently the records have been left in the arbitrary scale of receiver output current, and indicate in this instance mild solar activity at 60 Mc./s. and 100 Mc./s.

The absence of an outburst on 200 Mc./s. was not due to an instrumental defect, because the aerial was directed away from the sun several times during the period and gave a consistent reduction in receiver output. This indicated that a definite and steady noise contribution was being obtained from the sun.

It is of interest to note that the only other solar disturbance recorded for frequencies above 200 Mc./s. is a 480 Mc./s. storm reported by Reber[3], which also coincided closely with a radio fadeout[4]. In both Reber's case and ours, the occurrence of the fadeout may be taken as fairly certain evidence that a chromospheric flare occurred at the same time. Allen[5] and Appleton and Hey[6], observing at 200 Mc./s. and 64 Mc./s. (4·7 metres) respectively, have noted that some flares are accompanied by solar noise outbursts. As the noise radiation at 600 Mc./s. and 1,200 Mc./s. is believed to arise at lower levels in the sun's atmosphere, a closer correlation between outbursts and flares might be expected on these higher frequencies.

This work is part of the research programme of the Radiophysics Laboratory, Commonwealth Council for Scientific and Industrial Research.

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Jan. 13.

[1] McCready, Pawsey and Payne-Scott, *Proc. Roy. Soc.*, **190**, 357 (1947).

[2] Martyn, *Nature*, **158**, 632 (1946).

[3] Reber, *Nature*, **158**, 945 (1946).

[4] Ionospheric data issued December 1946. Prepared by Central Radio Propagation Laboratory, National Bureau of Standards, C.R.P.L.—F.28, p. 48.

[5] Allen, submitted for publication in the *Monthly Notices of the Royal Astronomical Society*.

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Cosmic Rays and the Magnetic Field of the Moon

IN a recent communication, S. Chapman[1] has calculated, on the basis of the theory of proportionality between magnetic moment and angular momentum developed recently by P. M. S. Blackett[2], that the ratio M_M/M_E between the magnetic dipole moment of the moon and that of the earth is 1/38,400. It may be readily shown that if this result is correct the magnetic field of the moon can only affect particles of primary cosmic radiation of very small energy, which are able to reach the earth only in the immediate vicinity of the geomagnetic poles. In fact, we have[3]

$$M_M/M_E = (D_M/R_E)^2 (r_E/r_M)^2,$$

which on replacing M_M/M_E by Chapman's value, taking for the ratio D_M/R_E (D_M, distance from the earth to the moon; R_E, radius of the earth) its known value, and using for r_M the limiting value $r_M = 0\cdot414$, gives $r_E = 0\cdot05$ millistörmers, or approximately 0·1 MeV. (1 MeV. = 10^6 eV.) if the primary particles are protons, 0·3 MeV. if electrons.

It is therefore clear that the present difficulties[4] concerning the origin of the diurnal and seasonal variations of the intensity of cosmic radiation cannot be traced to a possible magnetic field of the moon of the magnitude predicted by Blackett's theory. It is also obvious from the foregoing discussion that scarcely any measurable effects on cosmic radiation can be expected to arise from the possible existence of such a field.

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[1] *Nature*, **160**, 395 (1947).

[2] *Nature*, **159**, 658 (1947).

[3] Vallarta, M. S., *Nature*, **139**, 839 (1937).

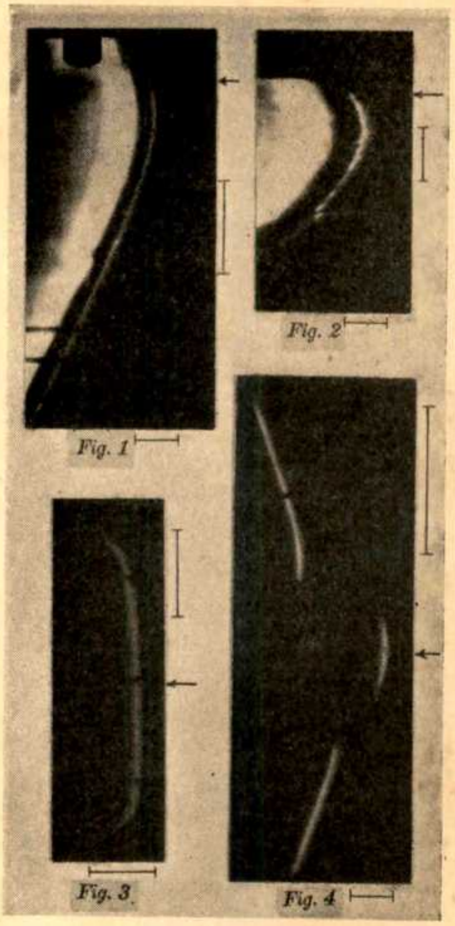
[4] Vallarta, M. S., and Godart, O., *Rev. Mod. Phys.*, **11**, 180 (1939).

Initiation of High Explosives

IN several communications in *Nature*[1–4], the spread of the detonation wave near the point of initiation has been discussed. During 1943–46, we carried out similar experiments at the University of Saskatchewan (sponsored by the National Research Council of Canada). Since our conclusions differ in several points from those in the above-mentioned letters, it may perhaps be of interest to summarize some of our results[5].

We used a rotating mirror camera with an image speed of 2,000 m./sec., which is twenty times that used by Weibull[1]. With this high speed it is possible to study changes in the detonation waves within much smaller intervals of space and time than has been done by Weibull and others.

Contrary to the results of Weibull[1], and of Mitchell and Paterson[3], we found that in all cases investigated by us the apparent centre of the spherical detonation wave is some distance (initiation distance) *in front of* the detonator. Fig. 1 shows a rotating mirror photograph of the detonation of three cylindrical cyclonite pellets (containing 9 per cent beeswax) of density 1·55 in tandem, initiated by a No. 6 detonator in contact with the centre of (but not embedded in) the top surface. The time axis is horizontal; the detonation proceeds from top to bottom. The explosive was contained in a wide glass tube filled with propane, which served to suppress the shock-wave luminosity. The thin track to the right is the detonation track; the broad and bright track to the left is due to the impact of the shock wave on the glass wall. Fig. 2 gives a similar picture for a pressed T.N.T. pellet of 32 mm. diameter and 22 mm. height, initiated by a No. 8 detonator (as used by Weibull). The important feature of these tracks is the bending back at the top (hook effect), which indicates that the centre of the spherical wave is *below* the top surface in spite of the fact that the initiation occurred at the top surface. It should be emphasized that the same effect was found consistently in many shots of this type, not only for cyclonite and T.N.T., but also for tetryl and NENO[6] (the latter both pressed and cast). The initiation distance is approximately constant for a given explosive in different shots. It varies from about 2 mm. for tetryl to 7 mm. for T.N.T. A positive initiation distance has also been found for liquid explosives (super-cooled NENO, and DINA[6] at about 70° C.) and even for lead azide (the latter initiated in a glass tube by a hot wire above the top surface).



HORIZONTAL LINES UNDER PHOTOGRAPHS INDICATE TIME OF 1 MICROSEC. VERTICAL LINES INDICATE LENGTH OF 1 CM. AT CHARGE; ARROWS INDICATE POINTS OF INITIATION. BLACK LINES THROUGH DETONATION TRACKS ARE IDENTIFICATION MARKS

When the explosive is initiated by a detonator placed near the surface that faces the camera rather than in the centre of the top surface of the cylindrical pellets, no hook effect is observed, in agreement with expectation. Instead, a dark space is observed; that is, for a distance equal to the initiation distance, no detonation luminosity is found.

Further evidence was obtained by the detonation of hemicylindrical charges initiated in the centre of the flat face, the axis of the cylinder being horizontal. If the spherical detonation wave originated at the point of contact of the detonator, it would reach all points along the intersection of a vertical plane with the surface of the cylinder at the same time. Actually, as Fig. 3 shows for cyclonite (density 1·5), the observed traces are not straight but bent back at top and bottom. This is again in agreement with the assumption of an initiation distance.

It appears to us that the interpretation of these results can only be that the detonator sets up a low-order detonation, which, after travelling for a distance, changes over within a rather small region of the wave front to high-order detonation. The low-order detonation described here seems to be of a fundamentally different type from the low-order detonations discussed by Shepherd[2] and by Jones and Mitchell[4] which we have also observed. While in the latter a change to high-order detonation occurs more or less uniformly and simultaneously over the whole wave front, in the former the transformation takes place in a small part of the wave front only, which forms the centre of the high-order spherical detonation wave. Moreover, this new type of low-order detonation appears even for rather strong initiation and never extends over large distances. Only by reducing the strength of the initiation (by interposing sheets of paper between detonator and high explosive) to a point very close to the limit where failure occurs have we been able to increase the length of the initiation distance by a factor of two or three. From our experience it would appear that this type of low-order detonation is a necessary preliminary in each individual initiation process.

In T.N.T. the situation is apparently more complicated, since in a number of photographs we found a slowing down of the high-order detonation, leading either to a fading out, or, at a certain place, to a second speeding up to the final high-order detonation. This second transformation is of the type observed by Shepherd[2] and by Jones and Mitchell[4]. The peculiar behaviour of T.N.T. may be due to the fact that the T.N.T. used in the pellets had a rather large particle size (about 1 mm.).

Very striking results confirming the peculiar behaviour of the new type of low-order detonations were obtained when thin flat pellets of a thickness of a few millimetres (that is, of the order of the initiation distance) were initiated in the centre of one flat face while the other flat face was facing the camera. Fig. 4 shows a photograph obtained with cyclonite. Instead of one single track, there are three apparently unrelated partial tracks. They represent three different high-order detonations produced at different points of one and the same pellet and at slightly different times by one and the same initiation. It appears that the initial low-order detonation changes to high-order at different places and times. In larger charges the first formed detonation wave will soon spread and leave no explosive for the others. But in sufficiently thin charges the different waves can be observed, as in Fig. 4. By putting a steel plate behind the thin pellets, we have checked that the different tracks are not due to different fragments of the detonator.

From the width of the track in Fig. 1 and similar photographs, an upper limit for the duration of the luminosity may be estimated. It is 0·05 microsec. (only a sixth of the limit given by Mitchell and Paterson). In the case of cyclonite it was found from other evidence that the actual value is close to this limit.

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[2] Shepherd, W. C. F., *Nature*, **160**, 92 (1947).

[3] Mitchell, D., and Paterson, S., *Nature*, **160**, 438 (1947).

[4] Jones, E., and Mitchell, D., *Nature*, **161**, 98 (1948).

[5] More details may be found in our reports on Project XR-84, copies of which are obtainable on application from the National Research Council of Canada, Ottawa, Ont.

[6] NENO and DINA are war-time abbreviations for bis-nitroxyethylnitrooxamide and bis-nitroxyethylnitramide, see Wright, G. F., *et al.*, *Can. J. Res.* (Jan. 1948).

Principle of a Counter-streaming Centrifuge for the Separation of Particles of Different Sizes

When a liquid containing suspended particles of uniform density streams through a conical tube, the velocity of the particles is greatest at the apex of the cone and decreases in the direction of the base. If the tube is placed in a centrifuge with the apex pointed away from the centre of rotation, in the direction of which the liquid is made to flow, the particles acquire, in addition to the velocity due to the liquid stream, a velocity in the opposite direction owing to the centrifugal effect. If Z is the distance between the apex and the centre of rotation, R the radius of the cone at the distance L from the apex, V the volume of liquid passing across any section of the tube in unit time, and x the distance from the centre of rotation, then the streaming velocity f over any cross-section of the tube is

$$f = \frac{V}{\pi(R/L^2)\,(Z-x)^2}.$$

The velocity of the particles in the direction away from the centre of rotation, however, increases linearly with the distance from the latter. In a certain cross-section (e) the two velocities are equal for a given particle size. Particles of this size situated centripetally from e are transported in the centrifugal direction and vice versa. Thus, when dynamic equilibrium has been attained, they have been accumulated in a very short section of the tube. Other particles are similarly accumulated in sections characteristic of their sizes; the smaller their radii (r), the nearer the centre of rotation are their planes of equilibrium. The distribution of these planes along the radius of rotation is derived from Stokes' law and the above expression for the streaming velocity:

$$r = \frac{3}{2\pi n} \cdot \sqrt{\frac{\eta \,.\, V}{2\pi(S-S')}} \cdot \frac{1}{\sqrt{X}\,.\,(R/L)\,(Z-x)},$$

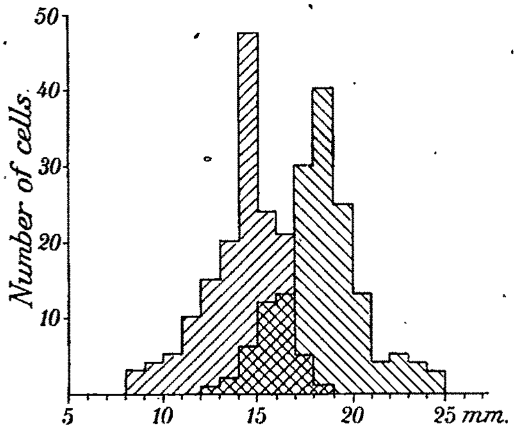
where n is number of revolutions per min., η is viscosity of liquid, S is density of particles, S' is density of suspension medium. For $x = Z/3$, r has a minimum value:

$$r_{\text{min.}} = \frac{3}{2\pi n} \cdot \sqrt{\frac{\eta \,.\, V}{2\pi(S-S')}} \cdot \frac{1}{\frac{2}{3} \cdot \frac{R}{L} Z \sqrt{Z/3}}.$$

This implies that only particles with radii smaller than $r_{\text{min.}}$ can pass with the liquid stream through the tube. This minimum value, characteristic of each tube, is dependent only on R/L (that is, the apical angle of the cone), other things being equal.

As soon, however, as particles accumulate in a centripetal segment of the tube, the centrifugal part of which contains a less dense suspension or pure liquid, the heavier layer breaks up, forming a centrifugally directed current. Also particles with radii smaller than $r_{\text{min.}}$ are carried by this current and caught in a kind of circuit current formed between the chief and the centrifugally directed currents. To avoid interactions between these two currents, that flowing centrifugally is conducted outside the tube through a side channel, the particles being introduced again near the apex and thus made to pass through the separating tube several times. Because of the influence of rotation on the moving liquid and particles, the centripetal part of the tube should be turned towards the direction of rotation. If two tubes with suitable chosen values of R/L are coupled in series so that the tube with a larger $r_{\text{min.}}$ is first passed by the particles, any desired fraction of particles can be removed from the suspension.

In work with large particles having a high density compared to that of the liquid, and a low liquid viscosity, a necessary condition is that the influence of gravity on the particles is eliminated. This can be realized by rotating the centrifuge in the vertical plane.



BAKER'S YEAST CELLS SUSPENDED IN TAP WATER AND CENTRIFUGED FOR 60 MINUTES. ABSCISSA, GREATEST DIAMETER OF THE CELLS (× 2,350). SHADED AREAS SHOW NUMBERS OF LARGER CELLS RETAINED IN THE SEPARATING TUBE AND IN A FOLLOWING TUBE RESPECTIVELY; THE OVERLAPPING WILL DIMINISH ON PROLONGED CENTRIFUGATION

A trial centrifuge has been constructed on these principles and is at present being employed for the fractionation of yeast cells (see graph) and other biological material. A detailed description will shortly be published elsewhere.

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Electrokinetic Potential and Surface Structure of Barium Sulphate

WHILE there are many investigations on the influence of electrolytes on the electrokinetic or ζ-potential of solids, very few investigators have considered the relation between the ζ-potential and the structure and composition of the solid itself. This is partly due to the fact that in many systems the potential-determining ions are foreign to the solid.

We are at present investigating the ζ-potential of sparingly soluble ionic solids such as barium sulphate against their saturated solution by the streaming potential method. In this case, the potential-determining ions originate from the solid. Precipitated barium sulphate is unsuitable for investigation, because the validity of the electrokinetic equations is limited to systems in which the diameter of the 'pores' of a plug is greater than the thickness of the electric double layer. We therefore prepared larger crystals (up to 2 mm.)—which could be ground afterwards to any desired size—by recrystallizing barium sulphate from hot concentrated sulphuric acid and subsequent ignition. The following results are typical:

	ζ in mV.
Recrystallized barium sulphate, sample 1	+ 24·2
Recrystallized barium sulphate, sample 3	+ 25·0 ; 24·3
Recrystallized barium sulphate, sample 4	+ 26·6 ; 27·1
Natural barite, sample *B*, ignited	+ 5·4 ; 5·3
Natural barite, sample *C*, ignited	+ 8·4

In spite of the fact that during preparation of recrystallized barium sulphate there was always an excess of sulphate ion, the potential is *positive* and well reproducible within 1 mV. for each sample. The ignition temperature (500–1,000° C.) has no influence on the potential. Most electrolytes change the potential *reversibly* at room temperature; barium salts increase it, sulphates decrease it; but when, after treatment with the electrolyte solution, the potential is then measured against a saturated barium sulphate solution, the original value is always obtained. This value must therefore be regarded as a property of the sample. This behaviour is shown both by recrystallized barium sulphate and natural barite.

There is, however, a striking difference between the high potential of recrystallized barium sulphate and the much lower potential of natural barite. Spectroscopic analysis of our samples revealed that natural barite contains strontium and traces of calcium as impurities. However, these impurities cannot be responsible for the difference in potential. We incorporated such impurities into the recrystallized barium sulphate (during recrystallization); but, as a result, the potential was slightly increased, never decreased. Moreover, when natural barite is recrystallized from sulphuric acid, a high potential (27 mV.) is obtained.

These and similar observations, which will be discussed in more detail elsewhere, lead us to the conclusion that the difference in potential between recrystallized barium sulphate and natural barite is not due to a difference in composition. The most likely cause is a difference in structure (geometrical or otherwise) of the surface. Natural barite, even after crushing, has even crystal surfaces, whereas recrystallized barium sulphate has very irregular surfaces. This is shown by an investigation in an optical as well as in an electron microscope, for the latter of which we are indebted to Dr. A. L. G. Rees and Mr. A. J. Hodge, of the Division of Industrial Chemistry of the Council for Scientific and Industrial Research. It is likely that the field of force is less well balanced in an irregular surface than in an even one.

Bikerman[1] suggested that the ζ-potential of a rough surface should be different from that of a smooth one for purely geometrical reasons. However, the distortion of the field of force in the surface as a factor influencing the electric potential at a surface is a somewhat unfamiliar concept in the field of electrokinetics. Nevertheless, besides our own observations, there are several findings of other investigators[2,3] which suggest that the ζ-potential of a crystalline solid is not solely determined by the composition of the system.

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[1] Bikerman, *J. Chem. Phys.*, 9, 88 (1941).

[2] Kruyt and Ruyssen, *Proc. Akad. Wetensch. Amsterdam*, 37, 498 (1934).

[3] Wood, *J. Amer. Chem. Soc.*, 68, 437 (1946).

Chemical Effects of Ionizing Radiations

In 1944 it was suggested[1] that the primary net process in the action of penetrating radiations (γ-rays, X-rays, etc.) on the water molecule consists in its splitting in the following way:

$$H_2O \rightarrow OH + H,$$

which presumably takes place by way of the formation of H_2O^+ and H_2O^-. All the known chemical effects in aqueous solutions can be interpreted on this basis[1,2], which furthermore permits an adequate description of the biological effects of radiations[3,4]. Recently, Dainton[5] found that acrylonitrile in dilute aqueous solution on irradiation by X-rays or γ-rays shows polymerization, which he attributed to the action of primarily formed hydroxyl radicals (according to the above scheme) in view of the fact that these radicals are known to initiate polymerizations[6].

We have now succeeded in demonstrating the mode of action of penetrating radiations in aqueous solutions by investigating the reaction products formed by irradiating some simple organic substances such as benzene and benzoic acid in dilute aqueous systems. If hydroxyl radicals are formed primarily, it should be possible to isolate some of the corresponding substances containing OH groups, that is, products of hydroxylation. This, indeed, proved to be the case.

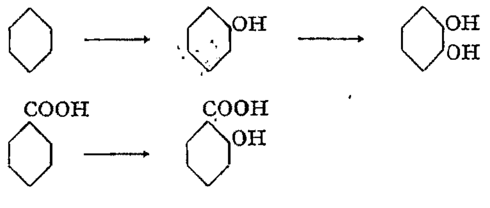
Benzene, suspended in water from which oxygen had been carefully excluded, was irradiated by X-rays by bringing it close to the target of a 200-kV. tube, and a dose of the order of 10^6 r. units was given. This resulted in about 0·1 millimol. of phenol being formed, which was identified as the tribromo derivative. A number of other substances were also found in smaller quantities, among which diphenyl was isolated.

In the irradiation of dilute aqueous solutions of benzoic acid by X-rays, under similar conditions, approximately 0·1 millimol. of hydroxybenzoic acids were formed. Salicylic acid was isolated and was identified by colour reactions and as *p*-nitrobenzene-azo-salicylic acid[7]. (The X-ray irradiations were carried out at the Royal Victoria Infirmary, Newcastle-upon-Tyne; we are indebted to Dr. F. T. Farmer, who made all the quantitative determinations of the X-ray dosage.)

We have also carried out similar experiments using a neutron – γ-ray source (corresponding to 1 gm. of radium mixed with beryllium powder). With this source, benzene gave, in addition to the products mentioned above, catechol and products originating from the opening of the benzene ring. This difference is presumably due to the higher local concentration of radical produced by the recoil protons (from the neutrons).

In all these cases the total yield of the hydroxylated reaction products depends on the *p*H of the solutions.

The above results suggest the following sequence of reactions in the case of benzene and benzoic acid:



In the case of benzene, the intermediate formation of free phenyl radicals is suggested by the appearance of small amounts of diphenyl among the reaction products. The dehydrogenation to the phenyl radical may be due to a reaction with the hydroxyl radical or possibly with hydrogen atoms. Experiments to decide this are in progress.

The results indicate that: (i) Hydroxyl radicals are formed by the action of radiations on aqueous systems, since the reaction products found are the same as those obtained by the action of hydroxyl radicals produced chemically (for example, by the system $H_2O_2 - Fe^{II}$ salt). (ii) The oxidation products are very similar to those obtained in the biological oxidation of these substances, which suggests that hydroxyl radicals may play an important part in certain biological oxidations[8].

We are indebted to Prof. F. A. Paneth for permission to carry out the neutron experiments in the Londonderry Laboratory for Radiochemistry at Durham.

A full account of this work will be published elsewhere.

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[2] Cf. Lea, E. D., "Actions of Radiations on Living Cells", 47 (Cambridge University Press, 1946).
[3] Weiss, J., *Nature*, **157**, 584 (1946).
[4] Weiss, J., *Trans. Farad. Soc.*, **43**, 314 (1947).
[5] Dainton, F. S., *Nature*, **160**, 268 (1947).
[6] Cf. Evans, M. G., *et al.*, *Trans. Farad. Soc.*, **42**, 668, 675 (1946).
[7] Cf. Beilstein, 4th ed., **10**, 247.
[8] Cf. Haber, F., and Willstätter, R., *Ber.*, **64**, 2844 (1931).

A Coefficient of Viscous Extension

While working on a generalized theory on straining of amorphous or quasi-amorphous solids, it became clear that one could include the straining of viscous fluids by means of a suitable stress-strain parameter λ which I call a 'coefficient of viscous extension' related to the 'coefficient of viscous shear' usually called[1] the coefficient of viscosity μ. In this communication only the flow strain component of a deformed substance[2] is considered, so that the elastic and plastic components[3] are neglected and, further, only isotropic substances are discussed.

An infinitesimal angle γ_{ij} of shear 'slide' has twice the arithmetical value of the normal strain e_{ij} in the 'auxiliary' plane at 45° to the planes on which the shear stress S_{ij} operates[3,4]. Hence, differentiating with respect to time t and using the coefficient of viscosity gives

$$2\frac{\partial e_{ij}}{\partial t} = \frac{\partial \gamma_{ij}}{\partial t} = \frac{S_{ij}}{\mu}. \qquad (1)$$

But the normal strain e_{ij} due to shear can be regarded as due to the 'partial' strains ε_{ij}, ε_{ji} and transverse contraction ratio q[5,1,2,3]. But the partial strain ε_{ji} is equal to but of opposite sign to ε_{ij}, so that

$$e_{ij} = (1+q)\varepsilon_{ij}. \qquad (2)$$

The normal stress T_{ij} is 'auxiliary' to, and of the same arithmetical value as, the shear stress S_{ij} if the displacements are to be single-valued[2]. Hence, if we *define*

$$T_{ij} = \lambda \frac{\partial \varepsilon_{ij}}{\partial t}, \qquad (3)$$

then from (1), (2), (3)

$$\lambda = 2(1 + q)\mu. \qquad (4)$$

This 'coefficient of viscous extension' allows one to synthesize the Navier–Stokes viscous fluid theory with a theory on the straining of solids. The coefficient λ in the flow case is analogous to Young's modulus in the static strain case. However, it should be noted that in (1) and (3) only *time-rates of straining* occur, so that my theory on strains of any magnitude can be used to give a general theory on straining that incorporates flow in solids and viscous fluids. As presented here, the coefficient of viscous extension λ is a non-constant tangent modulus if the substance is quasi-viscous[6]. The transverse contraction ratio q will have the value $\frac{1}{2}$ in solids as well as liquids if volume changes do not occur. However, caution is necessary in view of the static 'plastic' transverse contraction ratio value 0·36 for duralumin[7] found by me; this has been checked with a photo-grid and a specially designed optical extensometer[8]. Further, the same value was found for changes in thickness of the tensile specimen.

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Jan. 15.

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[2] Swainger, K. H. (communicated to *Phil. Mag.*, Oct. 14).

[3] Swainger, K. H., *Phil. Mag.*, (7), 38, 422 (1947).

[4] Swainger, K. H., *Nature*, 160, 399 (1947).

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[6] Houwink, R., and Burgers, W. G., "Elasticity, Plasticity and Structure of Matter", 10 (Camb. Univ. Press, 1940).

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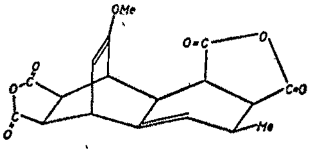
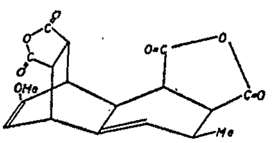
Addition of Maleic Anhydride to Anethole

ONE of us[1] has earlier obtained a small amount of a crystalline compound (m.p. 241°, decomp.) of anethole with two moles of maleic anhydride, the main bulk of the reaction product being a heteropolymer[1,2,3]. We found that, if a small amount of dimethylaniline is added, the formation of the heteropolymer product is prevented and the yield of the crystalline adduct was as high as 60 per cent. We have confirmed the structure previously proposed[1] and our work led further to the determination of the steric configuration of the compound.

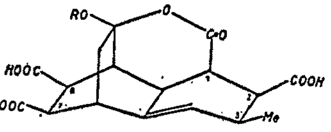
If we assume an endo-*cis* type addition[4] and start from anethole, which may be supposed to be a *trans* anethole, then the formation of four possible stereoisomers (that is, two racemates) could be expected, namely, I, II and their respective antipodes. The properties of our compound agree with those expected from I.



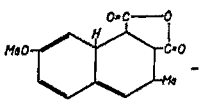
I.



II.



a...R=Me III. b...R=H



IV.

The following reactions may be cited in favour of I and excluding II. Mild alkaline hydrolysis leads to III (*a*); if the hydrolysis is more energetic, III (*b*) is obtained. The ultra-violet absorption spectrum of III (*b*) does not show the characteristic band of a carbonyl group. This acid forms heterocyclic compounds with hydroxylamine as well as with phenylhydrazine; hence one of the carboxyl groups participates also in the condensation. When III (*b*) was boiled with 5 *N* hydrochloric acid, the carboxyl groups in positions 1 and 8 became a *trans* position and an isomeric *trans* keto-acid was obtained containing a free carbonyl group, the presence of which was revealed by the ready formation of a regular oxime and by its absorption spectrum. The olefinic bond of III (*b*), which is resistant to catalytic hydrogenation, was confirmed by the addition of two hydroxyl groups. If compound I is heated with sulphur to 300°, it decomposes with formation of maleic anhydride and the anhydride of 3-methyl-7-methoxy-naphthalene-1 : 2-dicarboxylic acid.

The formation of the compound I makes it clear that, from the point of view of diene synthesis, anethole behaves as a conjugated tetraene, that is, it gives first with one mole of maleic anhydride the labile primary compound IV, which in turn reacts instantaneously with another mole of maleic anhydride, forming the stable end-product I.

Our observation seems to be of interest from the following two points of view: (1) So far as we know, this is the first *proved* example of the possibility of disturbing the aromatic character of a mononuclear system through a Diels–Alder reaction. Such a process leading to a compound of analogous structure to I had been suggested but later rejected by Wagner-Jauregg[5] in the case of the Diels – Alder reaction of *as.* diphenylethylene. This structure has, however, recently been accepted by Bergmann and co-workers[6], but was not established by them in a decisive manner. (2) From our results it is probable that the Diels – Alder reaction of some styrene derivatives is initiated by the heteropolar resonance form of the partners[7].

The full details of these investigations will be published elsewhere.

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Aug. 12.

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OSCILLOGRAPHIC ANALYSIS OF THE NON-ACOUSTIC FUNCTIONS OF THE VERTEBRATE EAR

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THE non-acoustic functions of the vertebrate ear are localized in the semi-circular canals with their ampullary end organs, and the utriculus, the anterior or uppermost of the two or three otolith organs of the vestibulum[1]. The function of the semi-circular canals is restricted to the perception of angular accelerations occurring during rotational movements, chiefly at their onset and cessation. The utriculus, on the other hand, is held responsible for the perception of changes in position within the gravitational field, of linear accelerations brought about by straight-line movements, and of the centrifugal effect during relatively fast rotations.

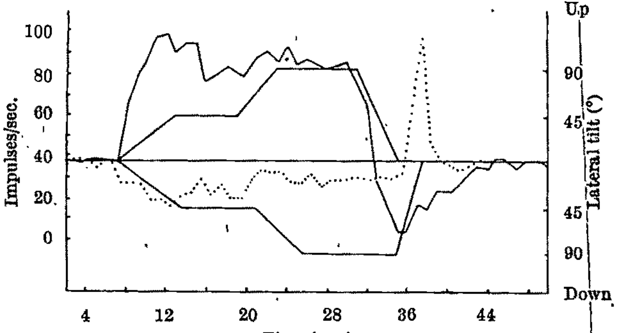
Until recently, analysis of the equilibrium function of the labyrinth was based entirely on evidence obtained by elimination experiments in which operative removal of the organ as a whole or in parts or transection of the various branches of the eighth nerve was followed, in the surviving animal, by observation of the equilibrium reflexes of head, eyes, or limbs, and their comparison with the normal labyrinthine reflexes. With the development of Adrian's technique of oscillographic recording of the electrical activity of sense organs arose the possibility of the direct analysis of the equilibrium function of the labyrinth. The first attempts in this field were reported by Ashcroft and Hallpike[2], and Ross[3] on the frog, and by Lowenstein and Sand[4] on the dogfish. Thanks to the ideal conditions offered by the cartilagenous nature of the elasmobranch cranium, it was found possible in the intact dogfish to record directly from the nerve-branch supplying the ampulla of the horizontal semi-circular canal. This led to the discovery that the intrinsic mechanism of canal function is based upon a background of resting discharge the frequency of which is, in the horizontal canal, increased by homolateral, and decreased by contralateral angular acceleration in the plane of the canal, with corresponding post-rotatory after-effects in response to deceleration. This mechanism clearly provides the means by which a single ampullary rotation-receptor unit can signal to the centre opposite phases of angular acceleration and deceleration in a given plane. The corresponding ampullæ on both sides of the head work antagonistically, and the reflex responses in the intact animal depend on the balance of the afferent discharges from left and right labyrinths.

Apart from serving as a background for this two-directional response, the resting discharge was also claimed to provide a continuous source of tonus supply to the musculature; and this could afterwards be demonstrated by means of elimination experiments carried out on the horizontal canal of the pike[5]. The analysis of the function of the ampullary end-organs in the two vertical canals which proved impracticable in the intact animal was carried out on the surviving preparation of the labyrinth in the isolated cranium of the ray[6]. As a result, a complete picture of the integrated action of all six semi-circular canals during rotation about the three primary axes was obtained, which could be correlated with the known eye muscle reflexes normally evoked by these rotations. In contrast to the horizontal canals, which respond to angular accelerations in or near their plane only, each vertical canal responds to rotation about all three primary axes. They are laterally synergic on rotation about the longitudinal axis, transversely synergic on rotation about the transverse axis, and react with reduced sensitivity to rotations about the vertical axis, when they are found to be diagonally synergic. An analysis of the integrated activity of the six semi-circular canals in relation to the known eye muscle reflexes evoked by rotational stimuli yielded a consistent picture, which furnished evidence for the vestibular origin of the simultaneous contraction of pairs of antagonistic eye muscles, occurring during labyrinthine eye nystagmus. These have been recorded myographically in the rabbit by Lorente de Nó[7], who described them as pivoting reactions, postulating their central nervous origin.

In a consequent quantitative study of the mechanism of canal function carried out on the horizontal semi-circular canal of the isolated labyrinth of the ray[8], single-fibre discharges were recorded in response to different intensities of angular acceleration and during rotations at constant angular velocities. During uniform angular acceleration the impulse frequency increases and decreases in a linear manner proportional to the acceleration and deceleration. The threshold acceleration was found to be as low as 3°/sec./sec., a fact which suggests that high turntable speeds often used in equilibrium experiments and in clinical tests may involve angular accelerations representing considerable overstimulation of the sense organ. During prolonged rotation at constant speed, the frequency of discharge, after reaching a maximum or minimum during the initial acceleration, gradually returns to the value of the resting discharge. It is interesting to note that the maximum time of 20–30 sec. taken for this return is the same as that described by Steinhausen[9] in his experiments on the physical properties of the living cupula terminalis of the semi-circular canals in the pike. It also agrees with the duration of post-rotatory after-effects, for example, nystagmus and vertigo, observed in all vertebrates, including man. Results on the human subject obtained by Jonkees and Groen (Utrecht), according to private intimation by the authors, also bear out this fundamental similarity in time relations. All this fully justifies the interpretation of reflexes to angular acceleration in terms of the elastic properties of the cupula, and makes unnecessary the assumption of their central elaboration.

The analysis of the mode of function of the vestibular receptor for gravitational stimuli and linear accelerations, namely, the otolith organ in the recessus utriculi, had been held up by the War, but has now been attempted in collaboration with my colleague, Mr. T. D. M. Roberts. The work was carried out at the laboratory of the Marine Biological Association at Plymouth during the summer of 1947, with the aid of a Royal Society grant from the Parliamentary Grant-in-aid of Scientific Investigations, and with the privilege of the use of the British Association Table at the Plymouth Laboratory. The results to be reviewed in this communication will be the subject of a fully documented publication elsewhere.

The method used was similar to that described in the publications on the function of the semi-circular canals. Considerable technical difficulties had, however, to be overcome in the attempt to record from



Horizontal line across graph indicates basic discharge level

RESPONSES TO LATERAL TILT FROM A 2–3 FIBRE PREPARATION FROM THE UTRICULUS OF THE ISOLATED LABYRINTH OF THE RAY. THE STRAIGHT LINES TRACE THE COURSE AND TIME RELATION OF LATERAL UP AND DOWN DISPLACEMENTS FROM THE NORMAL. THE CURVES SHOW THE COURSE OF THE RESPONSE IN IMPULSES PER SEC. AS DESCRIBED IN THE TEXT. ——— RESPONSE TO UPWARDS TILT, ... RESPONSE TO DOWNWARDS TILT. THE PREPARATION SHOWED A BASIC DISCHARGE FREQUENCY OF 38 IMPULSES/SEC. WHEN AT REST IN THE NORMAL POSITION

the branch of the eighth nerve supplying the macula utriculi. In a ray of a wing span of more than twenty inches this is only 5–6 mm. long, measured from its origin at the brain to the final terminations of its fibres in the macula, and of this about 2 mm. only were suitable for electrical pick-up. By carefully peeling off minute strands from the nerve fan on the lateral wall of the utriculus, preparations were made from which analysable records could be obtained of the activity of single sense endings or of groups of small numbers of independently firing units.

Again, as in the case of the semi-circular canal, it was found that, when at rest in the normal orientation in space, the sense endings in the macula utriculi fire off a continuous stream of low-frequency impulses, between 6 and 12 per sec. at 20° C. The frequency level of this discharge remains constant unless the spatial position of the preparation is changed. This could be achieved by slowly rotating the preparation and electrode system fixed in a holder about axes corresponding to the transverse and longitudinal body axes. By means of a clamping device, the preparation could be held stationary in any desired position in space. The accompanying figure shows the result of tilting a two to three unit preparation around the longitudinal axis to positions of 45° and 90° lateral tilt homolateral side upwards and downwards. It will be seen that during the rotation into the new position the discharge frequency changes, increasing during upwards and decreasing during downwards tilt. After the preparation becomes stationary in the 45° and 90° positions a certain return of the discharge frequency towards the level characteristic for the normal position occurs; but after a few seconds the frequency becomes stabilized significantly above or below the 'normal' level. During the return movement a drastic change in the discharge frequency takes place in a sense opposite to that brought about by the initial displacement from the normal. Back in the normal position the discharge returns to the original frequency level. If the same preparation is now rotated about the transverse axis to positions 45° and 90° nose up or down it is found to respond with equal sensitivity to this displacement. The preparation from which the curves shown in the diagram were derived yielded similar responses on rotation about the transverse axis, with an increased frequency level in nose up, and a decrease in frequency in nose down positions, and correspondingly similar behaviour during the rotation to and from the out-of-level positions.

Responses from preparations that yielded analysable records can be classified into four groups, namely, showing increased discharge (*a*) on side up and nose up, (*b*) on side up and nose down, (*c*) on side down and nose down, (*d*) on side down and nose up, while correspondingly reversed displacements bring about a decrease in the discharge frequency. We have not found preparations without a resting discharge or preparations which were capable of responding by either increase or decrease only. We also failed to find preparations which were confined to responding to displacements about either the longitudinal or transverse axis only; and the fact that the two-axis response with its diagonal plane of maximum sensitivity could be demonstrated in a single-unit preparation counters the suspicion that in few-fibre preparations this might have been due to recruitment from two different types of receptors, an assumption which could not be completely refuted on any other grounds.

The present results are based on the evidence from twelve successful preparations with the following numerical distribution of types: Type *a* : 2; *b* : 2; *c* : 1; *d* : 1; of the remaining six preparations, in which for technical reasons the response to displacement about the longitudinal axis could not be recorded, two showed an increase of discharge on nose up, and four on nose down displacement. As all these preparations were obtained from a relatively restricted area of the utricular macula, the conclusion appears unavoidable that the four types of sense endings are dispersed over the whole macula. Their typical mode of reaction will, in this case, have to be ascribed to their minute distribution in or around deformable structures intervening between macula and otolith membrane. We hope that a study of the microscopic pattern of the macula which we are about to carry out will throw further light on this question.

Experiments in which utriculus preparations were subjected to linear accelerations showed repeatable responses of fairly low threshold to straight-line movements in all three planes of space. This result is of special interest in view of the fact that no reliable reflex responses to linear accelerations have so far been detected in fishes[10].

It can thus be stated that the otolith organ of the utriculus is sensitive to positional changes about any horizontal axis, longitudinal, transverse and intermediary. In contrast to the semi-circular canals which respond to angular accelerations only, the otolith organ responds during tilting to angular accelerations and to rotation with constant speed; furthermore, it shows lasting responses to prolonged out-of-level positions. Its ready response to linear acceleration during straight-line translation makes it a certainty that it will also respond to centrifugal effects. The localization of all these functions in the utriculus adds further weighty evidence in favour of the contention that, contrary to the classical theory[11], the utriculus may well be the only otolith organ concerned with the maintenance of equilibrium. Its fundamental sensory mechanism recalls that found in the semi-circular canals, in so far as the responses appear against a background of a steady basic discharge activity which can be modulated in opposite directions.

So far as I am aware, gravity responses to positional changes have only twice before been studied by the oscillographic method. Recording from filaments selected at random from the cranial stumps of the anterior and posterior rami of the eighth nerve of the frog, Ross[3] described gravity responses from the anterior ramus which were presumed to be derived from the utriculus and generally reacted to one only of two opposite directions of tilting in the 'maximally stimulating' plane. The reaction obtained from the posterior ramus also included typical gravity responses, the accurate localization of which was, however, impossible.

Single-unit discharges from the vestibular nucleus of the brain-stem of the cat were recorded by Adrian[12], who was able to distinguish between gravity-controlled and rotation-controlled responses. The gravity receptors were increasingly stimulated during displacement from the normal. In the level position a low-frequency resting discharge was sometimes found which could be abolished by tilting in one direction and increased by tilting in the opposite direction. Response to lateral tilt and to fore-and-aft tilting was found to be separately localized in the vestibular nucleus, but Adrian points out in the discussion of his results that this does not necessarily imply their localization in two different otolith organs.

A discussion of these findings in comparison with the evidence reported in the present communication will be appended to the forthcoming full account of the work.

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POWER AND PERSONAL LEADERSHIP

THE Thomas W. Salmon Memorial Lectures, given in previous years by psychiatrists, were delivered at the New York Academy of Medicine last November by Prof. H. D. Lasswell, a social scientist known mainly for his studies of propaganda and his application of psychoanalytic concepts to problems of political science. His topic was "The Dynamics of Power and Personality". "The long-run aim of societies aspiring towards human freedom," said Prof. Lasswell, "is to get rid of power and to bring into existence a free-man's commonwealth in which coercion is neither threatened, applied nor desired. This is the thread of anarchist idealism that appears in all uncompromising applications of the key conception of human dignity." But the more accessible goal, to which Prof. Lasswell gave his main attention, is to secure a democracy in which power is shared as widely as possible and is subordinated to respect for the dignity of the human personality. He therefore discussed the types of people who in our society seek for power and provide leadership. He saw them as drawn very largely from the middle class, as a result not of economic accident but of the psychological characteristics of the class, in particular its tradition of sacrificing immediate gratifications to the acquisition of skills which will ultimately bring a larger reward. "We know that middle-class homes are hothouses of ambition, holding their children to high standards of achievement, and providing the tension between indulgence and deprivation so congenial to the accentuation of power [as a goal]." Within the middle class, professional families contribute a disproportionately large number of leaders, partly because their tradition of public service deters them from seeking purely private advantage in business life. Prof. Lasswell seemed to imply that political leaders' ideals of public service are largely rationalizations of narrower personal needs for power.

It was the less admirable types of power-holder to whom Prof. Lasswell gave most attention. He distinguished the compulsive (or obsessional) type, often bureaucratic in inclination; the dramatizing type, highly concerned with the emotional response he can elicit from others, and characteristically producing the agitator; and the detached type, whose own emotional response is largely screened from his consciousness, and who may supply "useful judges, arbitrators, conciliators, diplomatic negotiators and scientists", but in whom "the absence of lively emotional states can lead to calm, pitiless, destructive conduct". Apropos the obsessional bureaucrat, Prof. Lasswell developed the interesting suggestion that he harbours strong unconscious hostility to the authority of the system he is serving, and by excessive scruples and doubts in interpreting detailed rules he forces his superiors to take responsibility which they had intended to delegate, and so undermines the authority that he means most scrupulously to obey.

Prof. Lasswell pointed out that to understand the destructive form of power seen in war we must attend not only to war itself but also to manifestations of power found everywhere in our social structure; and he suggested that "concentrations of destructive impulse" occur as a result of competitive practices that we take for granted in commerce, industry and public life. "It is impossible to abolish acute destructiveness without altering the equilibrium of the entire social process, since such acute disturbances mainly give vent to stress that has accumulated through the social system as a whole." Hence he advocated a "social psychiatry", one function of which would be to study the tensions created by "the struggle to express native impulses in ways forbidden by authority", the sexual impulse providing one example. For the rest, his prescription against war was "Physical Defence, Psychological Offence", and he urged the opponents of Marxism to emulate the Marxists' effectiveness in political education and propaganda, especially in giving the public as clear a conception as possible of the goal of national policies.

THE FOURTH SOUTH AMERICAN CHEMICAL CONGRESS

THE Fourth South American Chemical Congress was held in Santiago, Chile, during March 1–7, with more than four hundred delegates attending from all the South American republics. Invitations to attend were also extended to a number of countries outside South America: Great Britain was represented by Prof. J. W. Cook, Prof. E. C. Dodds and Dr. F. N. Woodward, the United States of America by Dr. Alfred Gauger, Sweden by Prof. The. Svedberg and Republican Spain by Dr. Francisco Giral.

At the inaugural session in the Law School of the University of Chile, where most of the sessions were held, the delegates and representatives were welcomed by Don Enrique Molina, the Minister for Education, and Don Juvenal Hernández, rector of the University; Dr. Felipe Justo, president of the Chemical Society of Argentina, replied on behalf of the delegates.

In his speech formally opening the Congress, Dr. Edouardo Cruz-Coke, professor of biochemistry in the University of Chile and president of the executive committee of the Congress, stated that this Congress was the largest yet held in South America and was planned to cover a wider field of chemistry than was possible at the Third Congress held at Rio de Janeiro in 1940. He indicated the executive committee's particular pleasure at the presence of so many representatives of non-South American countries, and later accepted on behalf of the committee a letter of greetings from the president of the Chemical Society brought from London by Prof. Cook and a copy of the fellows' register presented by Prof. Dodds on behalf of the Royal Society.

The Congress, which was particularly well organised, due largely to the efforts of Prof. Cruz-Coke, the two secretaries, Prof. Jorge Mardones and Prof. Hermann Schmidt-Hebbel, and their associates on the executive committee, was divided into thirteen sections. These covered the fields of physical and electro-chemistry, inorganic and geochemistry, organic chemistry, biochemistry, chemistry in relation to medicine and toxicology, nutritional chemistry, chemistry in relation to agriculture and applied botany, industrial inorganic and organic chemistry, metallurgy, fuels, chemical engineering and chemical education. During the course of the week, some four hundred papers were read, abstracts of which were made available to delegates in the form of a well-prepared 131-page printed booklet before the opening of the Congress. In addition to these, there were also eight 'Conferencia', two of which were given by British representatives. On March 3 Prof. Cook read a paper on "The Chemical and Biochemical Oxidation of the Aromatic Polynuclear Hydrocarbons", and on the following day Prof. Dodds lectured on "The Proteins as Biochemically Active Substances".

During the course of the week, the British representatives, who were very hospitably received, were given an opportunity of visiting many of the Chilean chemical and medical schools, museums and industrial organisations. The tour around the impressively equipped and staffed Hospital del Salvador was made in the company of Profs. Alessandri and De Amesti, who have been largely responsible for making this one of the most modern and efficient hospitals in South America, comparing favourably with the best European and North American hospitals.

The work of Profs. Edouardo Cruz-Coke and Hector Croxatto and their colleagues at the Medical Schools of the University of Chile and the Catholic University respectively on a wide variety of subjects, including the cardiac stimulants, the biochemistry f the hormones and vitamins, biological oxidations, organic iodo compounds, antibiotics, etc., was found to be both academic and developmental in outlook and conception. The science schools of the Chilean universities, unlike those in Britain and the United States, rely on outside sources for much of their income, and the teachers and students of these two chools consequently associate themselves closely ith certain industrial organisations, and particularly ith the Instituto Médico Técnico "Sanitas" S.A., a company producing a wide variety of organic chemicals including penicillin, organic arsenicals, D.D.T., and the more common pharmaceuticals. The Government-sponsored Instituto Bacteriologico operates in a similar field, and like Sanitas has modern and well-equipped factories and laboratories, and a well-informed and research-minded staff.

For the final sessions, the delegates were taken by road and special train to Valparaiso, where they were first entertained by the directors of the Nitrate Corporation at an impressive alfresco luncheon in the beautiful Parque de Salitre under conditions reminiscent, as one distinguished delegate observed, of Europe before the First World War. In the afternoon, the delegates were shown round the Santa Maria Technical University, where the formal closing session was held later.

The week's activities were rounded off at a colourful reception at the Vergara Palace, in the hills behind Vina del Mar, the beautiful and world-famous South Pacific health resort.

SCIENCE MASTERS' ASSOCIATION (SCOTTISH BRANCH)

THE first annual general meeting of the Scottish Branch of the Science Masters' Association took the form of a three-day meeting in the University of Glasgow during April 1–3, under the presidency of Sir Hector Hetherington, principal of the University. The meeting was attended by about 250 members of the Branch, and there were many visitors. The close and active co-operation of the staffs of the various departments of the University resulted in many exhibitions and demonstrations being available.

During the first day the Department of Chemistry staged exhibitions of the first-year practical course, new apparatus for esterification and distillation, fluorescence spectroscopy and photochemistry. Specimens of rare chemicals were also on view. The Department of Natural Philosophy had much to show in connexion with research in nuclear physics. Cloud-chamber experiments were demonstrated, a large magnet was seen in course of erection for cosmic ray studies, and various artificial radioactive isotopes were produced by neutron bombardment. Great interest was shown in the new 30-million volt synchrotron, under construction by Messrs. Metropolitan-Vickers, and the million-volt proton accelerator attracted many visitors. Prof. W. M. Smart, of the Department of Astronomy, arranged for the Observatory to be open for inspection during the afternoon, while in the Zoology Department the magnificent museum was open to members, and new biology films were shown. The Botany Department contributed a series of demonstrations in plant physiology, antibiotics (penicillin and streptomycin) and products manufactured from marine algæ. New methods of preserving biological specimens in transparent plastics were also shown.

The afternoon of the second day was set apart for visits to well-known Scottish firms specializing in the manufacture of special steels, coal-cutting machinery, nautical instruments, optical instruments, sulphuric acid and in shipbuilding.

One feature of the meeting was the exhibition of apparatus designed and constructed by members, and there was a special exhibit showing surplus apparatus available at very low prices to schools through the Ministry of Supply and the Scottish Education Department. In cases where service apparatus could not be used in schools without adaptation, methods of doing this were demonstrated.

Mr. F. A. Meier, of the London Institute of Education, gave two lecture-demonstrations on the construction and use of scientific apparatus, and lectures were given by Prof. J. W. Cook, on "The Effects of Some Chemical Compounds on the Growth of Cells", by Prof. P. I. Dee, on "The Elementary Particles of Matter", and by Dr. H. F. Steedman, on "Practical Methods in Zoology".

At a discussion on "School and University Teaching", the chair was taken by Sir Hector Hetherington, and leading parts were taken by Prof. J. Walton, Prof. W. M. Smart and Mr. F. G. Daldy, of Trinity College, Glenalmond. Many other members of the Association joined in the discussion, and in response to suggestions put forward steps have been taken to promote a closer liaison between Scottish members of the Science Masters' Association and the faculties of science in the Scottish universities.

At the annual business meeting, Mr. H. S. Sowrey, Glasgow Academy, was elected chairman of the Branch in succession to Mr. W. J. Lodge, Fettes College. The joint secretaries are F. G. Daldy, Trinity College, Glenalmond, and J. Wallace, Melville College, Edinburgh, and the treasurer is W. P. D. Wightman, Edinburgh Academy.

A 150-TON UNIVERSAL STRUCTURE TESTING MACHINE

W. AND T. AVERY, LTD., of Birmingham have recently designed and built a 150-ton universal structure testing machine for Short Bros. and Harland, Ltd. (*Engineer*, December 26, pp. 594–596).

It is significant that it is no longer considered sufficient to carry out tests on the material from which a complicated structure is made, and to base design upon calculations made from the results of such tests alone. There is a growing need to apply as near full-scale tests as possible. Geometrical similarity in test-pieces tested under laboratory conditions show a dimensional effect which it is often difficult to explain, except by assuming an anisotropy or inhomogeneity of the material. It is still more difficult to predict the behaviour of a material under complicated stress distributions from the results of the standard mechanical tests carried out on carefully prepared samples of shapes designed to make the interpretation of the results as simple as possible.

The new Avery machine can accommodate specimens up to 9 ft. 9 in. long in tension and 15 ft. in compression, while it can also be adapted for carrying out transverse tests on specimens up to 7 ft. span.

The tension and compression units are separate. They are, in fact, two testing machines but having a common hydraulic oil pump for applying loads and a dynamometer and indicator cabinet which can be used with either. The advantages to be gained by the separate units are that the effective height is greater, so that longer specimens may be used; and although the two units cannot be used simultaneously, setting-up can proceed in one while testing goes on in the other. This is an important consideration when it is desired to attach the large number of strain gauges often required for the full interpretation of complicated sections or built-up structures. Against the separation of the testing units must be set one disadvantage, namely, the far greater space occupied by the whole machine.

The method of operation and load-recording is similar to previous machines made by Avery's and to other machines of this type. There are four load-ranges: 0–150 tons in increments of 0·5 ton being the highest and 0–15 tons in increments of 0·05 ton the lowest. It is doubtful whether a machine of this capacity can, in fact, be used with any degree of accuracy on the lower range, and it would appear to be preferable to omit this range entirely and to use the machine for the purpose for which it was designed and for which it is eminently suitable.

C. F. TIPPER

GROWTH-PROMOTING SUBSTANCES IN HORTICULTURE

A CONCISE review by Dr. T. Swarbrick of recent developments in the application of growth-promoting substances in horticulture, with special reference to the researches carried out at Long Ashton since 1939, appears in Occasional Publications on Scientific Horticulture No. 5 (published by the Horticultural Education Association, c/o Gibbs and Sons, 16 Orange Street, Canterbury, Kent). Present applications include the acceleration of rooting in cuttings, the prevention of pre-harvest drop in apples and pears, the induction of parthenocarpic development in tomato and other plants, and finally their employment as selective weed killers.

Parthenocarpic fruits of apple and pear have been obtained with certain varieties but not with others, employing 2-4 dichloro-phenoxy-acetic acid, 2-6 dichloro-phenoxy-acetic acid and also beta-naphthoxy-acetic acid. In all cases, however, the artificially 'set' fruit grew slowly and never attained normal size. Similar development was induced in Miller's seedling apple and Conference pear following frost damage to the 'set' fruit during the spring of 1945. Beta-naphthoxy-acetic acid has also proved effective in inducing a very marked increase in 'set' and yiel of the self-sterile varieties of strawberry, Tardive d Leopold and Oberschlesien.

Two interesting lines of investigation are suggeste by the fact that crude extracts of the flowers hav been found to induce parthenocarpic developmen in tomato, and secondly, that stilbœstrol, a syntheti œstrogen of high potency in animals, is similarly effective. Certain of these growth substances, when use at concentrations higher than that required to induc parthenocarpy, produce modification of leaf shape an venation and clearing of the veins closely simulatin many characteristic symptoms of virus infectio This raises interesting conjectures concerning th nature of the action of virus on host. The effect o tri-iodo-benzoic acid in modifying lateral and terminal vegetative shoots of tomato to form flow trusses constitutes an interesting parallel to th suspected action of naturally occurring hormon which are believed to initiate the formation of flow primordia.

The progress already achieved in this field sugges that a joint attack by biochemist and plant physi logist may be expected to lead to a rapid expansi in our knowledge of the biochemical control development and reproduction in plants.

FORAGE RESOURCES OF LATIN AMERICA

BULLETIN 37 of the Imperial Bureau of Pasture and Forage Crops, Aberystwyth, has been prepared by Hugo W. Alberts, in association with the Technical Collaboration Branch, Office of Foreign Agricultural Relations, United States Department of Agriculture. It has been issued by the Imperial Agricultural Bureaux (Pp. 24. 2*s.* 6*d.*).

Grazing and browsing, as it is best known to the forester, of domestic or semi-domestic animals has become an increasingly intensified problem in the modern world. The present monograph gives information in some detail on the position in Peru and their forage resources. The author divides the country roughly into three geographic regions, the coastal region, the sierra and the oriente or montana. The latter, situated to the east of the Andes, consists mainly of tropical forest, the grazing and pasture question having little importance. Since remote times, the Andean Indians of Peru have grazed llamas and alpacas, native to the grasslands of the sierra. These animals had been domesticated and raised for their meat and hides by the time the Spaniards arrived. The llamas were used also as pack animals. On account of the nature of the grasses in many of the mountain valleys, there was always some grazing even in the driest times, because there were two general types of forage, consisting of short grasses, fairly high in palatability, and tall grasses, of lower food value. The tall grasses were not eaten during the rainy season when there was plenty of the short grass available, and consequently the former formed a reserve for the winter months and periods of drought.

Along the coast, forage is produced chiefly to feed dairy cattle. In the sierra, native range grasses supply forage for sheep, llamas, alpacas and some beef and dairy animals. The kinds of forage grown along the coast are principally alfalfa and para grass, supplemented by maize, which is cut and fed in the green state. The native range lands of the sierra produce various species of grasses, which may be classified into two general groups, namely, tall grasses and short grasses, already alluded to. Tropical rain forest species of grasses comprise the principal forage in the oriente.

Some of the pasture lands in different regions are irrigated. The number of animals which can be grazed on areas of from two to three hectares varies considerably, and probably requires a further close study.

EARTHQUAKES DURING JULY–AUGUST, 1947

TWELVE large earthquakes and a score of smaller ones were recorded by the world's seismographs during July, and nine large shocks with numerous smaller ones during August. Provisional epicentres for the large earthquakes have been determined by the U.S. Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association.

The largest earthquakes of the two-monthly period were those of July 29 and August 5. That of July 29 occurred on the borders of Tibet and Burma, and was recorded in America, New Zealand and Europe. At Kew the resulting ground amplitude reached 290 μ at maximum. The earthquake of August 5 had its epicentre about lat. 25° N., long. 62° E. in the Arabian Sea, south of Baluchistan. It was registered in America and Europe, where the ground amplitude reached 250 μ at Stuttgart. It is not yet known whether the Tibet earthquake did any serious damage or not.

Deep-focus earthquakes occurred on July 13 east of the Fiji Islands (100 km. deep), on July 25 in the northern Argentine (400 km. deep) and on September 2 west of the Tonga Islands (200 km. deep). These demonstrate that the viscosity of the material in the earth was large at these depths, places and times, thus giving a clue to earth structure.

Two unusual epicentres are placed in North America; one on July 10 in Baffin Bay, recorded at American stations and Stuttgart, and the other on August 10 at lat. 41·9° N., long. 84·5° W., in southern Michigan, recorded in North America but not in Europe.

Also during the period movement was going on in mid-Atlantic, where an earthquake occurred at lat. 54° S., long. 30° W. near South Georgia on July 23, and one on August 9 at lat. 1° N., long. 28° W., the latter known to be a seismic area. On July 15 repeated earthquake shocks brought down the dome of the church of San Felipe at Pasto, Colombia, and destroyed the high altar. Houses also collapsed and serious damage was done to the University and to the airport. Four people were seriously injured, and the tremors may have been associated with the eruption of a volcano near the city. This shock may have been the one which was registered at De Bilt, Belgrade and Stuttgart near 14h. 30m. G.M.T.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, April 26

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Industrial Applications of Photo-electric Cells" (to be opened by Mr. F. Baxendale).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—Dr. Edward Lynam: "English Surveyors and Mapmakers, 1555–1611".

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Annual General Meeting.

Tuesday, April 27

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Papers.

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. D. B. Fry: "Speech". (Further lectures on May 4 and 11.)*

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. J. Wishart: "The Teaching of Statistics".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—James Forrest Lecture.

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Dr. Mary Clarke: "Impressions of a Visit to China".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. A. J. Young: "Some Impressions of Modern American Instrumentation".

Tuesday, April 27—Friday, April 30

INSTITUTE OF WELDING (at Manchester).—Annual Spring Meeting.

Wednesday, April 28

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Photographic Society, 16 Prince's Gate, London, S.W.7), at 3.30 p.m.—Dr. R. K. Schofield: "The Report on Colour Terminology"; Discussion on "The Correlation of Colour Terms used in Physics, Industry and Ordinary Speech".

Royal Microscopical Society, Section of Industrial Microscopy (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 6 p.m.—Dr. F. Smithson: "Microscopy of Ceramic and Raw Materials".

Society of Chemical Industry, Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Seventeenth Annual General Meeting; Dr. E. B. Hughes: "On the Chemistry of Coffee".

Thursday, April 29

British Glaciological Society (joint meeting with the British Rheologists' Club and the Institute of Metals, at 4 Grosvenor Gardens, London, S.W.1), at 3.45 p.m.—Film illustrating the Methods of Glacier Research in the Field used by the Jungfraujoch Glaciological Research Party, 1938; at 5 p.m.—Discussion on "The Flow of Ice and of other Solids" (to be opened by Dr. E. Orowan, F.R.S., and Dr. M. F. Perutz).*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. D. M. S. Watson, F.R.S.: "The Mechanism of Evolution" (Hooker Lecture).

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. B. Giles: "The Economical Utilization of Electricity in Great Britain".

Royal Statistical Society, Sheffield Group of the Industrial Applications Section (at the Royal Victoria Hotel, Sheffield), at 6.30 p.m.—Mr. R. A. Nowlan: "Statistical Methods Applied to the Inspection and Testing of Aeronautical Materials".

Royal Institute of Chemistry, Manchester and District Section (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Annual General Meeting; Mr. J. R. Whinfield: "Terylene".

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Mr. G. A. Jones: "Tone Control with Unsharp Masks".

Friday, April 30

Physical Society, Optical Group (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 3 p.m.—Seventh Annual General Meeting; at 3.15 p.m.—Prof. S. Tolansky: "Some Further Applications of Multiple-Beam Interferometry".

British Institution of Radio Engineers, Midland Section (at the Technical College, The Butts, Coventry), at 6.30 p.m.—Mr. J. Moir: "The Acoustic Aspects of High Quality Reproduction".

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 6.30 p.m.—Annual General Meeting; at 7 p.m.—Dr. D. Shoenberg: "Superconductivity".

Institution of Electronics, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Mr. D. M. Corke: "The Application of Electronics to Vibration Research".

Manchester Statistical Society, Industrial Group (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. E. C. Fieller: "The Mathematics Division of the National Physical Laboratory, with special reference to Statistical Methods".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Age of the Universe".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Biologist, with B.Sc. in Zoology or Biology, and a Chemist, with B.Sc., preferably in Biochemistry—The Clerk, Birmingham Tame and Rea District Drainage Board, 117 Colmore Row, Birmingham 3 (April 30).

Engineering Scientist to the research department of a group of Companies in the North-West manufacturing a large range of textile machinery—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting A.43/48A. (April 30).

Lecturer in Agriculture (Grassland Husbandry)—The Registrar, Wye College, Wye, Kent (April 30).

University Lecturer in Geography—The Secretary, Appointments Committee of the Faculty of Geography and Geology, Department of Geography, Downing Place, Cambridge (May 1).

Graduate Assistant in the Department of Biochemistry—The Administrator, Radcliffe Infirmary, Oxford (May 1).

Readership in Entomology at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 3).

Assistant Horticulturist in the Department of Agriculture, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (May 5).

Assistant Lecturer or a Lecturer in Geology, a Lecturer in Pure Mathematics, Assistant Lecturers in Applied Mathematics and Botany, an Assistant Lecturer in Geography, and a Demonstrator in Physics—The Registrar, University College, Singleton Park, Swansea (May 8).

Assistant Lecturer or Lecturer in the Department of Geography, an Assistant Lecturer or Lecturer in the Department of Physics, and an Assistant Lecturer in Economic Statistics—The Registrar, The University, Leeds 2 (May 8).

Assistant Lecturer in Mathematics, and a Lecturer or Assistant Lecturer in Geology—The Registrar, King's College, Strand, London, W.C.2 (May 8).

Lecturers (3) and an Assistant Lecturer in Natural Philosophy, and a Lecturer in Mathematics—The Secretary, The University, Aberdeen (May 10).

Senior Entomologist in a survey team investigating pest infestation in Nigeria—The Under-Secretary of State, Research Department, Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (May 10).

Demonstrator in the Department of Chemistry—The Secretary, Bedford College for Women, Regent's Park. London, N.W.1 (May 14).

Assistant Lecturer in Geology—The Registrar, University College, Southampton (May 15).

Lecturer in Experimental Physics—The Secretary, Queen's University, Belfast (May 15).

Lecturer or Assistant Lecturer in the Department of Geography—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (May 21).

Principal Research Officer or Senior Research Officer (Plant Physiologist), Division of Plant Industry, Canberra, Australia—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1642 (May 22).

Assistant Experimental Officers in Scientific Establishments in various Government Departments—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2162 (May 27).

Professor of Metallurgy at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (May 28).

Lecturer (Grade II) in the Department of Chemistry (with special qualifications in organic chemistry)—The Registrar, Queen Mary College, Mile End Road, London, E.1 (May 31).

Head of the Department of Social and Economic Research, University College of the West Indies—The Under-Secretary of State, Research Department, Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (May 31).

Lecturer and an Assistant Lecturer in Statistics—The Registrar, Trinity College, Dublin (June 15).

Scientific Assistant for miscellaneous duties connected with a scientific information service and an abstracting journal—The Director, Commonwealth Bureau of Dairy Science, Shinfield, Reading, Berks.

Assistant Curator—The Curator of the Museum, Institute of Jamaica, Kingston, Jamaica, B.W.I.

Laboratory Technician (Grade B), and a Junior Student Laboratory Technician (Grade C), in the Department of Morbid Anatomy—The House Governor, St. Mary's Hospital, Paddington, London, W.2.

Lecturer in Pedology—The Registrar, Wye College, Wye, Kent.

Inorganic Chemist for research—The Director, Tin Research Institute, Fraser Road, Greenford, Middlesex.

Lecturer in the Physics Department—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Laboratory Technician—The Director, British Welding Research Association, 29 Park Crescent, London, W.1.

Scientific Assistant (university graduate in science or agriculture)—The Director, Commonwealth Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeenshire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Science News. Vol. 1, No. 1. Special Number: Centenary of the Chemical Society of London. Pp. 16. (London: British Council, 1947.) 6*d*. [128

Heredity: an International Journal of Genetics. Published 3 times a year. Vol. 1, Part 1, July. Pp. 141. (London and Edinburgh: Oliver and Boyd, 1947.) 14*s*., 3 dollars; 40*s*., 8.50 dollars annual subscription. [128

Human Relations: a Quarterly Journal of Studies towards the Integration of the Social Sciences. Vol. 1, No. 1, June. Pp. 140. (London: Tavistock Institute of Human Relations; Cambridge, Mass.: Research Center for Group Dynamics, Massachusetts Institute of Technology, 1947.) 10*s*.; 35*s*. annual subscription. [138

Other Countries

Ministry of Public Works, Egypt. Physical Department Paper No. 47: The Nile Basin. By Dr. H. E. Hurst and R. P. Black. Third Supplement to Vol. 3: Ten-day Mean and Monthly Mean Gauge Readings of the Nile and its Tributaries for the Years 1938–1942 and Normals for the Period 1912–1942. Pp. 389. (Cairo: Governmen Press, 1946.) 50 P.T.; 10*s*. [128

Carnegie Institution of Washington. Publication 569: Studies o Carbohydrate and Fat Metabolism, with Especial Reference to th Pigeon. By Oscar Riddle and associates. Pp. v + 128. (Washington D.C.: Carnegie Institution, 1947.) 1.85 dollars. [12

Annals of the New York Academy of Sciences. Vol. 48, Art. 7 Some Aspects of Red Cell Production and Destruction. By Eri Ponder, William B. Castle, Harry A. Charipper, William Dameshek Albert S. Gordon, S. Granick and F. S. Robscheit-Robbins. Pp. 577–704. (New York: New York Academy of Sciences, 1947. 2 dollars. [13

German Hydrographic Institute, Hamburg. Authorized by Allie Control Council, Germany. Annual Report No. 1, 1946. Pp. 64 (Hamburg: German Hydrographic Institute, 1947.) [13

South African Science. Vol. 1, No. 1, August. Pp. 32. (Johannes burg: South African Association for the Advancement of Scienc 1947.) 1*s*. 6*d*.; 15*s*. per annum. [19

Dialectica: International Review of Philosophy of Knowledg Vol. 1, No. 1, February 15. Pp. 112. Vol. 1, No. 2, May 15. Pp. 113–240. (Neuchatel: Editions du Griffon; Paris: Presses universitaires de France, 1947.) 4.80 francs each; subscription, 18 francs. [21

NATURE

No. 4096 SATURDAY, MAY 1, 1948 Vol. 161

CONTENTS

Page

Rehabilitation of Europe 659

Sons of Cambridge. By Prof. F. J. M. Stratton, O.B.E., F.R.S. . . 661

'Little Fleas' and 'Lesser Fleas'. By Dr. G. Lapage . . . 662

Divination in Dahomey. By G. I. Jones 663

Anatomy of the Renal Circulation 663

Reason in the Modern World. By A. D. R. 664

Animals and the Laboratory. By Frances Pitt 664

African Fossil Primates discovered during 1947. By Prof. W. E. Le Gros Clark, F.R.S. 667

Britain's Fuel Problems. By Dr. D. T. A. Townend . . . 669

University of Prague Sexcentenary Celebrations. By Dr. Gerald Druce 670

Obituaries :

Sir Franklin Sibly, K.B.E. By Prof. H. L. Hawkins, F.R.S. . . 672

Mr. G. S. W. Marlow. By Prof. Eric K. Rideal, F.R.S., and F. I. G. Rawlins 672

Prof. Selig Hecht. By Dr. M. H. Pirenne 673

Prof. M. C. Potter 673

News and Views 674

Letters to the Editors :

Magnetic Observations and Thermometry in the Region of Millidegrees Absolute.—D. de Klerk, M. J. Steenland and Prof. C. J. Gorter 678

Radiation Damping and Velocity of Light.—Prof. W. Heitler, F.R.S. 678

Phase-Angle Determination in X-Ray Crystallography.—Dr. Alexander R. Stokes 679

Extensive Penetrating Showers.—B. Chaudhuri 680

Mesons of Different Masses.—Prof. J. Barnóthy 681

Stressed Aluminium.—Prof. E. A. Owen, Y. H. Liu and D. P. Morris 681

Mechanical Behaviour of Crystal Boundaries in Metals.—R. King, R. W. Cahn and Dr. B. Chalmers 682

Internal Stresses in Metals.—W. A. Wood and N. Dewsnap ; G. B. Greenough 682

Electrical Breakdown Strength of Air at Ultra High-Frequencies.—J. A. Pim 683

Magnetic Susceptibility of Borax Glasses Containing Crystallites of Alkali Metal Salts, Gold and Platinum.—Prof. Subodh Kumar Majumdar 684

Bridge Networks Discriminating between Positive and Negative Sequences in Polyphase Supply.—N. F. Barber 685

Smoothing Periodograms from Time-Series with Continuous Spectra.—Prof. M. S. Bartlett 686

Race, Pigmentation and Colour Vision.—Dr. R. W. Pickford . 687

Adsorption of Bacterial Polysaccharides to Erythrocytes.—Dr. E. V. Keogh, Dr. E. A. North and M. F. Warburton . . . 687

An Adaptation Mechanism of the Organism to Damage : the Role of 'Resistine'.—Dr. S. Karády and Dr. A. Kovács . . 688

Two Examples of Sera Containing the Anti-*d* Agglutinin Predicted by Fisher and Race.—Dr. Joseph M. Hill and Dr. Sol Haberman 688

Fibrinokinase and Fibrinolytic Enzymes.—Dr. Tage Astrup and Per M. Permin 689

Mechanism of Substitution in the Naphthalene Nucleus.—Dr. N. M. Cullinane and S. J. Chard 690

Nitration of Simple Heterocycles.—K. Schofield and T. Swain . 690

Electrokinetic Potential and Surface Structure of Barium Sulphate.—A. S. Buchanan and Prof. E. Heymann 691

Inhibition of SH Enzymes by Methyl Bromide. By S. E. Lewis . . 692

Determination of Radioactive and Stable Tracer Isotopes . . 693

International Radio Conferences 695

Indian Research Fund Association 696

Latin-American Cultures. By G. H. S. Bushnell 697

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REHABILITATION OF EUROPE

IN April 1947, a report on the "Economic Conditions of Germany To-day and its International Repercussions" was issued by the special committee of the International Chamber of Commerce; a revised edition, submitted last November to the Council of the International Chamber, has now been published*. Certain of the recommendations of the original report have indeed already been adopted, wholly or in part. For example, a time limit has been given for completion of the earmarking of German machinery and equipment on reparations account, and plants not so earmarked are then to be finally freed from the threat of being taken for reparations. Great emphasis has been given to the problem of coal production, and German industrialists have been given incentive to export by permission to use part of the foreign exchange earned by the products exported to buy raw materials. There has been improvement in the procedure for exporting, and the steel output has now been raised to a limit of 10·7 instead of 5·8 million tons. The Committee, which again recommends that economic authority be given as much as possible to Germans, welcomes the initiative of the British and American authorities in creating a German Economic Council in their bizonal area, with full economic powers, subject to the overriding authority of the Allied Military Government. It also welcomes the adoption of the principle of the rapid devolution of power to central German agencies, and urges the resolute pursuit of this policy.

To restore incentive to the German workers and employers, four measures are recommended: monetary reform, involving a drastic reduction of the present volume of money, restoration of the market over an ever-widening area of the German economy by freeing the prices of non-essentials and gradual adjustment of the prices of controlled goods; fixing a new parity for the mark; extension of the system whereby family rations vary with the output and type of work done by the main wage-earner, and the gradual raising of normal rations; and provision for workers of greater quantities of consumer goods from domestic output and from limited and carefully selected imports, distributed so as to afford the maximum incentive to production. The Committee recommends that the goal should be for the management of Germany's heavy industries to be returned to private enterprise; but the substantial directive control, shareholding and management should be retained in Allied hands for reasons of security.

An increase in Germany's coal output is essential, both for the recovery of Western Europe and in order to terminate Germany's dependence on foreign financial aid; and every possible step should be taken to stimulate production as well as the work of repair and construction of Germany's transport system, and especially of locomotives and rolling stock.

The general aim of policy set out in the report is to reduce government controls as rapidly as possible, and to restore a system of free enterprise under which a genuinely democratic society and Government might be established. In framing their policy, the Control Authorities should bear in mind the needs of the rest of Europe and avoid a narrow outlook. The prime task of Europe to-day is to raise its overall production. That requires the use of the Continent's resources, transport and inland waterway facilities in the most efficient way possible, thereby minimizing Europe's overall foreign exchange deficit. If each country—and the Occupying Powers in Germany—seek to minimize their individual foreign exchange deficit unilaterally, the whole process of European reconstruction will be retarded and much effort wasted. Finally, the Committee observes that when political and other considerations make it possible to form a customs union or low-tariff area in Europe to which Germany could be joined, the solution of the economic difficulties of Germany and of the whole of Europe will be materially assisted.

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* The Economic Conditions of Germany To-day and its International Repercussions. (Brochure No. 123.) Pp. 46. (Paris: International Chamber of Commerce, 38 Cours Albert 1.)

These recommendations, however, only indicate the scope of the report, which gives a clear picture of the situation to-day; quite apart from the suggestions as to the action required, it should materially assist in grasping the position now confronting us. An equally valuable contribution to that end is to be found in a broadsheet, "Local Government in Bizonia", which has been issued by Political and Economic Planning. This broadsheet, moreover, is a valuable study of the nature of democracy which merits attention quite as much from the point of view of the reorganisation of local government in Great Britain with which we are now faced.

The broadsheet is not intended to depreciate the difficulties involved in creating in Germany a democratic local government, or the value of the experiment that is being made in the British Zone. It questions, however, the wisdom of the British policy of following closely the system which has worked well in Britain, and suggests that the utmost flexibility and encouragement of bold improvisation are required. It recommends that much more freedom should be given in the British Zone, as is already done in the American Zone, for experiment, subject to supervision of general policy rather than of constitutional details, and exercised by people aware of local government as an adaptable instrument of administration.

The principles suggested in this broadsheet are not put forward as other than indicative rather than exhaustive. First, a clear line should be drawn between political appointments, whether full or part-time, and the non-political local government service under their direction. The best guarantee that legislation on these lines will be enforced is likely to be found in the service itself when its professional responsibility and *esprit de corps* can be developed. Full-time political administrators, it is thought, must either be elected directly by the people or indirectly by the German Economic Council, and in either case should be subject to re-election at frequent intervals as now happens in the American Zone. Financial control should remain with the Council, and the Council's officers must be answerable to the Council only. Where there is delegation of powers, it must be to the Council as a whole, which should be responsible for seeing that the work is carried out properly. The rights of party minorities must be recognized, and elected members are responsible to the electorate and not to outside members of their party. This means that while there may reasonably be consultation with outside organisations, decisions must be taken by the councillors, and outsiders have no right to see documents or to receive information not available to all electors.

The report from the International Chamber of Commerce makes it plain how closely Britain's own recovery is linked with that of Germany, and it is interesting to note a close parallelism of thought between that report and a recent "Design for Freedom" pamphlet. This pamphlet, entitled "Design For Recovery"*, argues that the failure of Britain to make the expected recovery from the effects of war is due largely to the Government's attempt to centralize the control of industry and to conduct trade on bilateral lines, as well as to irresponsible equalitarian propaganda, which has damped down individual effort. The recovery of Britain, it is urged, depends upon our overseas trade, and in this connexion emphasis is laid on the need for greatly increased production of the goods our customers require at prices they can afford, a restoration of multilateral trading, the re-establishment of sterling in its old position as an internationally accepted currency, and of freedom for the individual producer and trader to show his initiative.

Although the first recommendation is for a reduction of income tax by one third, the measures proposed in the pamphlet differ much less than might be expected from the policies of the Government. The earned income reliefs announced by Sir Stafford Cripps are designed to restore the incentives to greater production, which is the purpose of the reduction of the rate of tax advocated in the pamphlet; while the Government has already given evidence that it is concerned, where possible, to reduce the number of physical controls, to return to multilateral trade and to encourage the development of new sources of wealth. Even the strengthening of financial control, such as the rates of interest, control of credit and scientific taxation so as to reduce inflationary pressure, appear to be less distasteful; although there is as yet no evidence that either of the principal political parties is prepared to consider the fundamental reconstruction of the whole basis of taxation policy.

Much is said in the pamphlet about the importance of Colonial development; the present Government certainly cannot be accused of neglect of the latent resources of Colonial territories. The pamphlet, however, tends to neglect the practical and psychological difficulties which face any Government; although its support for the development of new resources, the encouragement of invention and the use of science to control pests and increase production should be welcome to the Government in view of some of its new proposals. Its criticism, moreover, points a way by which financial controls to reduce inflationary pressure may in themselves facilitate a large reduction of the physical controls which cause delay and waste, and encourage more fruitful co-ordination and stimulation in a freer economic life.

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* Design for Recovery. Pp. 44. (Design for Freedom Committee, 22 Chester Square, S.W.1.)

Where the pamphlet links up its design with the International Chamber of Commerce report, however, is in its emphasis on European economic unity as essential to recovery. It urges as a first step the development of a system of currency interchangeability on the lines of the recent agreement by France, Italy and the Benelux countries, and that this agreement, utilizing the Bank of International Settlements, should be extended to all the sixteen nations participating in the European recovery programme. When Sir Brian Robertson, in his address on April 7 to the State Assembly of Rhine–Westphalia at Düsseldorf, affirmed the will of the Western Powers to pursue their plans for German recovery in face of the 'Iron Curtain' and the tense situation in Berlin, he called on the new Germany to take its place as one of the great nations of Western Europe. In his broad review of the political and economic scene, he gave no forecast of allied intentions for the progressive development of German political organisations or for the transfer of authority and responsibility to German hands; although he did emphasize that the ultimate objective of the bizonal administration in Frankfurt is to lay a foundation on which German unity with an independent, freely elected and representative government could be restored, a unity which would ensure to the people of Germany and their children the elementary freedoms of President Roosevelt.

The implications of this speech are as important as its content. The appeal to accept the prospects of security and reconstruction which the Marshall Plan and the Western Defence Pact offer mean that there can be no retreat at Berlin. While the division in Germany is absolute for the time being, Sir Brian's speech makes it clear that everything must be done to secure the confidence of the German people that the Western Powers will stand firm. Without that, plans and prospects everywhere in Germany, if not in Western Europe, will be shattered.

It is well that the British people as well as the German people should clearly understand what is at stake and how their future is interlocked. There has already been tabled in the House of Commons a motion urging the creation in Western Europe of a political union strong enough to save European democracy and the values of Western civilization, and a trading area large enough with the Colonial territories to enable its component parts to achieve economic recovery and stability. For this purpose the motion advocates the establishment forthwith of a Council of Western Europe consisting of representatives of the sixteen countries participating in the European Recovery Plan and Western Germany, with power to set up permanent international staffs to co-ordinate the social, economic and defence policies.

The first and most important task of the economic staff would be to frame concrete proposals for stabilizing the currencies of Western Europe, for the development of trade, for executing the European Recovery Plan, for a comprehensive production plan, including agriculture and the heavy industries, and for Colonial development. The long-term policy should be to create a democratic federation of Europe with a constitution based on the principles of common citizenship, political freedom and representative government, including a charter of human rights. Such a federation should have defined powers in such matters as external affairs, defence, currency, Customs and the planning of production, trade, power and transport.

Soviet intransigence has thus given an impetus to federation which a year ago was inconceivable. The convening of an assembly to frame a federal constitution for Western Europe has been brought within sight of the bounds of practical politics. In Great Britain, the idea of a United Europe, whether by federation or other means, has strong support from all political parties and has received powerful encouragement from statements made by the Foreign Secretary. Formidable difficulties will yet lie in the way of translating the declaration of principle into practical policies and bold executive measures, and success or failure will depend to a large extent on the support of an informed and intelligent public opinion. The pamphlets noticed above, no less than Sir Brian Robertson's speech, are to be welcomed as useful contributions to the formation of such an understanding and alert body of public opinion. The development of a body of opinion on this subject, not only in Britain but also in the other European countries concerned, is the indispensable first step towards the realization of any such long-term policy of federation contemplated in the second part of the all-party motion to which Mr. Churchill referred in the House of Commons on April 7.

SONS OF CAMBRIDGE

Alumni Cantabrigienses

A Biographical List of all known Students, Graduates and Holders of Office at the University of Cambridge, from the Earliest Times to 1900. Compiled by Dr. J. A. Venn. Part 2: From 1752 to 1900; Vol. 3: Gabb—Justamond. Pp. iv+619. (Cambridge: At the University Press, 1947.) £7 10*s*. net.

A WELCOME must be given to this further volume of Dr. Venn's *magnum opus*. Much of historical interest in the life of Britain is to be garnered in its 619 pages of biography. In reviewing them we shall not attempt to summarize the records of the divines, the statesmen, the medical men, the schoolmasters and the soldiers, but shall touch upon points of interest to scientific readers and upon some of the odd items of biography which enlighten its pages.

More than ninety fellows of the Royal Society have been noted, of whom the largest group consists of statesmen, lawyers and people in public life; the second group of mathematicians and astronomers; then representatives of medicine and the medical sciences, and then geologists. From among them mention may be made of William Hamilton, who saved for England the famous Rosetta stone; William Jones, the first Englishman to master Sanskrit; and Richard Gough, the archæologist, whose life in Cambridge must have been marred by shyness, for he scarcely ever stirred out of college without his tutor and he left his magnificent library to the Bodleian; also the Rev. William Vernon Harcourt, founder of the British Association. Other clergymen may be mentioned: William Hildyard, who had six sons who became fellows of colleges; James Inman, a Naval chaplain who improved ship-building and gunnery; Henry Gwyther who, when vicar of Yardley, caused three barrow-loads of parchments to be burnt; and John Jope, whose dead son haunted the church and vicarage of St. Cleer, Cornwall, until the father "consented to his remaining in the shape of a spider, and gave him as a hiding-place a crevice in the mantelpiece". His was a case which would have interested Edmund Gurney and Richard Hodgson of the Society for Psychical Research, who both appear in this volume.

Viceroys and governors head a long list of distinguished statesmen: here we will only mention James, Marquess of Graham, who obtained permission for the Highlanders to resume their national dress, long banned. Wars figure in the biographies of many soldiers and civilians turned soldier; we must mention William Hope, who won the V.C. in the Crimean War; William Hodson of Hodson's Horse, which did more than any other regiment to save India for the British at the time of the Mutiny. Travellers and explorers include Francis Guilleward (the Marquesas), Walter Harris (Morocco), George Haviland (Borneo), Sydney Hinde (Upper Congo) and Frederick Jackson (East Africa)—the original of Captain Good in "King Solomon's Mines". Books of adventure recall Henty and Cutcliffe Hyne, creator of Captain Kettle. Great athletes include Goldie, of the Goldie boathouse; Hockin, of immense size and strength, picturesque in his exhortations to a crew, who rowed seven years in the Jesus boat while it was 'head of the river'; the Gurdon brothers (Rugby football), Hammer Hales, S. S. Harris (association football), Lord Hawke, F. S. Jackson and A. O. Jones (cricket), L. K. Jarvis, a triple 'blue' and a member of the famous eleven that beat the Australians in 1878, Gatehouse (tricycle champion), and Hutchinson, who rowed with Steve Fairbairn for twenty-five years, and by a slip of the pen gave his age as '45' instead of '54' so as to get into the Durham Light Infantry in the First World War.

From the many miscellaneous items of interest a short selection must be made: Frederick Gill of Trinity was described by Francis Galton as possessing a grand nose, the glory of his College; John Griffith, chaplain of Ely gaol, bequeathed his housekeeper the ropes he received after each hanging, and she sold them for the cure of sore throats; A. P. Humphry, the long-distance shot, was reputed to have tested his marksmanship by firing from the tower of the Pitt Press on targets on the University range; Holditch, president of Caius for thirty-two years, was so shy and so rarely seen that a fellow of his own college once showed him round the college, taking him for a stranger. A wide range of similar stories is to be found by looking carefully through this interesting volume.

F. J. M. STRATTON

'LITTLE FLEAS' AND 'LESSER FLEAS'

Parasites (animaux et végétaux) des helminthes
Hyperparasites, ennemis et prédateurs des helminthes parasites et des helminthes libres; essai de compilation méthodique. Par Robert Ph. Dollfus. (Encyclopédie biologique, 27.) Pp. viii + 482. (Paris: Paul Lechevalier, 1946.) 1500 francs.

NOT only helminthologists, but others also who are interested in parasitism, will be grateful to Dr. R. Ph. Dollfus for this addition to his well-known and valuable work. For many years he has been collecting for his own use records of the hyperparasites and other enemies of trematodes and cestodes, and also of both parasitic and non-parasitic nematodes. He had no intention of publishing these; but his colleagues have urged him to do so, and the result is this very useful volume. The author does not claim that it is complete and he has published the various records as he found them, without critical evaluation by himself. Some of them consist of notes or a few words only, but the 26 pages of references enable the reader to consult the majority of the sources from which the records have been derived. Critical evaluations will, says Dr. Dollfus, come later, when the doubtful organisms recorded have been found and described again. We shall then perhaps be in a better position to decide whether there are any biological reasons for the fact that the records of the enemies of the cestodes and trematodes collected by Dr. Dollfus occupy only 50 of the 482 pages of the book, while the remaining pages are given to the enemies of the nematodes. It seems unlikely that this disproportion is the result of greater attention given either by Dr. Dollfus or by biologists in general to the enemies of the last-named group.

Prof. Emile Brumpt, in his introductory preface, regards the book as a first step in the study of an important field, and he suggests that the enemies of the helminths may influence the non-parasitic phases, at any rate, of their life-histories, as much as physico-chemical factors do. One may doubt this; but the suggestion certainly opens up a field of work which needs investigation.

Many readers will no doubt be astonished at the number and variety of the organisms which attack trematodes, cestodes and nematodes. Best-known among them perhaps are the fungi, which destroy by various methods both parasitic and non-parasitic nematodes; these are well described and illustrated in the 245 pages given to them. Readers who are interested in this subject will remember Dr. Drechsler's valuable and suggestive essay in *Biological Reviews* (16, 265; 1941). Less well known are the bacteria, spirochætes and protozoa which attack trematodes, cestodes and nematodes. The systematic position of some of these is still doubtful, and more work is needed upon them. In the bodies of trematodes phases of the life-histories of nematodes, trematodes and cestodes have been found; in some cestodes the larvæ of nematodes, cestodes and trematodes have been recorded; and, apart from the nematodes which eat other nematodes, there are species of this class which have been found inside the bodies of other species of nematodes.

Whether all the helminths which thus appear to be parasitic are really so or not we shall not know until much more work upon them has been done. Some of them may be only accidental associations and others may be instances of commensalism, similar to those associations between different species of nematodes which Dr. Dollfus does, in fact, describe as instances of commensalism. The distinction between commensalism and parasitism is not, of course, sharply defined, and, when organisms associated together are, like many of those mentioned in this book, comparatively difficult to obtain and certainly not easy to study under controlled conditions, it may be difficult to place them in either category.

What we need is more knowledge of the physiology of these organisms, and it may be that, in the process of acquiring it, new aspects of the relationships between parasitism and other forms of animal associations will be opened up. Dr. Dollfus has certainly provided in this book an extensive and detailed survey of such knowledge as we have, and it is to be hoped that he will follow it up with a critical estimate embodying his own wide experience.

G. LAPAGE

DIVINATION IN DAHOMEY

La Géomancie à l'ancienne Côte des Esclaves

Par Bernard Maupoil. (Université de Paris : Travaux et mémoires de l'Institut d'Ethnologie, Tome 42.) Pp. xxvii+690+8 plates. (Paris : Institut d'Ethnologie, 1943.) 320 francs.

M. MAUPOIL, during a tour of administrative duty in Lower Dahomey during 1933–36, made an extensive study of the Ifa system of divination, which plays such a large part in the religious life of the Yoruba and of their neighbours in Dahomey who have borrowed it from them. Although to the masses Ifa, or Fa as it is called in Dahomey, has become personified as a god, to the initiated it is more truly the voice of god or of fate. Unlike the cruel, capricious and unreliable gods of the Dahomey and Yoruba pantheon, Ifa is infallible, impartial, and never deceives. It consists of an abstract method of divination by manipulation of sixteen palm nuts, in the course of which a number of signs are made with the fingers in a yellow powder placed on a special tray. It is these signs which reveal to the initiated practitioner the past or the future. In its simpler form Ifa gives the consultant an answer to the everyday problems of his life; in its more esoteric, it gives him an opportunity of discovering his destiny.

Though Ifa may represent a man's fate and cannot be tricked or deceived, the Yoruba or Dahoman does not feel unduly terrified of his destiny, for there may still be a chance of avoiding it. This power which may enable a man to escape his fate is found in the conception of Legba, a being defined by Prof. Herskovits in his anthropological study of Dahomy as the personification of accident in a world where destiny is inexorable. M. Maupoil has of necessity a good deal to say about this roguish priapic messenger of the gods who spends his time deceiving both gods and mortals, and who plays such unpleasant tricks on them that early missionaries could only consider him the Dahoman personification of evil. He comes to the same conclusion as does Herskovits, that Legba is not the Dahoman counterpart of the devil, but that he supplies that principle of chance needed to humanize and make tolerable the rigid inexorable discipline of Ifa.

M. Maupoil is also impressed by the wisdom and sincerity of the Bokono (Yoruba, Babalawo), the priests or practitioners of Ifa, who play such an important part in Dahomey social life, a part sadly neglected and ignored by missionaries and administrators. The Bokono is called upon to intervene incessantly in social and family matters, and his balanced and philosophic outlook finds constant opportunity for expression through his divination. This wisdom, concealed in the proverbs and mythological tales by which the Ifa signs are revealed, helps to maintain the solidarity of the social group among whom the Bokono lives and practices, and gives it the equilibrium it needs to withstand the vicissitudes of its existence.

The absence of serious anthropological research on the Yoruba people and their sacred city of Ife constitutes a most unfortunate gap in our knowledge of West African peoples and their descendants in the New World. In default of such studies, students have, of necessity, to refer to works like the present one, which relate to peoples to whom this Yoruba culture has been transmitted. They will be very grateful to M. Maupoil for this most comprehensive study of Ifa. Though his field-work had necessarily to be confined to Dahomey, he has taken considerable trouble to consult, and where needed, to quote, all the available authorities on the Yoruba Ifa, in particular Mr. J. D. Clarke, some of whose notes have not received publication elsewhere. "La Géomancie à l'ancienne Côte des Esclaves" will therefore remain the standard work of reference on Ifa divination for many years to come.

G. I. JONES

ANATOMY OF THE RENAL CIRCULATION

Studies of the Renal Circulation

By Dr. Josep Trueta, Dr. Alfred E. Barclay, Dr. Kenneth J. Franklin, Peter M. Daniel, Marjorie M. L. Prichard. Pp. xix + 187. (Oxford : Blackwell Scientific Publications, Ltd., 1947.) 25s. net.

MOST text-books of histology provide detailed diagrams illustrating the intricacies of the vascular pattern in the kidney, and, indeed, the classical work of Bowman, Virchow, Huber, MacCallum and others would appear to have exhausted the purely anatomical aspect of this system. But it seems that this provides yet another example of those 'comprehensive' studies the completeness of which is only apparent. For evidence has now been adduced demonstrating that a fundamental point in the renal circulation has hitherto been entirely overlooked—the fact that it comprises a *dual* system. The kidney, it appears, has two potential circulations, a greater, which traverses the cortex and involves the cortical glomeruli, and a lesser, which is confined to the medulla and the juxta-cortical glomeruli. While in normal circumstances the circulating blood passes through the cortex, under certain conditions it may by-pass it entirely through the lesser circulation.

This is the theme, abundantly documented by experimental evidence, of the monograph which has recently appeared from the Nuffield Institute for Medical Research at Oxford. This monograph represents the product of team-work which was initiated in order to determine whether the renal failure which occurs in the victims of crushing injuries to the limbs might be due to reflex vascular disturbances. The results of the investigation depend largely on the application of angiographic studies in living animals, and also on a radiomicrographic technique which is evidently capable of providing extraordinarily accurate information of small but important vascular disturbances. With the aid of such methods, it was possible to demonstrate that by a variety of procedures (such as the application of a tourniquet to a limb, the stimulation of the sciatic nerve, and the injection of staphylococcus toxin) a cortical ischæmia in the kidney can be induced which may be severe enough to lead to an actual necrosis. The clinical implications of these observations are clear, and it is no exaggeration to say that they are of profound importance for the consideration of a number of problems of renal pathology, particularly since the vascular effects observed are believed to have primarily a neurogenic origin.

Undoubtedly one of the outstanding features of the monograph is the profusion of most excellent photographs demonstrating the effects of various procedures on the vascular pattern in the kidney. These certainly carry conviction so far as the actual recorded observations are concerned. While the authors make it clear that the precise relationship of these vascular changes to disturbances of renal function in pathological conditions is still a matter of hypothesis, they have nevertheless succeeded in directing attention to a factor which may well prove to be of major importance in their elucidation. The style of presentation is commendable for its directness and simplicity, and for the care which has been taken to avoid any over-statement of the case which the authors put forward.

REASON IN THE MODERN WORLD

Eclipse of Reason

By Max Horkheimer. Pp. ix+187. (New York and London: Oxford University Press, 1947.) 16*s.* net.

THIS is a rather difficult book; not that the author's exposition is unclear—on the contrary, he writes well; but that his general position is difficult to grasp. It is important to grasp it, because he makes a profoundly suggestive diagnosis of the intellectual sickness of our day.

The main thesis can perhaps be summarized without too much distortion as follows. The confusion of thought of the modern world is not just academically deplorable; it leads to confusion in political, economic and other social activities. It springs from deserting 'objective reason' for 'subjective reason'. The notion of objective reason is that there exists in the universe an intelligible order to which the thought and action of men should conform, as Plato and Aristotle believed. We have replaced that notion, through what is possibly an inevitable process, by subjective reason, which means obtaining an adequate mental grasp of socially approved means to ends. The ends themselves are left undefined as a sort of continuation of the means, or else interpreted as self-preservation, either of individuals or of some society on the preservation of which the individual life depends. In effect, such an attitude destroys all proper relations between society and individuals, and even makes the natural world appear to be the enemy of men or their master. (The argument for these conclusions is intricate and cannot be abbreviated.)

The favourite philosophies of to-day, the various forms of positivism, including pragmatism and Marxism, all adopt the point of view of subjective reason. In consequence they all become just 'ideologies' in the original sense of the term, propaganda for political parties disguised as rational discourse. Neo-Thomism is condemned by Prof. Horkheimer, though less severely, as archaistic, an attempt to revive something for which the necessary conditions have passed away. In its own way it also becomes political propaganda. Objective idealism of the Hegelian type is dismissed cursorily, though the author's way of thought appears to be akin to it. What is there left? The author says we need philosophy, but he is understandably cautious about putting forward another bit of political propaganda; so he says no more than that philosophy should be the memory and conscience of mankind. This is a pregnant saying, even if it means 'Back to Socrates'. Socrates has been more effective than other philosophers or than any of his contemporaries—but at a price. A. D. R.

ANIMALS AND THE LABORATORY

The UFAW Handbook on the Care and Management of Laboratory Animals

With an Appendix on Statistical Analysis. Edited by Prof. Alastair N. Worden. Pp. xvi+368. (London: Baillière, Tindall and Cox, 1947.) 31*s.* 6*d.*

SCIENCE owes much to animals employed in laboratories. Guinea pigs, rats, mice, ferrets, etc., have helped greatly in many a valuable research. The care of such animals is important, both from the humane point of view and that of scientific investigation. The handbook under notice, edited by Prof. Alastair Worden, is indeed a useful volume. There are some twenty-three chapters by various writers. Major Hume leads off with "Law and Practice: the Rights of Laboratory Animals", and his chapter is followed by one on the laboratory where animals are kept, including construction, equipment and so on. Pests of the animal house are next considered, after which we go on to the various animals commonly and uncommonly employed in laboratories, each chapter being written by an authority on the species being dealt with.

As might be expected, the rabbit has pride of place, with the guinea pig next and the Norway or brown rat in the third chapter; though some of us might have expected the mouse to come earlier than Chapter 5. Many animals have been pressed into the service of science, from the common house mouse, *Mus musculus*, to the field vole, *Microtus agrestis*, and their suitability by reason of size, ease of handling, rapidity of breeding and other characteristics is obvious at a glance; but the most remarkable on the list is undoubtedly the hedgehog. That this most unaccommodating creature, ever ready to roll itself into an impenetrable ball of prickles, should have been utilized in research work says much for the enthusiasm and ingenuity of the workers; but utilized it has been, and with success, and in this volume we can learn how to keep, feed and handle it, how to breed it, about its diseases, etc.

The book is a mine of information, and will be indispensable to all engaged in research where animals are employed. FRANCES PITT

A Manual of Vacuum Practice

By Dr. L. H. Martin and R. D. Hill. Pp. x+120. (Melbourne: Melbourne University Press; London: Oxford University Press, 1947.) 10*s.* 6*d.*

THIS manual, which is written by the professor and senior lecturer of the Physics Department of the University of Melbourne, is an excellent addition to the all too few modern books in the English language on vacuum technique. So many appliances to-day depend upon the production and maintenance of a high vacuum that not only the physicist and research workers in other branches of science, but also the engineer and many industrial technicians need to have a working knowledge of vacuum processes. No book can take the place of actual practical experience; but even the most experienced vacuum worker will find it extremely useful to keep by him such a handy reference book as this, for it describes in a concise and practical form not only modern developments in vacuum apparatus, but also presents in an easily accessible form valuable data concerning the properties and uses of materials most suitable for vacuum systems.

The physical principles of the production of low pressures, together with some typical calculations which were made in designing the pumping system for a neutron generator, are described in Chapter 1; the various gauges for pressure measurement in Chapter 2; pumps in Chapter 3; and materials, valves, joints, traps, etc., under the general heading of 'vacuum plumbing' in Chapter 4. Eighteen appendixes, including details with regard to soldering, cleaning of mercury, making glass-to-metal seals, and greases, waxes and cements, together with a comprehensive index, complete the volume. The clarity of the numerous diagrams and drawings, many of which are provided with actual dimensions, will be greatly appreciated by those who design and construct their own vacuum systems. Each chapter is provided with a list of references to the original sources, and the commercial apparatus referred to in the text includes both English and American types of the most modern pattern. The book is small enough to be slipped into the laboratory coat pocket. It is excellently printed and well bound with a special ring binding which allows the book to open and remain quite flat, an important feature especially when the user's hands are occupied with some practical job.

Aristotelian Society

Supplementary Volume 21: Explanation in History and Philosophy. The Symposia read at the Joint Session of the Aristotelian Society and the Mind Association at Cambridge, July 4th–6th, 1947. Pp. iv+218. (London: Harrison and Sons, Ltd., 1947.) 21*s.* net.

THE title of this modest little volume is a masterpiece of understatement. The contents are immeasurably richer than the word 'explanation' would suggest. Prof. C. D. Broad leads off with some characteristically stimulating observations upon methods in speculative philosophy. (Actually, his address came in the middle of the conference, not at the beginning.) The symposia proper deal with historical explanation, truth by convention, the psychological study of mental acts or dispositions, and the problem of guilt.

Interesting as all this is, it is hard to find much coherence, and harder still to get any very definite impression of aim. To attempt to do so would be misleading, beyond the remark that the headings do represent the spirit of the discussion. But the point is this, that the conference room was evidently a philosopher's workshop, where things could safely be left lying about, without having to tidy up for the night. This is one of the most promising and creative ways of fashioning thought, and the Aristotelian Society may be congratulated upon the results. No less a scholar than the late Canon Streeter commended the intellectual workshop, and was himself an adept in handling its tools and assembling the bits and pieces. The speakers reported in this book have done likewise and deserve our gratitude.

So far as the more strictly historical matter is concerned, it is wholesome to be reminded that events really did happen—for good or for ill—and that the sequence of occurrences has a reality of its own, independent of the design into which a later historian may desire to weave them. F. I. G. RAWLINS

Housing the Country Worker

By Michael F. Tilley. Pp. 152+24 plates. (London: Faber and Faber, Ltd., 1947.) 12*s.* 6*d.* net.

THE importance of housing in Britain in relation to agriculture and the use of the land in rural areas was well brought out in the Scott Report, and has been stressed in recent discussions in connexion with the Government's agricultural policy and the housing situation in general. Mr. Tilley has discussed lucidly and most readably the broad aspects of the whole problem as seen against the changes in farming organisation and practice, the rural location of industry and the political, economic and social questions involved. There is an admirable chapter on the village plan, followed by others on the provision of public services, the repair and reconditioning of old buildings, the needs of the country worker as distinct from the urban dweller, recent housing developments and materials and equipment. This sane and balanced discussion, which always has close regard to the personal needs of those primarily concerned as well as to what is practicable, taking into account the materials available and the efficient use of sites and land, points the way towards harmonizing anew the erection of new houses and the advent of a new population on one hand and the existing structure of the village in all its aspects. These possibilities are clearly indicated, and the book should be read with interest not merely by the architect or builder, the rural councillor or others actively concerned with the preservation of the countryside, but also by the townsman accustomed to use the country as a week-end resort or daily dormitory. There is much in this book which should further the establishment of good relations between town and country as well as the new tradition of good planning and building worthy of the best in the past, to foster which is the primary purpose of the book. R. B.

A Planned Auxiliary Language

By H. Jacob. Pp. 160. (London: Dennis Dobson, Ltd., 1947.) 10*s.* 6*d.* net.

ONE of the suggestions for the scientific programme of the United Nations Scientific and Cultural Organisation made by the Mexican Delegation at the Conference of the Natural Science Committee of the Preparatory Commission in June last year was that a single international scientific language should be chosen from among German, English, Spanish, French, Latin, Russian and Chinese as the official language for international scientific conferences, congresses and other meetings, and scientific works written in any other language should always include a sufficiently full summary in this international language. The difficulties in the way of adopting any suggestion on these lines are obvious, though the numerous international scientific conferences during the past year have directed fresh attention to the need. This comparative review of the five systems of planned international language already proposed—Esperanto, Ido, Occidental, Novial, and Interlingua—merits careful consideration. Dr. H. E. Palmer contributes a preface describing the various approaches which have led to the proposals for artificial or planned languages, and after discussing the functions of a planned language, Mr. Jacob describes the five systems and then considers in succession the structural problems of the planned language and present-day movements in this field. Two chapters on the preliminary project of the Russian Academy of Sciences for a technical nomenclature, and on technology and the language problem, appear to exaggerate the barrier which language has placed to technical communication, and the treatment of nomenclature is altogether too superficial. There is an adequate bibliography.

Petroleum Production

By Park J. Jones. Vol. 3: Oil Production by Water. Pp. vii+271. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1947.) 30*s.* net.

WATER in oilfield development can be both a blessing and a curse. This volume deals with the former condition, although the alternative never seems far behind. Briefly, recoverable oil can be classified as dry, wet and marginal reserve. "The ratio of dry to wet oil reserve depends on how soon water appears in production." Obviously it is far more economical in every sense to produce dry oil than wet oil, and every operator strives to achieve the first, if not to control the second to his advantage.

In this thesis of oil production by water, theoretical considerations take care of the normal condition 'oil ahead of water', oil production by expansion, well producing capacity, injection of water, optima for reservoirs and oil migration. Practical applications concern radial reservoirs, two-pay intervals, impermeable wedges, saturated oil, linear and elongated reservoirs and bottom water. The author is clearly a master of his subject, but the reader needs more than average mathematical knowledge to follow all the arguments. The book is well produced and the text clarified by numerous graphs and line drawings.

H. B. Milner

New Developments in Ferromagnetic Materials

With Introductory Chapters on the Statics and the Dynamics of Ferromagnetism. By J. L. Snoek. (Monographs on the Progress of Research in Holland during the War.) Pp. viii+136. (New York and Amsterdam: Elsevier Publishing Co., Inc., 1947.) 6.75 fl.

QUITE apart from any other, this brochure is of interest as illustrating some of the work done by Dutch men of science during the period of the German occupation. Starting off with general accounts of what the author terms the statics and dynamics of ferromagnetism, the main interest lies in the work done on the development of new magnetic materials based on the cubic $M\mathrm{O.Fe_2O_3}$ compounds. The interesting fact emerges that the oxides containing zinc have higher permeabilities than the rest, presumably because the Curie point is lowered, the maximum permeability being found to occur just below this temperature. The samples are prepared by a sintering technique which is described, and in the case of mixed NiO, ZnO compounds, a maximum initial permeability of 4,000 has been obtained. Among the appendixes is one dealing with the decarburization of steel. The author claims that the rate of diffusion of carbon in α-iron is very much higher than that in the γ-modification, a view which is contrary to current opinion, and which requires further confirmation before it can be accepted.

F. C. T.

Proceedings of the First Canadian Mathematical Congress, Montreal, 1945

Pp. xliv+367. (Toronto: University of Toronto Press, 1946.) 3.25 dollars.

CANADIAN mathematics, at least in the English-speaking provinces, followed closely the English pattern of the nineteenth century. On the other hand, the Canadian school system had many points in common with that of the United States. As years elapsed, the distance of Canada from Great Britain and the traditional fear of being dominated by the United States prevented Canada from following the mathematical advances in either of these countries. This tendency towards isolationism has been aggravated by the lack of intercourse between different parts of Canada itself. A great step in overcoming these defects has been taken by the institution of the Canadian Mathematical Congress, the first meeting of which took place at Montreal in 1945. There were several lectures, some by Canadians and some by distinguished visitors such as G. Birkhoff and L. J. Mordell, research papers, and discussions on methods of fostering research work, on recent advances in statistics, and on the teaching of mathematics to engineering students and in schools. Most of the proceedings were in English, but a few were in French. It was resolved to recommend the founding of a mathematical journal.

H. T. H. P.

Mathematik, Logik und Erfahrung

Von Prof. Dr. Victor Kraft. Pp. vii+129. (Wien: Springer-Verlag, 1947.) 10 francs.

IN this modest little volume are signs of intense application and erudition, under conditions (in Vienna) truly 'impossible' as judged by British standards. There is nothing very new in these pages, suggestive as they are. The first half of the book deals with the empirical validity of mathematics—arithmetic and geometry—whereas the second is concerned with a spirited refutation of 'conventionalism', and a discussion of the conditions of application of logic. The prospective reader will naturally ask what this particular brand of conventionalism is to which Prof. Kraft devotes so much attention. It seems to be a species of what we should call idealism in natural law. By relegating it to the *Hinterland*, a healthy relationship is probably established (especially for the intellectual climate in which the author writes) between physics and epistemology; on the other hand, if everybody went all the way with him, there would be but scant quarters left for the 'poetry' of science, of which recent years have produced superb examples in other parts of the world. Nevertheless, Prof. Kraft has enriched his subject, and added distinction to its literature.

F. I. G. Rawlins

AFRICAN FOSSIL PRIMATES DISCOVERED DURING 1947*

By PROF. W. E. LE GROS CLARK, F.R.S.
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THE elucidation of the fossil record of the group of mammals of which man himself is a member is clearly a matter of the most profound interest. But it is a study which in the past has progressed extremely slowly, for the reason that the remains of fossil Primates are usually found only at rare intervals. It is all the more remarkable, therefore, that the year 1947 was outstanding in the field of palæontology for the great abundance of extinct representatives of the higher Primates, the Hominoidea, which have come to light. These discoveries were made in Africa, and it is particularly interesting to note that they followed so closely on the Pan-African Congress of Prehistory, held in Nairobi in January of that year, when the implications of earlier finds first gained a wide recognition. The discoveries are due primarily to two men of science, Dr. Robert Broom in South Africa and Dr. L. S. B. Leakey in Kenya.

The new discoveries made by Dr. Broom supplement those which he made between 1936 and 1941 at Sterkfontein and Kromdraai, and which he described in detail in a monograph published in 1946[1]. They are remarkable both in quantity and quality, for not only do they include considerable numbers of skulls, jaws, teeth and limb-bones of the Australopithecinæ, but also some of this material is extraordinarily complete and well preserved.

It will be recalled that the first specimen of the Australopithecinæ, an immature skull with an endocranial cast, was found at Taungs in 1924 and afterwards described by Prof. Raymond Dart[2]. Then in 1936 and later, Dr. Broom found portions of several adult skulls, jaws and teeth, as well as fragments of some limb-bones, at Sterkfontein and Kromdraai near Johannesburg. His report on this material made it clear that the Australopithecinæ were ape-like creatures with brains of simian dimensions, but which at the same time showed such a remarkable assemblage of characters hitherto regarded as distinctive of the Hominidæ that there could be little doubt of their importance for problems of human evolution. Among these hominid characters may be mentioned the morphology of the frontal region of the skull, the low level of the occipital torus, the construction of the tympanic region, the forward position of the foramen magnum, the palatal contour, the small canines, the bicuspid character of the anterior lower premolars, the morphology of the first deciduous molars, the flat wear of the molars, the details of the lower end of the femur, and certain features of the talus and the capitate bone. The evidence of the femur, combined with that of the foramen magnum, it should be noted, seemed to make it clear that the Australopithecinæ were capable of assuming an erect posture closely approaching that of man.

This accumulation of evidence was sufficient to convince most anatomists that the importance of the Australopithecinæ had not been exaggerated. A few critics, however, expressed scepticism, mainly, no doubt, because they had not had the opportunity of examining the original material for themselves. It is also a fact, however, that this material, although abundant, was in some respects fragmentary, and thus required a rather intimate acquaintance with the comparative osteology of the Hominoidea for a correct appreciation of its unusual characters. Early in 1947, Dr. Broom renewed his excavations at Sterkfontein, and in April announced the discovery of a practically complete adult Australopithecine skull, as well as the upper jaw of another adult, an upper jaw of an adolescent, and some isolated teeth[3]. The complete skull has been listed in the material from Sterkfontein as "Skull No. 5". Further excavations soon showed that many more remains of the Australopithecine fossils were embedded in the limestone matrix in the same area at Sterkfontein, and parts of at least five other skulls (some of which are fairly complete) have since come to hand. The preliminary notes on these discoveries so far published have now provided a remarkable vindication of the views previously expressed by those who had personally studied the earlier material described by Dart and Broom. For example, they appear to confirm the forward position of the foramen magnum and the human resemblances in the occipital and tympanic regions, while many other features such as the contour of the frontal region and the shape of the dental arcade conform closely with the evidence already supplied by less complete material. The discovery of a massive jaw in June 1947, with all the teeth in position, has also added further evidence that the canine was relatively small (compared with the premolars) and became worn down flat to the level of the adjacent teeth[4]. In all these skulls the endocranial capacity seems to vary about 500 c.c.

Dr. Broom, however, has not only found a number of skulls, but has also collected a considerable number of limb-bone fragments, including portions of a scapula, humerus and femur, a tibia, some ribs and vertebræ, and an almost complete os innominatum[5]. The last-named is without doubt the most remarkable find. In the shape of the ilium it corresponds very closely with that of man, and shows no resemblance at all to the os innominatum of an anthropoid ape. Indeed, it provides the final proof (if further proof were needed) that the Australopithecinæ stood and walked in approximately human fashion. So human in appearance is this fossil bone that the question may well be raised whether it really is part of an Australopithecine skeleton. But, apart from the fact that it is entirely consistent with the evidence previously provided by the femur and talus (and also the construction of the base of the skull), it was actually found by Dr. Broom embedded in a block of limestone matrix with portions of several other limb-bones, vertebræ and ribs and with a crushed Australopithecine skull. There can scarcely be any doubt, therefore, that all these bones are the remains of the skeleton of a single individual. It should be noted, also, that in certain features of the os innominatum, such as the details of the ischial tuberosity, it shows unusual characters which, it seems, are not paralleled either in the modern anthropoid apes or man.

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* Substance of a communication to the Linnean Society, April 22, 1948.

It will naturally be some time before a detailed account of all this new material from Sterkfontein can be published, but private communications, together with unpublished photographs and drawings, make it clear that the information now available on the anatomy of the Australopithecinæ is astonishingly complete. Stated briefly, they are ape-like creatures in respect of the general proportions of the brain-case and jaws, but approach the Hominidæ closely in the constructional details of the skull, in numerous features of the dentition, and particularly in the limb skeleton. There is no sign yet that the rich 'lode' of Australopithecine material discovered by Dr. Broom is yet approaching exhaustion, and thus there is a reasonable possibility that further remains of the hand and foot skeleton may be found which will permit an even more precise definition of the status of these extinct hominoids. But, when all the evidence now available is published, systematists will inevitably be faced with the question whether the Australopithecinæ should not be allocated to the Hominidæ rather than the Pongidæ.

Simultaneously with these remarkable discoveries of fossil hominoids in South Africa, discoveries of similar importance were being made in Early Miocene deposits of Kenya by Dr. L. S. B. Leakey and Dr. D. McInnes. In 1931, Dr. A. T. Hopwood described some fossil jaws and teeth recovered from Koru in Kenya and assigned them to three new genera of extinct anthropoid apes, *Proconsul*, *Xenopithecus* and *Limnopithecus*[6]. Afterwards, more Early Miocene material referable to these genera were obtained on Rusinga Island and adjacent areas by Leakey[7] and McInnes, and were described by the latter in 1943[8]. Following the Pan-African Congress on Prehistory, some of the delegates had the opportunity of visiting the sites of these discoveries and were impressed with the possibilities of further excavation. A British-Kenya Miocene Expedition was therefore organised with the aid of a grant from the Royal Society, with Dr. Leakey as field director. The expedition proved to be an outstanding success, for almost fifty specimens of fossil hominoids were collected[9]. This material is now being examined in the Department of Anatomy at Oxford, and the brief account which follows is entirely of a preliminary nature. Perhaps the most striking feature of the collection is the great variety of fossil apes which it represents. Before the first discoveries in Kenya, the only certain information available about fossil apes which existed earlier than the Middle Miocene was provided by two fragmentary jaws from the Oligocene of Egypt, *Parapithecus* and *Propliopithecus*. Now, with the accession of all the new material from Kenya, we are faced with such a bewildering variety of Early Miocene apes that it is by no means an easy matter to sort them all out. Much of the material consists of jaws and teeth of an ape considerably larger than *Proconsul africanus* (Hopwood), and in which the relative sizes of the premolars and molars, as well as the cusp pattern of the latter, also show differences. There is little doubt, therefore, that they should be assigned to a different species. To this group belongs the almost complete mandible found on Rusinga Island in 1942, as has now been established by the discovery during 1947 of a portion of the maxilla of the same individual, with the cheek teeth in position. A still larger species is represented by portions of a huge mandible found by the British-Kenya Miocene Expedition at Songhor. This jaw is in some respects more massive than that of many adult male gorillas.

In all these specimens (which provisionally are regarded as constituting several species of the genus *Proconsul*), there are certain characteristic features. The incisors are relatively small in comparison with modern apes, and the symphysial region of the jaw is narrow, the axis of the symphysis tending to be more vertical; the canines are large and there is little definite evidence of any marked sexual difference; the first lower molar is proportionately rather small, the upper molars have a well-developed internal cingulum which in some cases is elaborately beaded, and the lower molars have very evident traces of an external cingulum. Some immature jaws of *Proconsul* which have been found are particularly instructive for the information which they give on the dental succession in these primitive apes. Of similar dimensions to *Proconsul*, but with a very different cusp pattern, are a number of upper teeth found at Rusinga and the surrounding area. These show some resemblance to the teeth of the Middle Miocene Indian genus, *Sivapithecus*, and in the absence of a strongly developed internal cingulum presumably represent a type which is more generalized (or perhaps more advanced) than *Proconsul*. But more material of this type is needed before a definite diagnosis can be made.

Portions of upper and lower jaws of *Xenopithecus* with the teeth in position have now made it possible to make a fairly complete study of the dentition of this genus, and to demonstrate that it differs from *Proconsul* mainly in its smaller size and in the elongation of the last lower molar. Still smaller than *Xenopithecus* is the gibbon-like *Limnopithecus*, of which a number of jaw fragments are now available and also a maxilla and palate with the upper premolars and molars. It now appears probable, from this material, that at least two species of *Limnopithecus* existed in East Africa in the Early Miocene.

Only a few limb-bones of the Early Miocene hominoids have so far been found, but these have provided information of unusual interest. The femur provisionally referred to *Proconsul* is a long, slender and straight bone, very similar to the Eppelsheim femur, which is probably that of *Dryopithecus*. The humerus is likewise of somewhat delicate construction and, though of about the same length as that of an adult chimpanzee, lacks the powerful muscular ridges which are associated with brachiating habits. The talus and calcaneus of *Proconsul* have already been described by McInnes. It is a striking fact that, in many of their details, they conform much more closely to the corresponding tarsal bones of the cercopithecoid monkeys than those of the modern large apes. It is probable, indeed, that *Proconsul* was not a brachiating specialist, but led a more cursorial type of existence. Combined with certain features of the femur, the tarsal bones indicate that these Early Miocene apes were lightly built and active creatures, capable of running and leaping with considerable agility.

These observations will certainly have an important bearing on the problem of the evolution of the higher Primates, for they suggest that the adoption of the brachiating habits which are characteristic of the modern apes may have been a relatively late acquisition. More limb-bone material of the Early Miocene apes of East Africa is needed in order to follow up the very interesting implications of the specimens already available, and we require also to know more about the structure of the skull (which we have already learned was much shorter in the facial region than in the recent large apes). There is a reasonable prospect that, in continuing their excavations during the coming season, Dr. Leakey and Dr. McInnes may be able to secure this important evidence. Meanwhile, it is not a little remarkable to find, as the result of the excavations in Kenya, that already in Early Miocene times East Africa was populated with numerous species of primitive apes ranging in close gradations of size from small creatures no larger than *Hylobates* to great apes of gorilloid dimensions.

[1] Broom, R., and Schepers, G. W. H., *Transvaal Mus. Mem.*, No. 2 (1946).

[2] Dart, R., *Nature*, **115**, 195 (1925).

[3] Broom, R., *Nature*, **159**, 672 (1947).

[4] Broom, R., and Robinson, J. T., *Nature*, **160**, 153 (1947).

[5] Broom, R., and Robinson, J. T., *Nature*, **160**, 430 (1947).

[6] Hopwood, A. T., *J. Linn. Soc.*, **38**, 437 (1933).

[7] Leakey, L. S. B., *Nature*, **152**, 319 (1943).

[8] McInnes, D. G., *J. East Africa and Uganda Nat. Hist. Soc.*, **17** (1943).

[9] Le Gros Clark, W. E., *Nature*, **160**, 891 (1947).

BRITAIN'S FUEL PROBLEMS

THE authoritative reports issued periodically by P.E.P. (Political and Economic Planning)—an independent non-party organisation—have established for the compilers a reputation for clearly argued, factual and objective analyses to which industry and politicians alike may turn for guidance. Before the War, P.E.P. had issued reports dealing with the coal industry (1936), the electricity supply industry (1936) and the gas industry (1939) of Britain; all are now out of print. But for the War, a fourth report, on the co-ordination of the fuel and power industries, would have followed in natural sequence; and the need for such co-ordination became one of the principal reasons for the formation of the Ministry of Fuel and Power in 1942. "The British Fuel and Power Industries", published at the end of 1947*, reviews developments which have taken place since the earlier reports were issued. It does not argue the advantages or disadvantages of nationalization, and was prepared on the assumption that before long the major fuel industries would, in fact, be brought under national ownership. One aim was to indicate some of the steps necessary to bring these industries to a state of the fullest efficiency, and to suggest broad lines along which their co-ordination might be achieved.

The report invites use as a reference rather than as a book to be read; but an immediate clear summary of some fifty pages outlines the contents in bold précis. As most readers will make an approach from this summary, it might have been helpful had cross-reference been made in it to the 160 tables of valuable data which follow in the text. Both the summary and the text are arranged in four main sections; the first dealing with national resources, productive capacity and output; the second with consumption and market requirements (including a technical appendix relating to the iron and steel and textile industries), the third with organisation and relations with Government, and the fourth with co-ordination of the fuel and power industries.

It is estimated that on the basis of net useful therms supplied, coal accounted in 1945 for more than 90 per cent of the total British fuel consumption, imported petroleum products (including motor spirit) for about 9 per cent, and hydro-electric power and oil from indigenous petroleum and shales for well under 1 per cent. Full development of hydro-electric resources, including those in Scotland and North Wales, might provide an equivalent of 3 per cent of present coal output; the potential output of the Severn Barrage is equivalent to 0·5 per cent. Except for the possibilities inherent in the development of atomic energy, no great change in the proportionate consumption stated is anticipated, unless by an increase in imports of petroleum products at the expense of the country's balance of payments; and while there are no grounds for anxiety regarding the adequacy of total supplies or of particular types of coal over the next hundred years, total proved reserves are much less than estimated forty years ago. No mention is made of possible coal reserves revealed by recent prospecting for oil.

The report indicates that the exhaustion of the best low-ash seams, the increased use of mechanical means of coal winning, etc., call for more extensive preparation of coal for the market, and full co-operation between the producer, consumer and appliance manufacturer; a major problem is the disposal of fine coal, and research and development work are necessary. In view of shortage of coal on the home market, exports have been restricted since 1941; it is debatable whether in the long run large quantities of coal, a wasting asset, should be exported, but coal exports at the level prevailing before the War would make a substantial contribution to the national economy.

With the rapid growth of electricity generation, use of waste heat from power stations represents an important potential contribution to fuel conservation; and while there is scope for greater development of combined power and heating plants, the extensive development of district heating to utilize waste heat from existing power stations is considered economically impracticable. The possibility of district heating should, however, be taken into account in deciding the location of new power stations.

In the iron and steel industry, better geographical distribution and further integration are most likely to reduce fuel consumption. Blast furnaces are the most important single fuel-consuming plants, the coal equivalent of the coke consumed therein increasing from 6 per cent of total coal output in 1937 to nearly 8 per cent in 1944; increase in size of blast furnaces is desirable. In the textile industries, space-heating accounts for 70 per cent of the total fuel consumption in cotton weaving and for 40 per cent in worsted spinning; indeed, the seasonal nature of industrial fuel consumption suggests that the use for space-heating is considerable.

It is stated that a sound national fuel policy can be based only on a detailed knowledge of trends in fuel usage, and fuller information is necessary. Much has been obtained by various fuel efficiency committees and Government departments, but little has yet been collated and published; indeed, there is need for a regular audit of the fuel balance of all industrial users. On grounds of thermal efficiency, the large amount of coal used for steam raising is unlikely to be replaced by any form of processed coal or alternative fuels; in furnace firing, the overall efficiency of utilization of coal is low, and gas, liquid fuel or electricity have technical advantages in partic-

* The British Fuel and Power Industries. A Report by P.E.P. Pp. xi+406. (London: P.E.P., 1947.) 30*s*. net.

ular instances. Solid fuel will be compelled to carry the main load for domestic use for many years to come, if only because in this form sufficient stocks can be provided to meet peak loads ; for continuous space-heating of domestic premises, the most efficient appliances are solid-fuel closed or closable fires, and gas fires with convection.

After reviewing technical considerations affecting uses, the report passes to discussion of the possibilities of tariff co-ordination as a means for securing the best use of the national fuel resources of Britain, but without being able to lay down any novel basis. In order that consumers' choice of fuel coincides with national interest regarding resources and smoke abatement, close attention should be paid to the tariff structure of individual fuel supply industries ; subject to certain exceptions to cover promotional tariffs and the uneconomical consumer, tariffs should be closely related to cost of production and supply. Special importance is attached to regulation of coal prices ; relative prices for various grades and qualities must exert strong influence on trend of consumption and rate of development of the gas and electricity industries. The report recognizes the difficulties involved, and proposes tariff commissions for individual industries, guided by a national authority, probably the Ministry of Fuel and Power ; while unrestricted price competition is undesirable, administrative and technological competition has on the whole been of great benefit. There is a serious shortage of fuel technologists and the knowledge of the general public is small.

Even if the report leaves one a little in the air, it is invaluable at the present moment ; it will serve for some time as the most readily available guide. Reference may perhaps be made to the remarkable statement on page 131 : "the earth's internal store of thermal energy is dependent for its maintenance on solar radiation" ; and an omission in discussing possible future trends is reference to the gas turbine, for opinion recently expressed is that the raw coal turbine looks to most engineers a likely practical proposition for industrial service years ahead of atomic energy.

D. T. A. TOWNEND

UNIVERSITY OF PRAGUE SEXCENTENARY CELEBRATIONS

By DR. GERALD DRUCE

THE six hundredth anniversary of the founding of the Charles University of Prague was celebrated during the week commencing April 4. The precise date of its foundation is usually given as April 7, 1348, the day on which Charles, as King of Bohemia, issued his charter setting out the reasons for the institution of a seat of higher learning in the Czech capital. Until 1355, when the Carolinum was ready, tuition had to be given in religious buildings and in private houses that had previously served as Latin schools. The original building, enlarged and renovated, still serves for important University functions and was used for some of this year's ceremonies. For the general gatherings use was made of the large Vladislav Hall of the Hradčany Castle, which is capable of seating several thousands.

The first assembly was mainly for Czechoslovak participants, and included, as well as members of the University, several Cabinet Ministers, prominent ecclesiastics, authors and representatives of the arts and sciences, workers' educational associations and students. The Czechoslovak Premier, Mr. Klement Gottwald, reminded the assembly that during its long history the University had given the world many great men of science and thinkers and that it entered upon its seventh century at a time of considerable social and economic change from which, it is hoped, a better world is being born. In such a world the University will have a still greater mission to fulfil since more scientific men and other scholars than ever before will be needed.

Prof. Bohumil Bydžovský, rector of the University, dealt at length with the University's significance for the nation's cultural and intellectual life. "For us the Carolinum is a symbol of the struggle for truth and for spiritual and ethical perfection and progress." He stressed the contributions of John Hus and of T. G. Masaryk at different stages of its history. Prof. Z. Nejedlý, Minister for Education and president of the Czech Academy, pointed out that the University has always been associated with national aspirations and its influence to-day is as great as ever, and so are the tasks before it.

Messages of congratulation were given by Profs. Seifert and Rysavý respectively, on behalf of the sister University of Brno and the Prague Technical College, and by a representative of the students.

On the actual anniversary, the hall was filled with distinguished people and students when the procession of foreign delegates, the rector, members of the Senate, the deans and professors of the Charles University and of the other Czechoslovak universities entered. The rector escorted President Beneš to his seat, welcoming the visitors in short speeches in four languages, referring again to the University's part in the nation's historical evolution. He mentioned its early contacts with other universities, especially those of Paris and Oxford, expressing gratitude to Oxford in particular for allowing Czech students to complete their studies there when the Czech universities were closed in 1939. He expressed his deep regret that British universities and those of some other countries had not accepted the invitations to participate in this historic ceremony.

In presenting the renewed charter, written on parchment by Prof. J. Benda of the School of Fine Arts, to replace the original that disappeared during the German occupation, President Beneš pointed out how moral and political issues profoundly affected the fate of seats of learning, which could always be found on the side of recognized truth, liberty and morality. It was from the University that so many honorable and wise men arose to lead the nation in both glorious and difficult times ; but the Charles University had never been able to celebrate its centenaries in peace and tranquillity. Its first centenary occurred when King George of Poděbrady was vainly trying to set up the first league of nations. In 1548 the first Czech revolt against the Habsburgs was being heavily suppressed. The Peace of Westphalia in 1648 followed the Thirty Years War that had devastated and depopulated the kingdom, then in bondage with the University in foreign hands. The year 1748 fell between two more wars that were disastrous for the Czech people, apart from the added contemporary dangers of Austrian measures of centralization and Germanization. Finally, the year 1848, which brought the beginnings of constitutionalism to the Slavs, was also one of storms, and not even to-day are the celebrations taking place in tranquil times. Three years after the most terrible war in history there is still no such peace as is longed for so ardently. If this human longing, accompanied by freedom of belief, science, thought and profession, is to be fulfilled, President Beneš said, it is even more necessary to realize a universal freedom of the spirit. This freedom, founded on man's respect for man and on the common tolerance traditionally associated with the Charles University, will lead once more to a happy prosperity and a truly happy future.

The preamble in Czech and the Latin text of the renewed charter were read out by Prof. Nejedlý.

Prof. Jean Sarrailh, rector of the Sorbonne, gave a congratulatory address on behalf of the visitors. He referred to the links between Prague and other universities, and mentioned that the Czech scholar, Albertus Ranconis, came from the Charles University to Paris, where he was rector of the Sorbonne in 1355. Educated at Paris, Charles IV had carried French educational traditions back to Bohemia, where Hus was soon to make a stand for religious freedom and social justice. The successful extension of learning was interrupted by the Habsburgs, who even banned the use of the Czech language; and it was not until 1918 that free cultural activities could be resumed at the Charles University. Since then, Czech culture and civilization has become better known in France and elsewhere through the work of Prof. Ernest Denis, who also enabled Czech pupils to attend high schools at Nîmes and Dijon, where Eduard Beneš studied. The development of Czech culture was again interrupted by the German occupation in 1939; but no force can for ever prevail over the spirit, and the University is again happily in Czech hands. Prof. Sarrailh concluded, "Ainsi, comme au Moyen-Age, votre Université remplira son rôle international. Fidèle au grand rêve de Georges de Poděbrady, le plus populaire de vos rois, elle travaillera à l'avènement de la paix universelle et restera le temple de science et de progrès humain qu'avait voulu faire d'elle son fondateur".

A students' representative, M. Grohmann, spoke *extempore* in four languages, before the delegates of foreign universities presented illuminated scrolls to the rector.

On the following day, honorary doctorates were conferred at the Carolinum on about forty distinguished savants representing all branches of learning, including science and medicine. The theological faculty awarded a degree to Cardinal Mercatti, archivist at the Vatican; the medical faculty gave degrees to Prof. R. Leriche of the Collège de France, Prof. L. A. Orbelli of Leningrad and Prof. P. D. White of Harvard. The awards of the philosophical faculty went mainly to specialists in Slavonic subjects, such as Prof. André Mazon of Paris and Prof. Ali A. Siassi, rector of Teheran University. The natural science degrees were conferred upon Prof. P. E. Eskola of Helsinki, Prof. B. Isačenko of Moscow, Prof. S. J. Jakovljevič of Belgrade, Prof. L. Růžička of Zurich, Prof. W. Sierpinski of Warsaw and Prof. S. I. Vavilov of Moscow. The only Czechoslovak recipient was the Minister of Education, Prof. Z. Nejedlý, who recalled how he had graduated in the same hall forty-eight years earlier. A number of the degrees were conferred *in absentia*, and Prof. Nesmeyanov, rector of the University of Moscow and well known for his researches on organo-metallic compounds, in accepting them for his absent Russian colleagues, replied for the recipients.

The formal ceremonies of the sexcentenary celebrations terminated on April 9 at the Vladislav Hall. The six deans of the University gave brief accounts of the history and work of their respective faculties, and Prof. Bydžovský concluded by thanking those whose work and presence had made the occasion such a success. It had been a landmark in the history of the University and of Czechoslovak learning, and had served to strengthen the bonds of friendship between men of science and culture throughout the world.

At the Clementinum and in the Industrial Art Museum there were exhibitions of books, historic documents, *incunabulæ*, paintings and other objects that are rarely available for the public to see. These included various fourteenth century Bulls and decrees relating to the University, the original Kutná Hora decree dated 1409 of Wenceslas IV, a letter from the rector in 1414 protesting against the burning of books, fourteenth-century registers of students, the matriculation lists for 1372–73 and a manuscript written by Hus as rector in 1401–2.

The "Letter of Majesty" extracted from Rudolf II in 1609 which conferred greater liberty on the University was on view, and showed the scissor cuts of Ferdinand II, who revoked it in 1620. There were many early scientific tracts, diplomas, and early printed books. Most of the portraits were of early scholars and naturalists such as Mikan, Bohadsch, Procházka, Marcus Marci, Bolzano, Krombholz, the Presls, Dobrovksý and Šafařík. Tycho Brahe's portrait, sextant and "Tabulæ sinuum" were among the other interesting objects on view. The books included the earliest Czech works in science and mathematics, the 1879 edition of Goll's "Development of the English Parliament", which is said to have greatly influenced T. G. Masaryk, and Beneš's 1909 dissertation for his degree ("Developments of Political Individualism in the History of Modern Philosophy"). Among the historical works was the manuscript of Bohuslav Balbin, that waited a century before it was printed as "Bohemia Docta" in 1780. Another curiosity was the 1793 bilingual announcement of Pelcl's lectures (the first to be given in Czech since 1620).

The informal arrangements that followed the official proceedings included excursions to Lány (to see the simple but impressive tomb of President Masaryk and his son, Dr. Jan Masaryk), Lidice, Karlštein (the castle built by Charles IV as a retreat from the cares of State and for the custody of the crown jewels), Kutná Hora and Hradec Králové. It was at Kutná Hora, a medieval mining town and royal seat, in 1409 that Charles's son, Wenceslas IV, signed the famous decree expressly laying down the Czech character of the Charles University. Receptions in connexion with the celebrations were given by the Rector of the Charles University, the Lord Mayor of Prague and by the Minister of Foreign Affairs, Mr. V. Clementis. Mr. Clementis received no less than nine hundred guests in the large reception halls of the Czernin Palace that serves for the Foreign Ministry to-day. A special performance of Smetana's opera "The Bartered Bride" was given at the National Theatre, and the students also arranged some festivities, one anachronistic tableau representing Charles IV riding on a motor-cycle. Unfortunately the strain of the celebrations told upon the sixty-eight years old rector, Prof. Bydžovský, who was taken to hospital two days after the ceremonies ended.

OBITUARIES

Sir Franklin Sibly, K.B.E.

The life of the late Sir Franklin Sibly was notable as the triumph of a brilliant mind over physical frailty. After an almost precocious career as a student (he obtained the degree of D.Sc. at the age of twenty-five), he became a teacher and worker in geology. He seemed set for the life of an active academic geologist, and the work he accomplished in the ten years of this phase placed him in the front rank. But in 1920 his appointment as principal of University College, Swansea, brought out his latent genius for administration, and during the last twenty-six years of his active life he became successively vice-chancellor of the University of Wales, principal of the University of London and vice-chancellor of the University of Reading. Such responsibilities might well have filled a normal life, especially since their holder was by no means physically robust; but from 1929 until 1946 he held, often concurrently, a series of administrative positions to which he brought qualities of sagacity and geniality beyond the ordinary.

There is no room in this brief account for even a bare enumeration of Sir Franklin's manifold activities; but a few aspects of his achievements may be selected to show something of his qualities. His published geological work is concerned chiefly with the Carboniferous rocks of the Mendip and Forest of Dean districts. After nearly thirty years, his papers still stand as fundamental clarifications of these complex areas—they are by way of becoming classics.

As first principal of University College, Swansea, he achieved a vast amount of constructive administrative work that gave a firm foundation for future developments. As second vice-chancellor of the University of Reading he had further opportunities for building tradition. It was in the last-named office that he spent the longest single period of his life (1929–46), and his colleagues rejoice to realize that the wisdom and friendliness that they found in him were reciprocated in his happiness among them.

In the wider academic sphere, Sir Franklin was chairman of the Executive Committee of the Universities Bureau of the British Empire from 1929 until 1934. Later (1938–43) he held a similar position in the Committee of Vice-Chancellors and Principals, and during the difficult war years exercised a guiding influence on the policy of all British universities.

As a member of the Advisory Council of the Department of Scientific and Industrial Research (for a cumulative period of ten years) he was largely instrumental in devising the conditions of award of the Department's scholarships—now widely recognized as a model for all such schemes. For thirteen years he happily combined both phases of his genius as chairman of the Geological Survey Board.

The honorary degree of LL.D. was conferred on him by the Universities of Bristol, Wales and Liverpool. He was knighted in 1938 and received the K.B.E. in 1943.

In spite of his notable services to British science and also his administrative skill, the abiding memory for those who knew him is one of friendship. His good humour and understanding sympathy were never lacking, even when failing health might have excused their lapse. He improved on the recommendation to be all things to all men by being consistently himself to all; everyone who worked with him or for him knew him for a friend.

H. L. Hawkins

Mr. G. S. W. Marlow

George Stanley Withers Marlow, whose death occurred on March 5, was born in 1889, and educated at New College Choir School, Oxford, and King's College, University of London. He graduated B.Sc. in 1909, and the next year obtained his associateship of the Institute of Chemistry, taking as his special subject, food and drugs. The F.I.C. (now F.R.I.C.) followed in 1913. For a couple of years after graduating, he was assistant to Mr. E. Hinks, public analyst for the County of Surrey. In 1911, he joined the staff of the Government Chemist, where he remained until 1919, when he became assistant secretary of the Institute of Chemistry. After six years there, he left to become personal assistant to Mr. W. J. U. Woolcock, general manager of the Association of British Chemical Manufacturers. Meanwhile, in 1923, he had been called to the Bar, and decided to practise in 1927. He was a member of Gray's Inn, and pupil to the late Mr. W. Trevor Watson, K.C. He acted in such cases of chemical patents as arose, his first being the application of Boots Cash Chemists, Ltd., to revoke Sharp and Dohme in the matter of hexyl resorcinol.

In 1926, however, an event happened in Marlow's life which was to transform its pattern to a considerable extent and provide him with a task after his own heart. This was the suggestion by the Council of the Faraday Society that he should succeed the late Mr. F. S. Spiers as general secretary, and take over the management of its affairs, including the editorship of the *Transactions*. Marlow accepted, and in so doing initiated a tenure of some twenty-two years, during which the Society has advanced from strength to strength, largely due to his unflagging efforts, wisdom and guidance. Marlow lived for the Faraday Society, and his devotion to it knew no bounds.

The General Discussions, which have always been the Society's major activity, were a feature before Marlow took charge; but he managed to give them further weight and authority, at the same time enhancing their hospitable and social character. For more than a couple of decades, he always had at least one Discussion ahead, before he was clear of the one behind, and lived, scheming and planning, to make each one an individual success. He would journey to universities all over the country in search of appropriate places at which to meet, and no vice-chancellor or principal was safe from his clutches in his efforts to obtain accommodation and comfortable surroundings for the participants. On these occasions, the guest-night dinners were distinguished, the secretary radiating good-fellowship throughout the evening. During one of these General Discussions, Prof. P. Debye wished to give an impromptu demonstration of the properties of a dipole. Marlow, as to the manner born, quietly handed him a cigar for the purpose. Foreign guests were his special concern; nobody was permitted to worry for a moment on account of lost luggage, money, passports, or even relations. The secretary produced them all, safe and sound, with that engaging smile of his, as if nothing had happened.

So the years went on; the *Transactions* increased in bulk, and—during the War—no less an anxiety for Marlow, who remained editor until 1946. But above all, they increased in quality until to-day they stand unrivalled in their own field. Marlow worked his referees hard, and they responded.

By nature, Marlow was ever ready to do people or causes a good turn, and this led to his being much in request just perhaps upon the periphery of his normal avocations. He served the Royal Institution as secretary of the Visitors' Committee, and was a manager at the time of his death. His magnanimous but firm reaction to the abortive proposal of that body to revise its by-laws somewhat drastically was characteristic. He was prepared for change, where change was necessary, but not for ruthless pruning of those noble, rounded phrases of which we shall never see the like again. He delighted in them, and all for which they stood.

In recent years, Marlow took much interest in the Society for Visiting Scientists, and would often be found at its headquarters, lending a friendly hand with whatever was afoot. But in all this, the Faraday Society was Marlow, and Marlow was the Faraday Society; wholly impossible was it to think of one without the other. And that, alas, is what in practice we are obliged to do now. Nobody is irreplaceable, but Marlow's life-line had been approaching the asymptote of indispensability for a number of years, and with its end the margin of contact is seen to be exceptionally narrow.

ERIC K. RIDEAL
F. I. G. RAWLINS

Prof. Selig Hecht

THE death of Prof. Selig Hecht in New York on September 18, 1947, at the age of fifty-five, deprives the physiology of vision of one of its most outstanding workers. Hecht was born in Austria and was brought to the United States as a child. He studied and worked in the United States, in England, Germany and Italy. After a broad biological training, he devoted his life to the study of the mechanisms of vision, considered as a branch of general physiology. He became professor of biophysics at Columbia University and made his laboratory an international centre of visual research.

Hecht's main work was concerned with the investigation of the many visual functions in man, such as dark-adaptation, intensity discrimination, acuity and colour vision. He had begun, however, by studying the reaction to light of simple organisms, such as the clam *Mya arenaria*, and he carried out some remarkable experiments on the vision of insects. He also worked on the photochemistry of visual purple. All these researches were inter-connected comparative studies trying to reach the principles of visual response. Hecht's method was quantitative and his experimental standards exacting. The introduction to his lucidly written papers was often a concise but critical synthesis of a mass of literature on the subject, including the early classical work, of which he had an exhaustive knowledge. His aim, he said, was not to add to, but rather to subtract from, the literature on vision.

The leading idea of Hecht's research was that the very first reactions which take place between light and the photo-receptors are bound to determine to a large extent the characteristics of the visual response. He, therefore concentrated his attention on these reactions, because they were easier to study than more central processes, especially those in the brain. One result of his work was to establish beyond doubt the duplex nature of the mechanisms of the human retina, corresponding to the division of its photoreceptors into rods and cones. He clarified the relation between the rod visibility curve and the absorption of visual purple, and he devoted much attention to the photo-chemistry and kinetics of the reactions initiated by light in the receptors, introducing the notion of the 'stationary state' of excitation.

Just before the War, Hecht took up with characteristic thoroughness the problem of the minimum energy necessary for vision. He found that a man can see a source of light which delivers to his retina only six quanta or so, absorbed by the visual purple of the rods. Stimuli consisting of such small quantities of light have unique properties; for example, they undergo from one trial to the next uncontrollable variations, which are related to the uncertainty of seeing observed in the measurements.

Hecht worked strenuously on visual research for the American Forces during the War. As he was preparing to return to the study of quantum problems, he died suddenly of a coronary thrombosis.

A painter and a man of discriminating taste, Hecht had many interests. A well-done piece of scientific work would fill him with delight. It was both as a scientific man and as an artist that, for example, he admired Schultze's pioneer work and his drawings of the retina. He was a brilliant lecturer and expositor —he wrote a book entitled "Explaining the Atom". The lack of synthesis discernible in present-day knowledge and teaching perturbed him, and he took an active interest in all the human implications of science. He dealt with persons and ideas on the basis of their intrinsic worth and was always ready to give genuine help, so that he won the affection of all those working with him. Selig Hecht will be mourned by many friends and colleagues throughout the world, and his death is a great loss to science.

M. H. PIRENNE

Prof. M. C. Potter

PROF. N. S. ALEXANDER, Physics Department, Raffles College, Singapore, writes: An interesting link with Victorian science ends with the death at the age of nearly ninety of Prof. M. C. Potter [see *Nature*, April 17, p. 590]. Some time ago, Prof. Potter presented me with a copy of "A Treatise on Hydrostatics and Hydrodynamics" written by his uncle, Dr. Richard Potter, formerly professor of natural philosophy in University College, London. Part 2 of this work was completed in 1880, the author being then eighty-one years of age, and was published by M. C. Potter in 1887. These two lives between them span nearly 150 years.

Richard Potter's book takes one back into the 'caloric' controversy, and his views are sufficiently shown by the following quotations: (*a*) referring among others to Rumford's experiments, "The whole three cases are mills for grinding atmospheric air under pressure with the production of heat from its condensation"; (*b*) "In Mr. Joule's experiments which were performed in air, the effect rising from its presence is entirely neglected, and the phenomena of heat being attributed to the mechanical force applied alone . . . the conclusions drawn from them are erroneous"; (*c*) "c/c' (the ratio of the principal specific heats of a gas) $= 1$ nearly for small values of δ (the condensation), and the *instantaneous* change in specific heat of a gas is insensible for small rarefactions and condensations. After some time which has not yet been ascertained, the change in capacity for caloric is completed, and the temperature has changed considerably."

Prof. M. C. Potter had clearly been influenced by these views, and up to the time of his death was endeavouring to show that the usual statement of the First Law of Thermodynamics is incomplete. He had obtained some quite interesting results on electrical effects accompanying various chemical and mechanical changes, and believed that the neglect of these effects constituted a fatal objection to the experimental basis of the First Law. He frequently used to remark, "Joule will have to go". Perhaps it would not be too much to refer to Dr. Potter as the last of the calorists.

We regret to announce the following deaths:

Prof. S. C. Brooks, professor of zoology in the University of California, Berkeley, known for his work on the biological effects of radiations and the permeability of cells, on April 25, aged fifty-nine.

Dr. H. W. Richmond, F.R.S., president during 1920–22 of the London Mathematical Society, on April 22, aged eighty-four.

NEWS and VIEWS

Archæology in the University of London: Dr. R. E. Mortimer Wheeler

Archæologists will be pleased to learn that Dr. R. E. Mortimer Wheeler has accepted a chair in the University of London. He shares with Sir Cyril Fox the distinction of being one of the most stimulating of archæological exponents in Great Britain. Dr. Wheeler has had a distinguished career both in archæology and in the army. For a time he was director of the National Museum of Wales, and then he became head of the London Museum. It was during this London Museum period that Mrs. Wheeler died; to her splendid personality and experienced help he owed much both personally and archæologically; as, for example, when he set about the founding of the Archæological Institute, which is housed in Regent's Park. A member of the Territorial Army, the War sent him to Africa with the 8th Army and Italy with the 5th, where he ended up as one of the small band of non-professional soldiers who achieved the rank of brigadier. Recently, he has been director-general of archæology in India. He has been president of innumerable archæological bodies and has served on the Royal Commission on Historical Monuments. Dr. Wheeler has undertaken not a few archæological excavations, the most important, perhaps, having been that at Maiden Castle, and has published extensively on various subjects. His book "Prehistoric and Roman Wales" is a standard work on early times in that country. He has also written on the ancient sites at Lydney and Verulamium. His influence will greatly strengthen the growing school of archæology in the University of London, and we may look forward to many interesting results from excavations undertaken by him.

Institution of Metallurgists: Dr. A. D. Merriman

Dr. Arthur D. Merriman has been appointed to the full-time post of registrar-secretary of the Institution of Metallurgists. Dr. Merriman's initial training was in physics, mathematics and chemistry, and he has had some twenty years experience in academic fields, including the post of principal of the County Technical School, Wallsend-on-Tyne, 1926–38. During the early part of the Second World War, he served with the Directorate of Scientific Research, Ministry of Supply, and was the senior member of a group of scientific men and engineers dealing with bomb disposal problems; for his personal courage in emergency situations he was awarded the George Cross. From 1941 until 1944 he was scientific adviser to the Commander-in-Chief, Middle East, and in 1944 was appointed to a special intelligence assignment in the U.S.S.R., followed by similar work in north-west Europe and Germany. Since then he has been a principal scientific officer (technical intelligence) at the Armaments Design Department, Ministry of Supply. Dr. Merriman succeeds Dr. Harold Moore, the Institution's first president, who has been serving as registrar, and Mr. K. Headlam-Morley, secretary of the Iron and Steel Institute, who has acted as secretary of the Institution. Office accommodation will continue to be provided for the Institution at 4 Grosvenor Gardens, London, S.W.1.

British Council Science Department: Mr. E. Bolton King

Mr. E. Bolton King, formerly managing director of the Oxford Instrument Co. and during the War a member of the Ministry of Supply Rocket Team, has been appointed director of the Science Department of the British Council. Educated at Warwick School and Balliol College, Oxford, where he was a mathematical exhibitioner, he obtained first-class honours in Physics Finals. He was elected to a research studentship at Christ Church, Oxford, and carried out research at the Clarendon Laboratory, largely on photo-electricity. Later he formed the Oxford Instrument Co. Early in the War he joined the Ministry of Supply Rocket Team under Sir Alwyn Crow and was engaged on rocket development, with special emphasis on proximity fuses, investigation of the performance of British and enemy rocket weapons in the Mediterranean theatre and liaison with rocket development in the United States, where he was an assistant director of the British Commonwealth Scientific Office. At the end of the War he went to Germany in connexion with the British firings of the V-2 rocket and became superintendent of the Ministry of Supply Establishment, Cuxhaven; since then he has been in the Directorate of Guided Weapons of the Ministry of Supply.

Exhibition of the Development of Lighting

A special exhibition, "Darkness into Daylight", was opened at the Science Museum, London, on April 29 to illustrate the development of lighting from the earliest times to the present day. A historical section, in which the Victoria and Albert Museum has co-operated, shows vividly by means of examples and dioramas the growth of lighting until the lamps of Swan in 1878 and Edison in 1879 marked the beginning of an era of intensive research culminating in modern discharge lamps. Among these, the xenon arc, which has so far been confined to laboratory demonstrations, is exhibited, together with micro-second flash tubes and compact source lamps. The history of fluorescence is covered by an attractive series of demonstrations, and its applications, including that of mine lighting, are also shown. Applications of lighting to the theatre, television, roads and medical uses include many interesting demonstrations, while good lighting in the home is shown by a full-scale sequence exhibit called the "Room of To-morrow". The Exhibition will remain open until the end of September.

Davy Faraday Exhibition in Paris

An exhibition devoted to the life and work of Davy and Faraday has been arranged at the Palais de la Découverte in Paris (which operates in association with the University of Paris) with the close collaboration and support of the Royal Institution, the Institution of Electrical Engineers, and the Science Museum, and will remain open until July. The managers of the Royal Institution have lent a number of the relics of Michael Faraday from their collection, as, for example, some of the original apparatus used by him in his experiments and pieces of his laboratory and office equipment. The Council of the Institution of Electrical Engineers has lent a number of Faraday manuscripts and letters and the full-sized reproduction of the statue of Faraday, the original of which stands on the main staircase in the Royal Institution, which dominated the Faraday Centenary Exhibition at the Albert Hall, London, in 1931. The General Post Office has provided an ingenious working section of an automatic telephone exchange, recently shown at Radiolympia. With the collaboration of the British Council, arrangements have been made for a number of lectures to be delivered at the Exhibition by British men of science and engineers on the life and work of Davy and Faraday.

British Institute of Management

Presiding at the first meeting of the British Institute of Management on April 21, Sir Charles Renold, chairman of the Institute, said that the Institute would need the goodwill, active interest and co-operation of all who exercised the major responsibilities of management. Management, he emphasized, is not concerned with party politics or with theories of ownership, and it is with the principles which apply to all industries and with the problems arising in their application that the Institute is concerned. A national drive for better management would be developed along three main lines: by the compilation of knowledge about management; by promoting education and training facilities; and by the dissemination of knowledge about management. Speaking of the necessary research, Sir Charles hopes that the Institute will have the co-operation of the universities and other bodies, including the trade unions, and he pointed out that there is little or no guiding experience in Great Britain for some of the problems of management presented by the vast scale of some of the nationalized industries. The Institute has already initiated discussions with university authorities on the preparation at the university-level of men for management, and is also studying training for foremen and supervisors. Sir Stafford Cripps, who, as well as Sir Frederick Bain and Miss Florence Hancock, chairman of the Trades Union Congress, also spoke, emphasized the importance of the Institute being wholly free from Government interference and from concern with party politics. While providing a grant-in-aid, the Government is in no way attempting to control expenditure within the broad purposes agreed. The failure of so many production units to attain the high standards of efficiency set by the most skilled and enlightened managements is a cause of many of the present economic difficulties of Britain; but in spite of the great importance of the technical side, the first and overriding requirement is the creation of an atmosphere of trust. Only in that atmosphere can we secure the co-operation of those working in the factories in the difficult adjustments which the new techniques of production often involve.

British Association: Brighton Meeting

The British Association has now issued a preliminary programme of the annual meeting to be held in Brighton during September 8–15, with Sir Henry Tizard as president. At Dundee last year 3,300 people attended the first of the annual meetings to be held after the outbreak of war in 1939, and the theme of the meeting was the conversion of science from the destructive uses of war to the constructive uses of peace. The programme for the Brighton meeting is again topical and of wide general interest. Among the topics to be discussed are: achievements of X-ray analysis; newer metals and alloys in industry; geology to-day and to-morrow; biology in schools; Colonial development; movements of population in the Commonwealth; the metric system; building materials; human blood groups; colour vision; changing aspects of nutrition; selection of university students; problems of old age; aspects of world education; administrator and teacher; maintenance of world food supply; forestry and the community. The programme can be obtained from the Secretary of the Association, Burlington House, Piccadilly, London, W.1.

The presidents of the various sections are as follow: (A) *Mathematics and Physics:* Sir Lawrence Bragg; (B) *Chemistry:* Prof. John Read; (C) *Geology:* Dr. A. E. Trueman; (D) *Zoology:* Prof. H. Graham Cannon; (E) *Geography:* Lord Rennell of Rodd; (F) *Economics:* Sir Hubert Henderson; (G) *Engineering:* Prof. T. R. Cave-Browne-Cave; (H) *Anthropology and Archæology:* Mr. R. U. Sayce; (I) *Physiology:* Prof. H. Hartridge; (J) *Psychology:* Prof. A. Rex Knight; (K) *Botany:* Prof. J. R. Matthews; (L) *Education:* Mr. O. Lester Smith; (M) *Agriculture:* Dr. G. Scott Robertson; *Conference of Delegates of Corresponding Societies:* Prof. H. J. Fleure.

Colonial Microbiological Research Institute, Trinidad

Acting on a recommendation of Sir Robert Robinson and Prof. J. L. Simonsen, who paid a visit to the Caribbean in 1944, the Colonial Products Research Council decided to erect in Port of Spain, Trinidad, a Colonial Microbiological Research Institute. This Institute, of which Dr. A. C. Thaysen, formerly of the Chemical Research Laboratory, Teddington, is the director, will be opened officially on July 5 by Lord Hankey, chairman of the Colonial Products Research Council. Invitations to attend the opening have been sent to Canada, the United States, the Caribbean Commission, and to a number of South American Republics. The opening will be followed on the Tuesday and Wednesday by scientific meetings.

Anti-Pernicious Anæmia Factor

Twenty-two years ago, Minot and Murphy postulated the presence in liver of a factor effective against pernicious anæmia, and many attempts at its isolation have been made. The long quest now seems to be nearing its end with the independent appearance within a week of two papers, from the United States and Britain, announcing the isolation of red substances having extremely high potency. The American workers (E. L. Rickes, N. G. Brink, F. R. Koniuszy, T. R. Wood and K. Folkers, *Science*, **107**, 396; 1948) describe crystalline material effective in a single dose of some 15 µgm., that is, with roughly two thousand times the hæmatopoietic potency of folic acid. Dr. Lester Smith (*Nature*, **161**, 638; April 24, 1948) does not appear to have taken the purification so far but has separated two different red pigments, both clinically active. These may turn out to be peptide conjugates of this crystalline substance. He gives more information about the properties of his materials than do the Americans, including a value of approximately 3,000 for the molecular weight. The Americans were assisted in their fractionation by a microbiological assay method using *L. lactis* Dorner. The British work depended on clinical assays, of which more than eighty were carried out, and on the red colour. It also established the important fact that the highly purified red material, unlike folic acid, is effective against subacute combined degeneration of the spinal cord. The crystalline substance, for which the Americans suggest the rather unsatisfactory name 'vitamin B_{12}', is remarkably potent, being effective at a daily dose of about 1 µgm. only. A rough calculation indicates that it would require at least twenty tons of liver to yield 1 gm. of crystals. This is in itself sufficient explanation of the fact that these advances have come not from academic institutions but from two industrial laboratories, namely, those of Merck and Co., Inc., Rahway, New Jersey, and Glaxo Laboratories, Ltd., Greenford, Middlesex.

Plant Pathology at the Rothamsted Experimental Station

A useful report by F. C. Bawden from the Department of Plant Pathology and Section of Biochemistry (Rothamsted Experimental Station, Harpenden, 1947. 1*s*. net) covering the years 1939–45 provides an informative summary of certain aspects of research in mycology, plant virus diseases and related biochemical problems. Before 1939, virus research in this Department dealt with insect vectors, the cytology of infected plants, purification of the virus, and the chemical, physical and serological properties of viruses. This work has been continued; but, in addition, much field work on factors affecting the rate of spread of virus diseases in potato and sugar beet has been undertaken. Mycological work has been concentrated largely on the study of soil-borne fungi, the control of which constitutes a major challenge to plant pathology. *Ophiobolus graminis*, *Fusarium* spp., *Plasmodiophora brassicæ*, *Cercosporella herpotrichoides* and *Helicobasidium purpureum* are the disease-producing fungi which have received most attention. The Section of Biochemistry was established in 1940, under the direction of N. W. Pirie. It was originally an offshoot of the Plant Pathology Department, but has now become separate as the work has extended. Work on purification of virus extracts raised some problems with plant enzymes and other systems, which now form an important theme of work in the Section. Most of the published work of the Department and Section has been reviewed in these columns from time to time; the collected accounts in this report will be of value to teachers, advisory officers and others who require a summary of published literature, with an overall digest of its significance.

Pregnancy Test using the Male Toad

Mainini has described (*Semana Medica*, **64**, 337, March 1947) a pregnancy test in which, following injection of pregnancy urine into the male toad (*Bufo arenarum* Hensel), liberation of spermatozoa into the urinary bladder occurs within three hours; the same animal can be used again after five days. Drs. Octavio Rodrigues Lima and Oswaldo Gelli Pereira, of the Obstetrical Clinic, Medical School of Rio de Janeiro, University of Brazil, state in a communication submitted to the Editors that they have confirmed this work, using as test animal the male toad (*Bufo marinus*), as the species used by Mainini was not available to them. Using standard chorionic gonadotrophin (supplied by Organon), they have found that 20 I.U. produced a positive reaction in all of eight animals within an hour. Doses above this level invariably produced a positive reaction within an hour, even if the animals were kept at a low temperature in a state of torpidity (9° C.). Doses below 20 I.U. did not produce positive results within three hours (twenty animals). Œstrone, progesterone, water and saline gave no positive results. Sixty tests were carried out with the urine of amenorrhœic women. Positive results were found between half an hour and two hours, and were confirmed clinically in all cases. The test appears to be simple, economical and reliable.

High-Vacuum Equipment

A booklet issued recently by Messrs. W. Edwards and Co. (London), Ltd., Kangley Bridge Road, London, S.E.26, specialists in the manufacture and provision of high-vacuum equipment since their formation twenty-five years ago, describes briefly the range of products now available. High-vacuum processes are no longer of interest solely to the specialist, for in recent years there has been an astonishing growth in laboratory and industrial applications of high-vacuum technique; hence, in addition to a wide range of the essential components of any vacuum system (rotary backing pumps, diffusion pumps, vacuum measuring instruments, and accessories), complete vacuum plants, combined mobile units, and vacuum pipe-line units, suitable for schools, laboratories or works, are now available. Special vacuum plants listed include: vacuum coating equipment, for depositing thin films of precious and other metals, alloys and non-metallic materials on metallic and non-metallic bases by the evaporation or cathodic sputtering techniques; electron diffraction equipment, suitable for the investigation of surface structure; vacuum sublimation and centrifugal freeze-drying equipment, designed specially for the production of ampoule quantities of dried pharmaceutical and biological materials. Developed in conjunction with Dr. R. I. N. Greaves, this freeze-drying plant utilizes his special technique, consisting of centrifuging *in vacuo* the material to be dried, whereby rapid freezing and sublimation results without frothing, a process which Dr. Greaves successfully employed for his work on blood plasma drying during the War and which has already been described in these columns (*Nature*, 153, 485; 1945).

World Magnetic Data

WITH reference to the article "The Earth's Surface Magnetic Field and its Secular Change" by Prof. S. Chapman in *Nature* of January 31, Commander Elliott B. Roberts, chief of the Division of Geomagnetism and Seismology, U.S. Coast and Geodetic Survey, Department of Commerce, Washington 25, writes: "The Department of Terrestrial Magnetism of the Carnegie Institution of Washington adopted a change of policy after the accomplishment of the monumental magnetic study culminating in the isomagnetic chart series for 1945.0 and publication 578. Routine work in magnetic surveying and compilation of isomagnetic charts will no longer be performed by the Department, which will henceforth restrict itself to experimental and theoretical scientific researches. The Coast and Geodetic Survey has assumed the function, in addition to its normal work of magnetic field surveys in the United States, of collecting all available magnetic field and observatory data from world-wide sources. It is intended to maintain a national reference library of such data for future American use in connexion with the compilation of world isomagnetic charts. The Bureau will continue to compile United States charts on its own account, and, by arrangement with the Hydrographic Office, United States Navy, will henceforth compile world isomagnetic charts, in editions successive to the 1945.0 series. The Bureau solicits magnetic data and copies of isomagnetic charts from all world-wide sources and will undertake in exchange to furnish any required data of American origin."

The Museum in Education

THE Bulletin of the Cleveland Museum of Natural History (*The Explorer*, No. 93, Winter, 1948) contains interesting information about the way in which the Museum's exhibits are put to effective use as part of a general educational campaign. A caravan has been converted into a travelling museum and fitted out with exhibitions to suit the season of the year and the various types of audiences. The "Traveling Trailside Museum" is towed out to schools, hospitals and other organisations, where the contents are exhibited and usually explained in a supporting talk by one of the Museum staff. This travelling museum is greatly in demand and is performing an educational function which brings great credit to its sponsors. Another feature of the educational work of this Museum are the weekly walks led by one of the staff and which are well attended by members of the public. The walks are supported by exhibitions at the Museum depicting local natural history at the time of the walks.

International Council of Scientific Unions

THE report of the Executive Committee of the International Council of Scientific Unions, July 1947 (London: Cambridge Univ. Press. Pp. viii+79), affords the usual handy reference to the activities and personnel of the Unions, the present report including, moreover, the statutes of the newly formed International Unions of Crystallography, of Geodesy and Geophysics, of Biological Sciences, of Theoretical and Applied Mechanics, and of History of the Sciences, as well as the revised statutes of the International Union of Geodesy and Geophysics. The most important feature of the year was the conclusion of a definitive agreement with the United Nations Educational, Scientific and Cultural Organisation. The text of this agreement is appended to the report, which also includes details of grants made by the Organisation for the year 1947. The Organisation has undertaken to give attention to the reorganisation of a scientific inquiry into the causes of international tension and the methods of overcoming them, and to take positive action to forward international scientific organisation for research and the development of free exchange of scientific information.

Conference on Modern Applications of Liquid Fuels

THE Institute of Petroleum and the Institute of Fuel are to hold a joint conference on "Modern Applications of Liquid Fuels" in the University of Birmingham during September 21–23, together with an exhibition of items related to the subjects on the programme. The general scope of the Conference will be indicated in an opening address on "The Place of Liquid Fuel in the British Economy". Separate sessions, each of 2½ hours, will then be devoted to the following subjects: Diesel engines for power generation and railway traction; oil for gas making; gas turbines for land and marine power purposes; agricultural drying processes; and fuel oil in the steel, metal, glass and ceramic industries; there will also be an evening lecture on domestic heating. The fifteen authoritative papers, to be presented at the Conference in summary form, will be printed in full and issued, bound in one volume, one month before the Conference. Inquiries in connexion with the Conference should be sent to the Secretary, Institute of Fuel, 18 Devonshire Street, London, W.1.

Biography of the late Sir James Jeans

PROF. E. A. MILNE, F.R.S., 19 Northmoor Road, Oxford, states that he is engaged upon a biography of the late Sir James Jeans, to be published by the Cambridge University Press. If any readers of *Nature* have in their possession letters or papers of particular interest written by Sir James Jeans, Prof. Milne would be grateful for their loan.

The Night Sky in May

NEW moon occurs on May 9d. 02h. 30m., U.T., and full moon on May 23d. 00h. 37m. The following conjunctions with the moon take place: May 10d. 03h., Mercury 0·06° S.; May 12d. 10h., Venus 0·1° S.; May 15d. 08h., Saturn 4° S.; May 16d. 05h., Mars 4° S.; May 24d. 23h., Jupiter 4° N. In the early part of the month, Mercury is too close to the sun to be seen, but it sets at 21h. 25m. on May 15 and at 22h. on May 31, nearly two hours after sunset, and can be seen in the western sky. The planet is in greatest easterly elongation on May 29. Venus is conspicuous in the western sky, setting at 23h. 42m., 23h. 31m., and 22h. 40m., on May 1, 15 and 31, respectively, and attains its greatest brilliancy on May 18 when 0·305 of the illuminated disk is visible, its stellar magnitude then being − 4·2. Mars and Saturn are conspicuous in the constellations of Leo and Cancer, respectively, and can be observed during the earlier hours of the night, neither planet setting until after midnight. Jupiter, in the constellation of Sagittarius, rises at 23h. 30m., 22h. 27m. and 21h. 22m. at the beginning, middle and end of the month, respectively. No occultations of stars brighter than magnitude 6 take place during May. An annular eclipse of the sun occurs on May 8–9, invisible at Greenwich.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Magnetic Observations and Thermometry in the Region of Millidegrees Absolute

It is usual to characterize the very low temperatures obtainable by adiabatic demagnetization by

$$T^* = C dH/dM,$$

the temperature which would correspond to the magnetic susceptibility dM/dH if the Curie law

$$M = CH/T$$

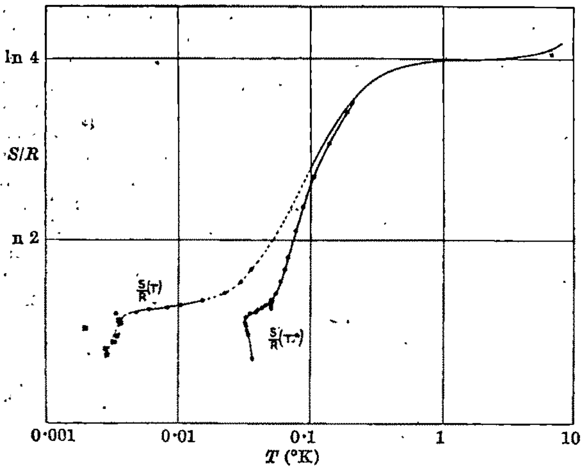
were valid. As, however, the lowest limit of the temperatures obtained is determined by deviations from the Curie law, considerable differences between T^* and the real temperature must be expected there. The lowest value of T^* so far reported is 4·4 millidegrees absolute in a mixed crystal of chromium potassium alum and aluminium potassium alum[1].

Experimenting with a spherical single crystal of chromium potassium alum, we confirmed the observation of Kürti, Lainé and Simon[2] that the susceptibility χ has a maximum below which a feeble magnetic hysteresis occurs. The magnetic behaviour at these temperatures is very similar to that of anhydrous salts like cobalt chloride and bromide and nickel chloride at much higher temperatures[3]. The minimum of T^* corresponding to the maximum of χ was 32 millidegrees. In the accompanying diagram the right-hand curve gives the entropy S as a function of T^* as obtained by adiabatic quasi-static demagnetizations. From a T^* about 60 millidegrees downward, paramagnetic losses have been measured which between 225 and 525 cycles seem to vary slightly more slowly than in proportion to ν^2 (see ref. 4).

The width of the hysteresis loop proved to be a useful thermometer at the lowest temperatures. In the intermediate region the paramagnetic loss mentioned may provide a useful thermometer.

We calibrated T^* and the width of the hysteresis loop against the thermodynamic scale of temperature, following suggestions of Keesom[5], Kürti, Lainé and Simon[6] and Casimir, de Haas and de Klerk[7]. Known small amounts of heat ΔQ were supplied to the sphere by electrically measured paramagnetic losses. The thermodynamic temperature is now given by

$$T = \frac{\Delta Q}{\Delta S}.$$



Entropy of $CrK(SO_4)_2.12H_2O$ as a function of T^* (right-hand curve), and as a function of T (left-hand curve). ●, susceptibility thermometer ; ⊡, remanence thermometer

The results lead to the left-hand curve of the diagram, in which the entropy S is given as a function of T. The maximum of the susceptibility occurs at about 5 millidegrees absolute, while the lowest temperature observed is slightly lower than 3 millidegrees. These temperatures are lower than expected, and they are in disagreement with the calculations as well as with the provisional results of gamma-ray heating by Kürti, published by Hebb and Purcell[8]. Gamma-ray heating seems to us a very uncertain way of supplying heat at the lowest temperatures, as a fraction of the absorbed energy may be stored instead of being transmitted as heat to the spin system.

The highest temperature measured accurately was 22 millidegrees. In plotting the curve for higher temperatures, unpublished measurements of Bleaney, kindly placed at our disposal, were used.

At the lowest temperatures a known quantity of heat could also be supplied to the salt by describing a number of hysteresis loops, the surface of which had been determined by a ballistic method. The results were in reasonable agreement with those obtained by the other method of heating ; they have been omitted in the diagram.

The slope of the $S-\ln T$ curve gives the specific heat. It is seen that there is a marked plateau at $S = 0{\cdot}4 R$ corresponding to a low minimum in the specific heat. It is noteworthy that this plateau lies so much lower than $R \ln 2$.

Details of this work will be published in *Physica*.

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Radiation Damping and Velocity of Light

In a recent communication, Ferretti and Peierls[1] have applied the theory of radiation damping suggested by Peng and me[2,3] to the problem of the propagation of light. By considering the exchange of excitation energy between two like atoms through emission and absorption of light, they came to the conclusion that, according to this theory, light does not travel with the velocity c. The result must seem surprising for the following reasons : (i) The propagation of light is a property of the vacuum and has nothing to do with the approximation in which the interaction with electrons is treated. (ii) The problem has already been treated by Kikuchi[4] on the grounds of the earlier theory of Weisskopf and Wigner[5], which is a special case of the more general theory quoted above. Kikuchi found the correct velocity of light. (iii) The theory of damping consists of nothing but a *systematic* elimination of the infinite parts of quantum-electrodynamics, a procedure which for special problems has been, and had to be, adopted before in nearly all applications of quantum-electrodynamics, including the theory of Weisskopf–Wigner (which does not mean that this crude procedure yields always exact and correct results. It is particularly to be noted that the avoidance of the infra-red catastrophe rests on the low-energy end of the neglected diverging integrals[6].)

In refs. 2, 3, only the case of collisions between free particles was treated in detail, that is, the case in which all initial and final states belong to the continuous spectrum and have zero line-breadth; and it was mentioned in ref. 3 that the theory reduces essentially to that of Weisskopf and Wigner for the emission of light by atoms in discrete levels. A representation was used in which the probability amplitudes of all states were functions of time. For collisions between free particles, it is permissible, as was done in refs. 2 and 3, to distinguish between states with energies equal to that of the free particles before the collision, namely, E_0, and states with different energies, because the total energy of the system is equal to that of the free particles. However, as Pauli[7] has shown, this distinction is unnecessary; it comes out automatically. For this purpose it is more convenient to consider all processes as a superposition of stationary processes and work with energy representation. The two methods are exactly equivalent, being Fourier transforms of each other. In the stationary method, a variable energy E occurs instead of the time t (as a result of the Fourier transformation), representing the total energy of the system including the interaction. For collisions between free particles this energy is equal to E_0. This will no longer be the case when discrete levels are involved.

When using the equations of the damping theory as they stand (equat. II, III on pp. 245, 247 of ref. 3), Ferretti and Peierls have pointed out an ambiguity arising there when the line-breadth is finite. Indeed, if one distinguishes states within a narrow energy band around E_0, it is not clear how wide this band is to be taken when the line-breadth is finite. Any marking off of such an energy band for a finite line-breadth would be very artificial, and, as was pointed out above, is unnecessary. To resolve the ambiguity, the obvious way is to re-examine the derivation of the equations of the damping theory, without distinguishing between states of equal energy. For this purpose the use of the energy representation is more convenient. This has now been done in collaboration with Dr. S. T. Ma. The result is that the form of the equations III of ref. 3 is the same as before. Only the quantities occurring in these equations, like U_{AO} and the compound matrix elements, appear in a slightly generalized form (a trivial generalization), in that they depend, as was expected, on the variable energy E also, which is now no longer identical with the energy of the initial state E_0.

Transforming to time representation, one obtains he time-dependent equations II of ref. 3 also in exactly the same form as before, provided that $E_0t \gg 1$, an approximation which, of course, always holds. In these equations E no longer occurs. No distinct energy band occurs either, that is, the energy differences of the final states cover the *whole* line-breadth and extend in principle up to infinity, a result which might have been anticipated even without proof. No additional compound matrix elements occur in which a photon ranks as intermediate state.

It should be pointed out that here the same infinite parts of the theory can, and have to be (at the present stage of our knowledge), eliminated as before, and that the same method has been used for this purpose.

The theory of Weisskopf–Wigner results, if one neglects, as one may well do, certain small reaction terms. The case of collisions between free particles and vanishing line-breadth is, of course, also included, with $E = E_0$.

The solution of the equations in question for the problem of the propagation of light is a matter of a few lines of calculation. The result is the one to be expected: Let $b_0(t)$ $b_1(t)$ be the probability amplitudes for the two states: (i) the first atom is excited, the second in the ground state; (ii) first atom in ground state, second atom excited; and let the initial conditions be: $b(0) = 1$, $b_1(0) = 0$. If R is the distance between the two atoms, then $\dot{b}_1(t) = 0$ (and therefore also $b_1(t) = 0$) for any time $t < R/c$. Thus the exchange of excitation energy travels with the correct velocity c. There is no immediate connexion of this problem with that of *Bremsstrahlung* and the infra-red problem.

A full publication together with Dr. Ma is being prepared for the Royal Irish Academy. Considerations in a similar direction have also been carried out by Mr. Hamilton, and I am indebted to him for having sent me his manuscript.

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Dec. 1.

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Phase-Angle Determination in X-Ray Crystallography

A. D. BOOTH has suggested[1] that a study of the diffuse reflexions in X-ray diffraction photographs should give information as to the phase-angles of the Bragg reflexions. In particular, in the case of a centro-symmetrical structure, for which the phase-angles of the reflexions are all 0° or 180°, a streak of diffuse reflexion joining two Bragg reflexions would indicate that there can be no change of sign in the structure factor between the Bragg reflexions, and that these two reflexions must therefore have the same phase-angle.

There are, however, two serious theoretical difficulties in this argument. The first is that although the Bragg reflexions from a centro-symmetrical structure must all have phase-angles equal to 0° or 180°, the diffuse reflexions need not, since they are due to *disturbances* in the structure caused by thermal motion, and the disturbed structure need not have a centre of symmetry. Thus the diffuse reflexion may have phase-angles other than 0° or 180°. If the phase-angle changes continuously from 0° to 180° as we go from one Bragg reflexion to another, the intensity need nowhere be zero. In other words, the amplitude of the diffuse reflexion (which is not the same as the structure factor for the unit cell of the structure calculated at a point between two Bragg reflexions, as Booth[1] seems to imply) may be complex; and a quantity can change continuously from real and positive to real and negative without anywhere passing through zero if complex values are possible. In practice the amplitudes and phases of the diffuse reflexions are continually changing as the crystal vibrates, and what is observed is the *mean* intensity.

Secondly, the phase-angle of a reflexion is not an absolute quantity, as is often implied; it depends on the position taken for the origin of the unit cell of the structure. For example, consider a simple cubic structure of the KCl type. If we take the origin at one of the atoms, every reflexion has a phase angle of 0°. If, however, the origin is shifted to a point at the centre of the unit cell considered above (this still gives us a centre of symmetry at the origin), then the phase of the (h,k,l) reflexion is 0° or 180°, according as $(h + k + l)$ is even or odd. This shows that one must treat with caution any general argument leading to the conclusion that two reflexions have the same phase angle, since this conclusion may, in some cases, be meaningless.

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Extensive Penetrating Showers

AN investigation has been carried out in which extensive showers selected by a fourfold array of Geiger–Müller counters (each of area ~ 200 cm.^{2}) were used to trigger a cloud chamber of collecting area about 70 cm.^{2}. In addition, the operation of a large single counter tray (area ~ 720 cm.^{2}), shielded by 15 cm. lead on the top (or in part of the work with 16 cm. iron + 10 cm. lead) and surrounded by 8 cm. lead on all sides, in coincidence with the fourfold array was recorded on the chamber photographs by means of an indicator lamp. Thus a density sample of the showers was obtained in the chamber and the probability of the operation of the shielded tray was studied as a function of the number of shower tracks in the corresponding photographs.

The total fourfold shower counting-rate was found to be $2{\cdot}08 \pm 0{\cdot}08$ counts per hour, of which $0{\cdot}345 \pm 0{\cdot}024$ counts per hour were accompanied by penetrating effects under 15 cm. lead, while $0{\cdot}365 \pm 0{\cdot}032$ counts per hour was the rate of penetrating counts under 16 cm. iron + 10 cm. lead.

Following the treatment described by Jánossy and Broadbent[1], we deduce from these data that the average probability that a single shower particle is accompanied by a penetrating event is $k = 0{\cdot}020 \pm 0{\cdot}002$. The result is in good agreement with those of previous workers.

Assuming the density spectrum of extensive showers given by Cocconi[2], Daudin[3] and Clay[4], we were further able to deduce the expected rate of photographs showing a number n of shower particles. The expression for the fraction of the photographs with n tracks is

$$R(n) = \int_0^\infty (1 - e^{-sx})^4 \, e^{-s_1 x} \, \frac{(s_1 x)^n}{n\,!} \, x^{-(\gamma + 1)} dx,$$

where $\gamma = 1{\cdot}5$ is the integral exponent of shower density, and s, s_1 are the collecting areas of each of the fourfold counters and of the cloud chamber respectively. The calculated values are given in column 3 of the table, and are in agreement with the observed numbers (col. 2).

Now using an extension of this analysis to the penetrating part of the shower, we are in a position to compare the fraction of penetrating counts when n shower tracks appear in the cloud chamber photograph, with that to be expected on a specific assumption about the relationship between the probability of the occurrence of a penetrating count and the local density of the extensive showers. We use here the simplest assumption: that the occurrence of a penetrating count in any region of an extensive shower is proportional only to the particle density in that region; in fact, that the constant $k = 0{\cdot}020$ refers not only to the average over all showers but also in detail over the whole range of shower densities important in this experiment. An expression can be deduced for the fraction f of photographs showing n tracks not accompanied by penetrating counts:

$$f = \frac{\int_0^\infty (1 - e^{-sx})^4 \, e^{-s_1 x} \, \frac{(s_1 x)^n}{n\,!} \, e^{-s_2 k x} \, x^{-(\gamma + 1)} dx}{\int_0^\infty (1 - e^{-sx})^4 \, e^{-s_1 x} \, \frac{(s_1 x)^n}{n\,!} \, x^{-(\gamma + 1)} dx},$$

where s_2 is the area of the shielded extension. In the table, values of f calculated using this expression are compared with those observed. It is evident that the assumption made about the distribution of penetrating events throughout the extensive showers represents closely the observed results. The table combines data in which the tray of counters, recording penetrating events, was shielded by 15 cm. lead and by 16 cm. iron + 10 cm. lead. No significant difference was found between these two conditions; the implication of the result will be treated in more detail elsewhere.

No. of particles, n, in the cloud chamber	Total No. of showers		Fraction, f, of showers not accompanied by penetrating count	
	Observed	Calculated	Observed	Calculated
0	805	759	$0{\cdot}87 \pm 0{\cdot}01$	0·91
1	342	366	$0{\cdot}83 \pm 0{\cdot}02$	0·85
2–3	206	222	$0{\cdot}75 \pm 0{\cdot}04$	0·75
4–7	57	68	$0{\cdot}54 \pm 0{\cdot}09$	0·52
$\geqslant 8$	27	22	$0{\cdot}18 \pm 0{\cdot}08$	0·17

I wish here to record my sincere thanks to Prof. Blackett for the encouragement and facilities he has given for conducting this experiment. I am also greatly indebted to Dr. Jánossy for suggesting the problem and helping me in the interpretation of the results, and to Dr. Wilson and Mr. Hamilton for many helpful discussions during the progress of the work.

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Mesons of Different Masses

Leprince-Ringuet[1], Powell and co-workers[2], Rochester and Butler[3] and others have found convincing evidence for the existence of mesons with different masses. It seems, therefore, appropriate to emphasize that these experimental facts, which are to my knowledge not yet satisfactorily explained by either of the current meson theories, can be accounted for by a theory I have proposed recently[4]. I have made an attempt here to solve the problem of elementary particles with the help of four-dimensional spaces. My theory involves that electrons, and similarly protons, may exist in instable 'meso-states' as well as in their normal stable state. The theory provides one solution for the meso-state of the electron (meso-electron) and eighty-two solutions for the meso-protons.

The meso-electron has a spin of 1, a magnetic momentum of 1/137 Bohr magneton; its mass can unfortunately not be determined with as much accuracy as was possible for the other elementary particles; however, its value can be given as (250 ± 10) m_e. A neutral meso-electron (neutretto) may also exist, the mass of the latter being only slightly smaller than that of the charged particle.

The meso-protons all have spin $\frac{1}{2}$, and we may divide them into two classes, according to whether the quantum number n is even or odd (see *loc. cit.*, equation 13.1.) The circumstance that the proton belongs in class I renders it plausible that the meso-protons of class I are more stable. The masses and magnetic momenta of the first nine meso-states belonging to class I are indicated in the following table:

No.	n	Mass	Magnetic momentum
1	6	995·8 m_e	0·0037 Bohr magneton
2	8	481·8	0·0096 " "
3	10	217·8	0·0256 " "
4	12	94·6	0·068 " "
5	14	40·1	0·187 " "
6	16	16·7	0·51 " "
7	18	6·85	1·38 " "
8	20	2·77	3·77 " "
9	22	1·12	10·26 " "

The masses of the smaller meso-protons can be derived in good approximation from the equation

$$m_{\text{MP}} = 5720 \frac{\ln 2\,(1 + \exp n/2)}{1 + \exp n/2}.$$

In principle also neutral meso-protons may exist, with configurations similar to that of the neutron; however, on account of their large negative mass-defects, it is very unlikely that they would be found in Nature.

It seems justifiable to identify the meso-electrons with the ordinary mesons to be found in cosmic ray experiments, which according to the best mass determination[5] have a mass of about (240 ± 30) m_e.

From the data collected in the table, we may infer that the first meso-proton might perhaps correspond to the mesons of mass (990 ± 100) m_e observed by Leprince-Ringuet and recently by Rochester and Butler.

The second meso-proton of mass 481·8 m_e may be he π-meson of Powell. This particle could disintegrate, on account of mass, charge and spin conserva-ion, into a meso-proton of mass 217·8 m_e (No. 3, μ-meson of Powell) and a neutretto. Taking the mass of the neutretto as 250 m_e and assuming that the energy corresponding to the mass-difference of 14 m_e emaining after decay is divided between the two decay products in such a way that both of them acquire equal impulses, the kinetic energy of the 217·8 m_e meso-proton will be 3·8 MeV., which would enable the latter to have a range of 500 microns in the photographic emulsion. Powell found for the range of the μ-mesons a value of about 600 microns.

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[2] Lattes, C. M. G., Occhialini, G. P. S., and Powell, C. F., *Nature*, **160**, 453 (1947).

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Stressed Aluminium

In the course of an investigation on the behaviour of aluminium (purity 99·998 per cent) after the release of compressional stress to which it had been subjected, it was found that immediately after compression, the lattice parameter was increased, but that in course of time it decreased according to an exponential law, finally reaching a value at room temperature which was higher than the equilibrium value. The rate of recovery increased as the amount of cold work, measured by the percentage reduction in thickness, increased; but the final constant value reached was the same for all the compressions investigated. On annealing the material for a suitable period after it had reached the 'metastable' state, the lattice parameter decreased from the metastable to the true equilibrium value.

Back-reflexion photographs showed that after compression, recrystallization took place, the rate of recrystallization increasing as the percentage amount of compression increased. In case of very severe compression, recrystallization occurred rapidly and immediately after the release of the stress.

Foils made by compressing annealed filings of aluminium did not show the same phenomenon. In this case the increased lattice parameter after compression returned in course of time to the final equilibrium value of the powder from which the foils were produced.

When foreign atoms were introduced into pure aluminium, whether these atoms entered the crystal lattice to form an unsaturated solid solution, or a supersaturated solid solution, that is, an ageing alloy, or whether they were distributed along the grain boundaries, they hindered recrystallization and grain-growth in the compressed material to a marked degree.

Filed and polished surfaces were examined in the light of these results. It was concluded that whereas in a filed surface the lattice parameter of the broken surface crystals changed, finally assuming the lattice parameter of the metastable layer to which they were anchored, in a polished surface the metastable state was reached immediately after polishing, and the crystallites, as in the final state of the filed surface, were in a strained condition. The residual stresses remained until the material was suitably heat-treated. Polishing and filing produce the same metastable state in the surface as severe cold-work produces throughout the body of the material.

These experiments and a discussion of the results will shortly be published in detail.

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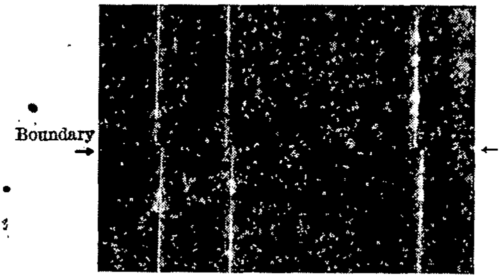
Mechanical Behaviour of Crystal Boundaries in Metals

It has been shown by Kê[1] that differences in the mechanical properties of specimens of aluminium with large and small crystal sizes can be accounted for by assuming that the crystal boundaries behave as viscous liquids. Quantitative experimental evidence of the relative movement of neighbouring crystals in a manner consistent with this hypothesis has so far been lacking.

We have made preliminary experiments on specimens of tin consisting of two crystals and one straight boundary, prepared by a method that has been described previously[2]. The specimens were subjected to tensile loading so arranged as to provide a component of shear stress acting on the boundary. When such a stress is applied at a temperature a few degrees below the melting point, progressive relative shear displacement of the two crystals takes place. This movement is observed by means of fine marks inscribed at right angles to the boundary. The accompanying photograph shows a typical specimen after the application of the stress.



Specimen after application of stress (× 10)

As an indication of the magnitudes involved, the following experimental result may be quoted. With a shear stress component of 590 gm./cm.^{2}, at a temperature of 222° C., the initial rate of relative movement was 7×10^{-4} cm./hr. Experiments so far carried out suggest that the rate of movement diminishes with time. The maximum displacement so far recorded is 0·1 mm.

If the direction of the shear stress is reversed after the rate has diminished to a small value, displacement takes place in the new direction with considerably increased velocity.

There is evidence that lateral movement of the boundary may occur during the process of boundary slip. It is not clear whether this is an inherent part of the process, or whether it is due to some condition not associated with boundary slip.

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[1] Kê, T. S., *Phys. Rev.*, **71**, 544 (1947).

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Internal Stresses in Metals

Heyn pointed out in 1914 that plastic deformation of a metal could result in irregular internal stresses because of the inherent elastic and plastic anisotropy of the grains[1]. With the development of X-ray diffraction methods it has been possible to study the internal stresses by direct experiment. Such X-ray measurements, made by Wood and his co-workers, led, however, to the unexpected result that the internal stresses in a number of metals were by no means irregular, being related in magnitude and direction to the previously applied stress[2]. Iron and carbon steels are typical examples. It was concluded that the stresses were too regular to be explained satisfactorily by the type envisaged by Heyn (which we shall term intergranular stresses).

In a recent communication in *Nature*[3], G. B. Greenough suggests that Wood's results still might be explained by the intergranular stresses if account is taken of the fact that in a given test specimen the X-rays measure the stresses in grains of the same crystallographic orientation only. This property of the X-ray method was pointed out in the above work; but as an explanation of the results it was rejected for the following reason, which further work has confirmed.

Since the intergranular stresses arise from interaction between a grain and its surroundings, the magnitude and direction of the stress experienced by an individual grain will be determined mainly by the relative strength and orientation of its neighbours. The grains of the similarly oriented group which respond to the X-rays are not contiguous but are distributed throughout the specimen. Each grain of the group will be surrounded by a different arrangement of neighbours, and therefore will experience a different internal stress. Further, since on the whole all arrangements of neighbours are possible, the various members of the group taken together will exhibit a whole range of stresses from tension to compression, with a mean stress zero. Therefore the intergranular stresses measured by X-rays will vary at random about a mean zero stress, even though the selection of grains reflecting the X-rays has the same orientation. The regular type of internal stresses, which in contrast are characterized by a mean tensile or compressive stress, according to the experimental conditions, remains unexplained by the intergranular effects.

Indeed, it is difficult to see any manner in which the intergranular stresses could form a systematic system, because the stress-strain curve of a single metal crystal is notoriously structure-sensitive; the behaviour of the grain when part of a polycrystalline aggregate must be even more variable.

We have proved, however, that the intergranular stresses are irregular, even in grains of the same orientation, by experiments on the following lines. If the grain size of a metal specimen is sufficiently coarse, then a random distribution of neighbours for the similarly oriented reflecting grains is impossible. Then the intergranular stresses will not have a mean zero value at the point covered by the incident X-ray beam, but will vary irregularly from point to point in the specimen as different grains reflect. We have made a study of aluminium tensile test-pieces of various grain sizes and found this to be the case. The internal stresses were irregular in magnitude and independent of the direction of the previously applied stress, contrary to the suggestion made by Greenough. In such coarse-grained materials, where the inter granular stresses are not averaged out, it would be impossible to say whether the regular type of internal stress is present or not.

Further, it is interesting to consider the effect of the intergranular stresses on the X-ray diffraction ring itself. The diameter of the ring depends on the magnitude of the stresses in the reflecting grains; if the mean stress is tension, the diameter will change in one direction, and in the opposite direction if the mean stress is a compression. If, however, the stresses consist of a mixture of tensions and compressions about a mean zero stress, in the manner to be expected from the intergranular stresses in a fine-grained aggregate, then the diffraction ring will broaden radially, but will not change its mean diameter. Now this is the result found for copper. The diffraction ring from a copper tensile test-piece broadens most markedly after plastic deformation, but no appreciable change in the mean diameter occurs; if any change does occur it is masked by the diffusion of the ring and is too small for accurate measurement. In this metal, the irregular type of stress must predominate, although the metal is distinctly anisotropic.

We conclude that two types of internal stress may arise in a metal during plastic deformation: first, the irregular stresses which may be explained by the Heyn hypothesis of anisotropy and inhomogeneities of granular texture; and secondly, the regular type of internal stress which is of special interest because it must be associated in a fundamental manner with the response of the metallic lattice to external stress.

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N. Dewsnap

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[1] Heyn, E., *J. Inst. Met.*, **12**, 3 (1914).

[2] Wood, W. A., and Smith, S. L., *Proc. Roy. Soc.*, A, **182**, 404 (1944). Wood, W. A., *ibid.* (in the press).

[3] Greenough, G. B., *Nature*, **160**, 258 (1947).

If a polycrystalline metal is being extended plastically, the tensile stress in any grain in the metal depends on the orientation of the grain and of its neighbours. When the applied stress is removed, the interactions between grains and their neighbours will result in a complex system of Heyn stresses, the residual stress in any grain being of the same order as the difference in the yield tension of the grain and the average yield tension of its neighbours. The important difference between this concept and that advanced by Wood and Dewsnap is that the latter consider the principal cause of the Heyn stresses to be the variation of the strength of the neighbours, whereas here it is considered that the yield tension of the grain itself is equally important.

Grains of a given orientation in the aggregate have different surroundings, so that the residual stresses in these grains will not be the same after a uniform plastic deformation. However, the mean residual stress, and hence the mean residual strain, in these grains will not be zero, but will depend on the difference between the yield tension of the grain with the given orientation and the average yield tension of the aggregate. It will also be closely related in direction to the original applied tension. The random variation from grain to grain, both in magnitude and direction, about this mean strain due to the effect of the varying surroundings of the individual grains is removed by taking a mean of the strains in a sufficiently large number of the orientated grains in the aggregate. Hence to determine the mean residual lattice strain in grains of a given orientation by observations on the maximum of a diffraction line, the experimental arrangements should be such that many grains contribute to the diffraction line.

The experimental conditions used in the work described previously were such as to ensure that many grains did contribute to each diffraction line. Not only was the grain-size of each specimen so small that enough grains were in the region irradiated by X-rays to give a uniform diffraction ring from the annealed material, but also the results quoted were a mean of the residual lattice strains determined, using at least three different specimens. There can be little doubt that the values of the residual lattice strains are mean values, and that the fortuitous variations in strain due to the varying surroundings of individual grains, although causing a broadening of the X-ray diffraction line, have been eliminated from the results quoted.

While it is considered that the experimental observation of residual lattice strains which represent both compressive and tensile stresses in a plastically extended aggregate is sufficient confirmation of the hypothesis, reference must be made to the success of attempts to interpret the hypothesis in numerical terms. A summary of the results has already been given[1], and it is hoped to publish the work in detail elsewhere. This hypothesis of Heyn stresses appears to give an adequate explanation of the observation of residual lattice strains, and it does not appear to be necessary to postulate any further type of internal stress.

It is interesting to note that the general hypothesis offers some explanation of the recent observation made by Wood and Rachinger[2] on the breadths of X-ray diffraction lines from iron filings and from a plastically extended aggregate. In the former, the stresses in the reflecting grains may have any magnitude and any direction relative to the X-ray beam; whereas in the latter, the stresses have a preferred value, although they show some variation about this value. Hence the variation of the strain in the direction of the reflecting normals in those grains contributing to a diffraction line will be greater in the case of the filings than in the case of the aggregate. One would therefore expect the breadths of the diffraction lines from filings to be greater than that obtained from a plastically extended specimen, if it can be assumed that the broadening is largely due to a variation of strain in the reflecting grains. This is, in fact, the result observed experimentally by Wood and Rachinger.

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Royal Aircraft Establishment,
Farnborough, Hants. Feb. 26.

[1] Greenough, G. B., Inst. of Metals, Mon. and Rep., Series No. 5 (in the press).

[2] Wood, W. A., and Rachinger, W. A., *Nature*, **161**, 93 (1948).

Electrical Breakdown Strength of Air at Ultra High-Frequencies

Difficulties in producing sufficient voltage to break down air gaps at ultra high-frequency have led recent investigators[1,2] to use pulsed magnetrons in order to obtain the high peak voltages that are required. The accuracy of the measurement of the electric stress which is obtained at breakdown in these circumstances must depend on a number of

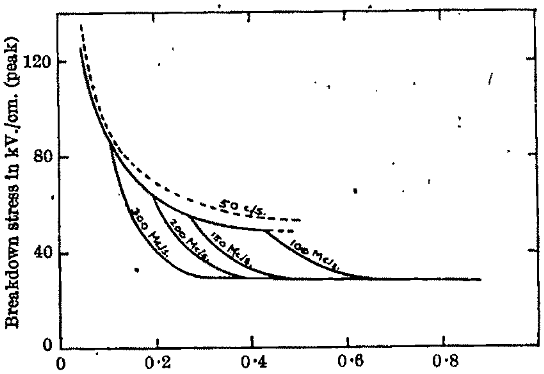

Fig. 1

factors, including pulse width, shape and repetition-rate.

The present series of experiments employs continuous waves throughout, and thereby enables some of the uncertain factors to be eliminated.

A method of measuring the radio-frequency voltage at the point of breakdown has been evolved which relies on the valuable property exhibited by 'Distrene', that its permittivity remains substantially constant over the frequency range 0–1,000 Mc./s. A form of dielectric voltmeter has been constructed which enables calibration to be carried out from a power frequency source.

Throughout the experiments the gap was irradiated by placing a small quantity of mesothorium near it. The effect has been to make the determination of the breakdown stress more precise. Without irradiation it is still possible to obtain the same value of the breakdown stress under given conditions, provided that the voltage has been applied for a long enough time to allow random irradiation to bring about the necessary initial ionization of the gas. A small spark discharge in the vicinity has also been found to give irradiation which leads to the same breakdown stress.

For frequencies in the region of 100–300 Mc./s. and higher, a discontinuity has been observed in the relationship between the breakdown stress and the gap width (Fig. 1). At a critical gap width (which varies with frequency) there is a sudden lowering of the breakdown stress to a constant value of about 28 kV./cm. at atmospheric pressure.

The variation of the breakdown stress at 200 Mc./s. with gas pressure has also been examined (see Fig. 2). It will be observed that the gap width at which the breakdown stress suddenly decreases is practically independent of the gas pressure. This is also true of the gap width at which the breakdown stress begins to become substantially constant.

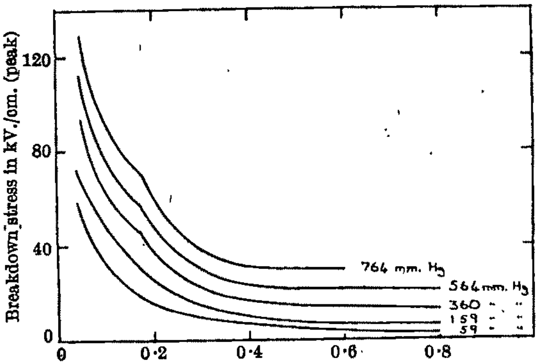

Fig. 2. f = 200 Mc./s.

These results suggest that, with an alternating field of a particular frequency, some charged particles are unable to cross the gap before the field is reversed. The sharpness of the breakaway would indicate that these particles are, in fact, electrons.

The flat portion would therefore correspond to the condition similar to an electrodeless discharge in which the electrons have space to move without coming into contact with an electrode throughout the time period for which the field remains in one direction.

The theoretical terminal energy U_T of an electron under the influence of an electric stress of E volts/cm. can be shown to be[3]:

$$U_T = \frac{0\cdot644\,\lambda E}{\sqrt{\eta}},$$

where λ is the mean free path and η is the fraction of energy lost per impact. From this it would appear that if there is a minimum energy for the electron to initiate breakdown, the corresponding field strength would be inversely proportional to the mean free path (λ) and therefore proportional to the gas pressure. This is, in fact, true of the flat portions of the breakdown stress curve over which the electron can attain its maximum energy (Fig. 3).

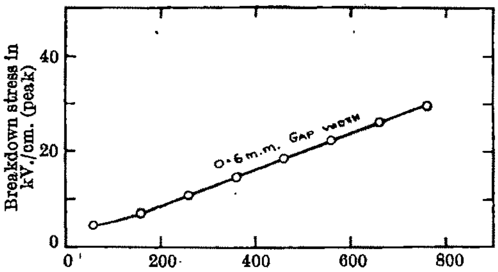

Fig. 3. f = 200 Mc./s.

Further investigations are in progress to examine these phenomena, with the view of establishing, if possible, the mechanism of breakdown for small gap widths.

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[1] *J. Inst. Elect. Eng.*, 94, Pt. 3 (Sept. 1947).

[2] *Nature*, 161, 310 (1948).

[3] Loeb, L. B., "Fundamental Processes of Electrical Discharge in Gases", 186.

Magnetic Susceptibility of Borax Glasses Containing Crystallites of Alkali Metal Salts, Gold and Platinum

In two previous communications[1], the results of X-ray diffraction experiments with salts of alkali metals, gold and platinum dispersed in boric oxide and borax glasses have been reported. It has been shown that crystallites of these substances exist in a finely divided condition in these glass media, the size of the particles in the case of the noble metals being somewhat greater than the colloidal particles of these in Zsigmondy's sols, which give only diffuse bands in their X-ray diffraction pictures, as opposed to the sharp lines which I have obtained.

Measurement of magnetic susceptibility of these systems has brought out certain interesting facts. The samples were prepared in the way detailed in previous communications, and their magnetic susceptibility determined in a magnetic torsion balance (Krishnan and Banerjee[2]). The susceptibility of the dissolved substance was calculated by the additivity formula :

$$100\chi = p\chi_1 + (100 - p)\chi_2,$$

where χ is the mass susceptibility of the sample, χ_1 that of the dissolved salt or metal, p its percentage, and χ_2 the mass susceptibility of the borax.

With the diamagnetic system $Na_2SO_4 - Na_2B_4O_7$, a surprisingly large value of χ for the dissolved salt is obtained, as will be seen from the following table :

Na_2SO_4–$Na_2B_4O_7$–glass system (Majumdar and Banerjee[3])

% Na_2SO_4	$\chi \times 10^6$ (calc.)	$\chi \times 10^6$ for pure Na_2SO_4
8·68	– 1·4389	
10·67	– 1·6428	
13·43	– 1·9394	– 0·337
15·62	– 2·0372	
17·36	– 2·2922	
17·71	– 2·3186	

A set of parallel measurements of the same salt in aqueous solution shows but slight increase in the value of χ for Na_2SO_4, as may be expected.

Na_2SO_4 aqueous solution (Majumdar and Majumdar, unpublished)

% Na_2SO_4	$\chi \times 10^6$
4·73	– 0·3577
7·12	– 0·3631
10·15	– 0·3700
14·30	– 0·3800

With the diamagnetic system $Au - Na_2B_4O_7$, the same increase is noticed; although the increase is not so large as in the previous case.

Au–$Na_2B_4O_7$–glass system (Majumdar and Basu Chaudhury, unpublished)

% Au	$\chi \times 10^6$ (calc.)	$\chi \times 10^6$ for pure gold
0·303	– 0·1512	
1·059	– 0·1528	
1·306	– 0·1538	– 0·1500
1·561	– 0·1552	
1·912	– 0·1574	
2·280	– 0·1604	
3·150	– 0·1682	

The system containing the paramagnetic platinum dissolved in borax glass shows, on the other hand, a decrease in the value of χ of the dissolved metal.

Pt–$Na_2B_4O_7$ glass system (Majumdar and Bhattacharyya, unpublished)

% Pt	$\chi \times 10^6$ (calc.)	% Pt	$\chi \times 10^6$ (calc.)	$\chi \times 10^6$ for pure platinum
0·319	0·9090	1·16	0·7413	
0·57	0·8948	1·41	0·7163	
0·69	0·8841	1·64	0·6359	1·10
1·021	0·8322	1·97	0·3134	

It may be mentioned that gold and platinum are not known to form any borates, and hence cationic exchange in the case of the first system is excluded ; so that the systems may be regarded as consisting entirely of the particles as such, held in suspension in glass.

These results, which in every case indicate an *increase* of diamagnetism of the dissolved particles, can be explained on my view of the effect of the dielectric medium on the lattices of the dissolved crystals[4]. The forces operating within a polar crystal are mainly two, namely, electrostatic forces due to the ions and the short-distance repulsive forces. If a medium possessing a higher dielectric constant is introduced, as is the case when the crystal dissolves in a glass, the Coulomb forces would be diminished and also the short-distance forces, so that a new equilibrium in the lattice will be set up with an increased spacing. This will explain qualitatively the observed increase of diamagnetism of the dissolved crystals. A similar explanation will also hold good for metallic lattices.

The change in magnetic susceptibility on the size of particles has been studied by different workers. But in all cases, such as graphite, colloidal bismuth, antimony, etc., the diamagnetic susceptibility has been found to be *less* than in bulk.

The increase in diamagnetism in the cases studied may be due in part (in the case of the metallic lattices) to the so-called Raman – Ehrenfest binding of the valency electrons. In such a case, the valency electrons have large orbits encircling a relatively large number of atoms ; but it is doubtful if the large increase observed could be explained by such an effect.

My thanks are due to the Indian Association for the Cultivation of Science, Calcutta, for permission to use the torsion balance, and to the Council of Scientific and Industrial Research for a research grant.

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[1] *Nature*, 156, 423 (1945) ; 158, 753 (1946).

[2] *Phil. Mag.*, 231, 235 (1933).

[3] *Ind. J. Phys.*, 20, 221 (1946).

[4] *J. Ind. Chem. Soc.*, 19, 461 (1942).

Bridge Networks Discriminating between Positive and Negative Sequences in Polyphase Supply

A NETWORK or filter constructed for use with single-phase supply will generally have a different transmission at different frequencies ; a network constructed for use with a three-phase supply has in general a transmission which depends not only upon the frequency of the supply but also upon its sequence.

Fig. 1 shows a bridge network for a three-phase alternating current supply which will transmit a frequency f equal to $1/\sqrt{3}\pi RC$ without change of voltage on condition that the supply has a phase sequence 1, 2, 3. If the phase sequence of the supply is reversed, the output voltage falls to zero. The diagram shows also the calculated transmission curve of the network.

It appears probable that any network which is not the same as its mirror image will show a transmission which changes when the sequence of the supply is reversed. G. B. Madella[1] has shown that the reversal of sequence in the phases of a multiphase supply is correctly thought of as being a reversal in sign of the frequency of the signal. A network may then be expected to have a transmission curve extending throughout the whole frequency range from plus to minus infinity, and the curve will not necessarily be similar in the regions of positive and negative frequency.

The network in Fig. 1 can generate three phases from a single-phase supply if the points 2, 3 and E are made common, and the input voltage applied to point 1, the neutral point and point 2 is in the ratio 1 : 0 : $-\frac{1}{2}$. The single-phase supply may then be regarded as the sum of two polyphase supplies of

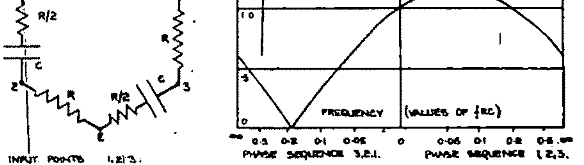

Fig. 1. BRIDGE NETWORK FOR THREE-PHASE ALTERNATING CURRENT SUPPLY, AND ITS TRANSMISSION CURVE

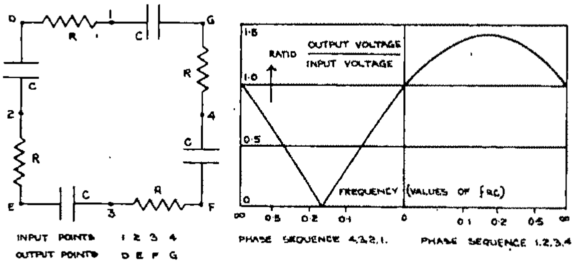

Fig. 2. BRIDGE NETWORK FOR FOUR-PHASE ALTERNATING CURRENT SUPPLY, AND ITS TRANSMISSION CURVE

opposite sequence, and the network transmits one and blocks the other. With this arrangement the impedances between points 2, *E* and 3 are, of course, omitted, and the arrangement appears as a simple phase-splitting network.

Fig. 2 shows a discriminating bridge for a four-phase supply of frequency *f* equal to $1/2\pi RC$, together with a calculated transmission curve. If this network is used to generate four-phase supply (or two-phase and neutral) from a single phase, then point 2, the neutral point and point 4 are made common, and voltage applied to points 1, neutral and 3 in the ratio 1 : 0 : −1. In this case the arrangement becomes a conventional phase-splitting network.

Madella has incorporated his concept of negative multiphase frequency in an improved form of heterodyne wave analyser[2]; he has also shown[3] that the concept gives a full explanation of the action of a modulating filter[4] which has been used in a modified form by D. G. Tucker[5] to give a highly selective transmission measuring equipment. Apart from the greater completeness which appears in the study of multiphase frequency as opposed to single phase frequency the concept seems likely to have considerable technical application and deserves to be more widely known.

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Admiralty Research Laboratory,
Teddington. April 16.

[1] Madella, G. B., *Alta Frequenza*, xiii, 1, 31 (1944).
[2] Madella, G. B., *Alta Frequenza*, xiii, 3, 132 (1944).
[3] Madella, G. B., *Wireless Eng.*, **24**, 310 (1947).
[4] Barber, N. F., *Wireless Eng.*, **24**, 132 (1947).
[5] Tucker, D. G., *J. Inst. Elect. Eng.*, **94**, Pt. 3, 211 (1947).

Smoothing Periodograms from Time-Series with Continuous Spectra

IN his review[1] of M. G. Kendall's brochure[2] on oscillatory time-series, David G. Kendall made the pertinent observation that the smoothing of periodograms obtained from autoregressive or other time-series with continuous spectra is equivalent to considering the first few sample autocorrelations. I had arrived at a similar conclusion, though possibly by an alternative route, having noticed that the averaging of periodograms obtained from contiguous lengths of series is approximately equivalent to a truncation of the correlogram at a point represented by the length of the subseries. From preliminary computation already made on M. G. Kendall's artificial series to test out this smoothing device, it appears promising.

In terms of the periodogram intensity $I(\omega)$, standardized to have expectation equal to the variance σ^2 of the series if the latter were entirely random, and related to the correlogram by the identity

$$I(\omega) \equiv \sum_{s=-N+1}^{N-1} C_s \cos \omega s, \qquad (1)$$

where C_s is defined in terms of the observations X_r as

$$C_s = \frac{1}{N} \sum_{r=1}^{N-|s|} X_r X_{r+|s|}, \qquad (2)$$

the (continuous) spectrum of X_r, apart from a factor $1/(\pi\sigma^2)$, is the limit of $E(I)$ as N increases, where E denotes expectation[3]. For M. G. Kendall's series, with autocorrelations ρ_s satisfying $\rho_{s+2} + a\rho_{s+1} + b\rho_s = 0$, $(s \geqslant -1)$, it may be shown that this limit is

$$\frac{\sigma^2(1-b)\,(1-a^2+b^2+2b)}{(1+b)\,\{1+a^2+b^2-2b+2a(1+b)\cos\omega+4b\cos^2\omega\}}, \quad (0 < \omega \leqslant \pi). \qquad (3)$$

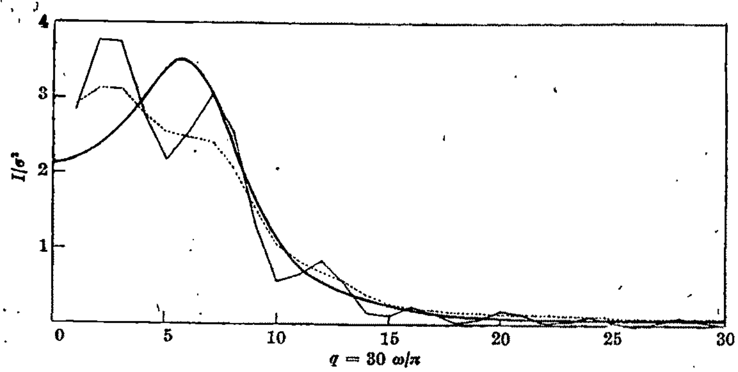
However, in accordance with general spectral theory and as remarked by the late P. J. Daniell, $I(\omega)$ unless smoothed never tends to this limit whatever N, random fluctuations being of the same order of magnitude as the expected value and only the 'resolving power' increasing.

The smoothing procedure first considered was to calculate

$$I_n(\omega) = \sum_{s=-n+1}^{n-1} C_s \cos \omega s, \qquad (4)$$

where n is a submultiple of N, chosen in practice to be a compromise between the averaging power required and the avoidance of bias in the expected value of $I_n(\omega)$. The standard deviation of fluctuations should be approximately reduced by the factor $\sqrt{(n/N)}$ and the bias should remain small if n is still large enough for ρ_n to be effectively zero. A variant of (4) which should be less subject to systematic error, though also rather less convenient since it implies fixing n in advance, is to replace C_s by

$$C_s' = C_s\left(1 - \frac{|s|}{n}\right) \Big/ \left(1 - \frac{|s|}{N}\right). \qquad (5)$$



SMOOTHED PERIODOGRAM (I_{16} JAGGED LINE, I'_{16} DASHED LINE) COMPARED WITH THEORETICAL SPECTRUM (SMOOTH CURVE).

In the diagram the expected intensity (divided by σ^2) is shown for Series 1 ($N = 480$), together with the values of $I_n(\omega)$ computed for $q = 30\omega/\pi = 1 \ldots 30$ and $n = 16$. There is a tendency to systematic oscillation in $I_n(\omega)$, but this is largely eliminated in $I_n'(\omega)$ (corresponding to C_s' in (5)), the values for which are also shown. Even $I_n(\omega)$, however, is a very great improvement over the unsmoothed periodogram, which includes a peak of 12 at $q = 3$ (see M. G. Kendall's Fig. 4.1, where it should be noted that the intensity contains an extra factor of approximately $2/N$ and is plotted against the trial period p, which is $N/8q$)

The arithmetical results also suggested the increase in the fluctuations about the mean as n was increased, but the computation (for most of which I am indebted to Mr. D. F. Ferguson) was carried out with the aid of the serial correlations recorded by M. G. Kendall, and hence was approximate and limited to n less than 48. It is hoped to test out and compare $I_n(\omega)$ and $I_n'(\omega)$ more precisely in due course. For Series 3 ($N = 240$) M. G. Kendall found the unsmoothed periodogram less confusing, owing to the closer approach of this series to an undamped harmonic, but the results for the modified periodogram still suggested an improvement even for n as low as 16.

Two further comments are: (i) this method of estimating the true spectrum could, of course, be improved if the correct form of the autoregressive scheme were assumed, its unknown constants estimated and the corresponding spectrum calculated, but a direct and more empirical estimation of the spectrum will often be required; (ii) the most rapid methods of obtaining spectra for series defined for continuous time avoid computation (for example, employ optical or electrical methods), and it may be possible to arrange for the smoothing to be carried out automatically without the above machinery of the truncated correlogram.

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Feb. 13.

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[1] *Nature*, 161, 187 (1948).

[2] "Contributions to the Study of Oscillatory Time-Series" (Cambridge, 1946).

[3] See Wold, H., "Analysis of Stationary Time-Series" (Uppsala, 1938).

Race, Pigmentation and Colour Vision

BURT[1] has given evidence of a small correlation between darkness of skin pigmentation and colour-vision weaknesses. Vernon and Straker[2] have shown that red-green blindness is more common in the south and west of the British Isles, where the original dark-skinned inhabitants were pushed by the Nordic invaders. Geddes[3] has shown that red-green blindness is less common among the natives of Fiji than among peoples of Caucasian stock. Clements[4] has shown that red-green blindness is less common among American Indians and American Negroes than among American Whites.

Subjects whose colour vision was studied in Glasgow were classified as 'dark' or 'fair' on the basis of skin and hair pigmentation. There were 571 men and women who had colour vision with normal variations of sensitivity, and 138 colour blind and anomalous subjects (not all found by chance) who had major red-green defects which are sex-linked. There was no significant difference between the proportions of dark and fair among the normal and among the red-green defective subjects. The relative frequencies were:

	Normal subjects	Sex-linked red-green defectives
Dark	248	53
Fair	323	85

Protanopes, in whom the red end of the spectrum is greatly darkened, did not have dark skin pigmentation more frequently than deuteranopes. Sex-inked red-green defectives are on the average about ten times less sensitive to these colours than people with normal variations of colour vision. Any tendency for pigmentation to be coupled with major red-green defects in the population sampled in the south-west f Scotland would have been brought out by this xperiment.

Among the normal group as a whole no relationship was found between variations in sensitivity to any colour and skin or hair pigmentation. If, however, twenty members of dark-skinned races were taken separately, they were found to have significantly lower sensitivities to blue and yellow (but not to red and green) than the remainder. Of this group, nine who were Dravidians were significantly less sensitive to yellow and blue than Europeans, while six West Africans were significantly less sensitive to these colours than the Dravidians.

It would appear that pigmentation is not associated with loss of colour sensitivity in Britain, except where there is evidence of racial differences. Negroes and American Indians are less often red-green blind than Europeans; but Dravidians and Negroes are more often weak in yellow and blue.

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Jan. 18.

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[1] Burt, Sir Cyril, *Eug. Rev.*, 37, 154 (1946).

[2] Vernon, P. E., and Straker, A., *Nature*, 152, 690 (1943).

[3] Geddes, W. R., *Brit. J. Psych.*, 37, 33 (1946).

[4] Clements, E., *Amer. J. Phys. Anthrop.*, 14, 417 (1930).

Adsorption of Bacterial Polysaccharides to Erythrocytes

WE recently reported that saline extracts of smooth strains of *Hæmophilus influenzæ* (Type *b*) contain a substance adsorbable to erythrocytes[1]. Cells treated with such extracts are agglutinated by type-specific antisera. A sample of the type-specific polysaccharide, prepared by the method of Dingle and Fothergill[2], absorbed from immune sera their power of agglutinating erythrocytes so sensitized, but was not itself capable of sensitizing them. We concluded, therefore, that the fraction in saline extracts which was adsorbed to erythrocytes was a combination of the type-specific polysaccharide with some other substance.

Further work has shown that the assumption of another substance in combination is unnecessary. The sample of polysaccharide employed had apparently been degraded during preparation. Influenzal polysaccharide has since been prepared by extraction with 90 per cent phenol[3,4]. The phenol-insoluble, water-soluble fraction of the organisms contains the type-specific polysaccharide in an undegraded state in which condition it is adsorbed to the red blood corpuscle. If this undegraded polysaccharide is treated with dilute acid or alkali (0·01 N or less), it loses successively, first, the capability of being adsorbed to erythrocytes; secondly, the property of precipitation with antibody; and thirdly, the power of combination with antibody. The second and third of these changes have been shown by Morgan to occur during the hydrolysis of the polysaccharide of *B. Shiga*[5], and we have found that the undegraded Shiga polysaccharide is, like that of *H. influenzæ*, adsorbed to the surface of erythrocytes which then become agglutinable by Shiga antiser

We have, so far, prepared polysaccharides which adsorbed to erythrocytes from strains of *H. influ* *Meningococcus*, *Staphylococcus* and *Salmonella* *derby*, *typhi murium* and *pullorum*. Simil saccharides have been obtained from *Pn* and *B. proteus* by Dr. J. L. O'Connor *Streptococcus* by Mr. P. L. Bazeley, oratories. The relationship of these to recognized antigens and haptenes is being explored. This preliminary note is forwarded because we have found erythrocytes coated with bacterial polysaccharides to be useful reagents in various immunological procedures.

Our present technique is to add one volume of packed washed human or fowl erythrocytes to ten volumes of polysaccharide solution (0·1 per cent). The sensitized cells are then washed twice and re-suspended in normal saline in 5 per cent concentration. One volume of the suspension of sensitized erythrocytes is added to ten volumes of graded dilutions of antiserum, and the presence or absence of hæmagglutination is noted. The polysaccharide antibody content of sera may be rapidly estimated, by this procedure, and the polysaccharide content of solutions can be determined by their ability to inhibit such hæmagglutination. We have used these methods for estimation of the protective antibody in rabbit antisera for treatment of influenzal meningitis, and to determine the polysaccharide content of the cerebrospinal fluid of patients suffering from this disease.

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An Adaptation Mechanism of the Organism to Damage: the Role of 'Resistine'

We have shown by experiments on rats and mice, using the Indian ink method devised by Jancsó[1], that the exposure of the organism to various damaging stimuli (injection of formaldehyde, adrenaline, agmatine, exposure to cold, X-ray irradiation, starving, surgical trauma, etc.) leads always to local and often general release of histamine. The site of histamine liberation looked as if it had been painted with Indian ink.

Though the shortening of the time of circulation of the intravenous injection of Indian ink solution (and according to Jancsó's observations that means histamine release, because the histamine is an effective activator of the whole reticulo-endothelial system) did not indicate *in vivo* histamine liberation because of the shock developed at the same time, the increased activity of the reticulo-endothelial system stimulated by released histamine could be detected in our perfusion experiments on surviving rat liver even in the stage of shock. 60–70 per cent more Indian ink was picked up during 40 min. from the perfusion solution by the surviving liver of the rat exposed to damage in comparison to the surviving liver of a normal rat.

It could be shown further that the histamine liberated by certain damage (what might be considered as a 'common pathway' in the adaptation mechanism) brings about as a basic factor all the changes haracteristic of the alarm reaction[2,3,4], causes shock nd plays also an essential part in setting in operation e defence mechanism of the organism, resulting lly in acquired increased resistance. In the stage of resistance, the Indian ink injected intravenously circulates in the blood significantly longer—about twice as long as in normal control animals. The prolongation of the circulating time is particularly pronounced when the resistant animal is investigated after having been exposed anew to damage. The results obtained in further experiments on resistant animals, when the surviving liver was perfused with Indian ink for 40 min., are in accordance with these findings. The amount of Indian ink absorbed during that time was 25 per cent less than that absorbed by the surviving liver of normal control animals. The absorption of Indian ink was especially diminished (more than 50 per cent decrease compared with the normal liver) when the animal has been again exposed to damage just prior to the perfusion experiment. Similar results were obtained with normal rats treated with antihistamine (Antistine s. Ciba or the preparation of Halpern 3277).

From these observations it seems clear that the increased resistance of the organism is caused by an excess formation of a substance possessing antihistamine activity. Since this substance, formed in the organism by its own cells, is responsible for the acquired increased resistance, it has been called by us 'resistine'. The antihistamine activity of resistine produced in great amount and stored in the organism will be apparent particularly when needed, that is, when the resistant organism has to face further damage.

Experiments concerning the chemical nature of resistine, the mechanism of its formation and its patho-physiological importance, other than the role of rendering the organism resistant, are already under way.

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Two Examples of Sera Containing the Anti-*d* Agglutinin Predicted by Fisher and Race

Two sera which have been shown to contain the anti-*d* antibody have been referred to us by Dr. E. E. Dilworth of Shreveport, Louisiana, and Drs. J. W. Davenport and Bruce Everist of New Orleans, Louisiana. The first case, an iso-immunized mother of type *CDe*/*CDe*, produced a high titre of anti-c agglutinin which was greatly increased by the administration of small doses o *cde*/*cde* cells. Studies of the antibodies produced during this programme of stimulation showed the development of an anti-*d* antibody demonstrated by agglutination with *CDe*/*Cde* red cells. The second serum was also from a mother of genotype *CDe*/*CDe*. Fortunately the serum from this iso-immunized mother contained an anti-*d* agglutinin active with saline suspensions of red cells, while the anti-c antibody present at about equal titre did not react with saline erythrocyte suspensions but could be demonstrated with the Coombs (developing) test or with suspension of erythrocytes in albumin. Using the classical test-tube method with saline suspensions of test erythrocytes, this serum agglutinated cells of the following genotype: *CDe/cde*, *cde/cde* and *CDe/Cde*, but failed to agglutinate cells of genotype *CDe/CDe*, C^wDe/CDe, *cDE/cDE* and *CDe/cDE*. However, when the Coombs anti-human globulin method[1] was used to detect the antibodies, all erythrocytes containing the *c* antigen and/or the *d* antigen gave positive tests. The same results could be obtained by using albumin suspensions of erythrocytes by the method of Diamond and Denton[2]. Further agglutination studies ruled out any correlation with *A*, *B*, *M*, *N* or *P*. The possibility of the agglutinins present in these sera being identical to the anti-Kell[3], anti-Lutheran[4] and anti-Lewis[5] agglutinins was also ruled out by parallel tests with sera supplied by Mourant and Race.

To check further the identity of the agglutinin thought to be anti-*d*, the hæmolytic activity of the serum was studied by techniques previously described[6,7]. These studies showed an equivalent amount of hæmoglobin released at the end of 48 hours from cells of genotype *CDe/cDE* as compared with cells of genotype *CDe/Cde*. On the other hand, cells with antigens determined by a single gene dose of both *c* and *d* showed hæmolysis equal to the sum of that produced by the action against the cells containing one gene dose each of *c* and *d* respectively (*CDe/cDE* and *CDe/Cde*). These results not only seemed to confirm the identity of the anti-*d* and anti-*c* antibodies of the serum, but also revealed a unitary relationship between gene, antigen determined thereby and the amount of hæmolysis produced by the action of the corresponding antibody in the presence of complement.

Since Fisher has predicted a specificity of 64·43 for the anti-*d* agglutinin, it is of interest to note that the closely agreeing specificity of 65·16 per cent was obtained for the anti-*d* agglutinin of this serum when tested against 155 random blood samples of the white population. Furthermore, when the reactions were compared with those of anti-*D* serum, an antithetical relationship was found similar to *M* and *N*, as well as *c* and *C*.

In using the anti-*d* agglutinin, it was noted that certain genotypes could be resolved further. For example, type *CDe/Cde* could be differentiated from *CDe/CDe*. Likewise, *cDE/cDe*, *cDE/cdE*, *CDe/cDE*, *CDe/cdE* and *cDe/cde* could be demonstrated. Obviously family studies are still required for some genotype differentiations, for example, *Cde/cDe*. Efforts to produce usable quantities of the anti-*d* agglutinin by intentional stimulation are now under way.

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Fibrinokinase and Fibrinolytic Enzymes

CONFUSION has arisen concerning the terminology of the fibrinolytic enzymes and pro-enzymes contained in blood plasma. In our papers on the fibrinolytic activator contained in tissue cells[1,2], we adhered to the nomenclature used by Loomis, George and Ryder[3], which is adequate from a biochemical point of view, and which has also been used recently by Guest, Ware and Seegers[4] and by Goldhaber, Cornman and Ormsbee[5].

Since the appearance of the paper of Ferguson[6] on the nomenclature of parenteral proteases, we have discussed the problem several times, especially with the group working under R. G. MacFarlane at Oxford[7], who use the nomenclature introduced by Christensen and MacLeod[8].

The major objection to the terminology of Loomis *et al.*[3] is that it does not avoid confusion with the term 'fibrinolysin', when used in its old sense as a substance originating from streptococci. This term is still being used by bacteriologists and serologists (immune antifibrinolysin). The term 'plasmin' for the active enzyme (Christensen[8]) suits all cases, as it is specific for the plasma enzyme and pro-enzyme.

The whole problem of terminology was discussed recently at the Conference on Blood Clotting and Allied Problems held in New York, February 16–17, 1948, under the auspices of the Josiah Macy, Jr., Foundation. No final agreement was reached, but it was recommended that authors should use both terms in the title and introduction of a paper in order to avoid confusion in abstracting and indexing.

The following observations may be added to those already published[1,2].

Fibrinokinase from pig's heart is completely devoid of action on chicken fibrinogen and fibrin. After incubating this pig fibrinokinase with ox pro-enzyme, a solution results with a powerful lytic action on chicken fibrin. This shows the specificity of the fibrinokinase and its properties as an activator for a proteolytic enzyme.

While the pro-enzyme present in ox serum will yield powerful solutions of enzyme after incubation with fibrinokinase from different tissues and animals, it is not activated by streptokinase. On the other hand, fractions of human serum containing pro-enzyme often yield very active solutions with streptokinase, but are activated to a far less extent by fibrinokinase even after repeated treatments. Such a solution, which cannot be increased further in potency by means of fibrinokinase, will upon addition of streptokinase develop a considerable amount of new activity. Thus there seems to be present in ox serum only one pro-enzyme, which is activated by means of fibrinokinase. In human plasma two pro-enzymes seem to be present, one of which is activated by fibrinokinase, and one by streptokinase. In order to distinguish between two such pro-enzymes and enzymes and in order to avoid confusion, we propose the terms: '*s*-profibrinolysin (*s*-plasminogen)' and '*f*-profibrinolysin (*f*-plasminogen)' for the two pro-enzymes which are activated respectively by streptokinase and fibrinokinase.

We have compared the fibrinokinase activity of normal tissues with that of malignant tissues. The results have so far been variable, showing that the activity often, but not always, is higher for the malignant tissue than for the corresponding normal tissue. An interesting case was encountered in which the primary tumour showed considerable activity, while a metastasis in the liver was just as inactive as normal liver tissue.

Finally, it may be mentioned that the thrombin B [9] used was found to contain a small amount of pro-enzyme which could be removed by extraction of the thrombin with 0·45 saturated ammonium sulphate and precipitation by adding solid ammonium sulphate (cf. Milstone[10]).

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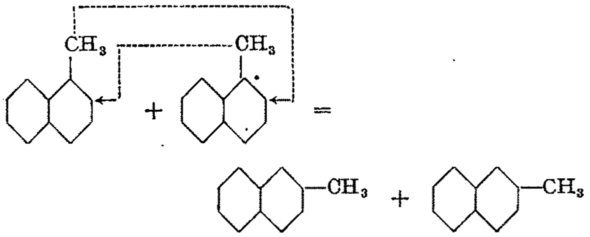
Mechanism of Substitution in the Naphthalene Nucleus

SUBSTITUTION in the naphthalene nucleus appears to occur initially at the α-position, while under more vigorous treatment an increasing proportion of β-substitution is observed; this tendency has been noted in alkylation by the Friedel-Crafts method by Roux[1] and by Tzukervanik and Terentieva[2]. We have found that by passing methyl alcohol and naphthalene vapours over catalysts of the alumina-silica type at 450°, β-methylnaphthalene and dimethylnaphthalenes are formed but not α-methylnaphthalene.

The suggestion that methylation first occurs at the α-position is supported by the results obtained when α-methylnaphthalene is passed over the catalyst at 450°. The initial material is completely transformed, yielding the β-methyl isomer as the main product, with smaller amounts of naphthalene and dimethylnaphthalenes.

As this transformation takes place in the gaseous phase, the methyl group doubtless migrates as a neutral radical. Moreover, there is evidence that the radical moves to a foreign nucleus[3]; for if the rearrangement were intramolecular, the formation of naphthalene and dimethylnaphthalenes would not be accounted for. It is possible that cleavage of the methylnaphthalene molecule to naphthalene and olefin takes place as a side reaction; but the formation of olefin cannot be an intermediate stage in the process: for in such a case, if the ethylene produced reacted with the naphthalene, ethyl, not methyl, derivatives would be formed. It is suggested, therefore, that an interchange of methyl groups between two molecules of α-methylnaphthalene occurs, the methyl group in the first molecule migrating to the β-position in the second molecule, while the methyl group in the second molecule moves to the β-position in the first molecule, thus:



The formation of naphthalene and dimethylnaphthalene would be accounted for as follows:

$$2C_{10}H_7CH_3 = C_{10}H_8 + C_{10}H_6(CH_3)_2.$$

Experimental details of this work will be published elsewhere.

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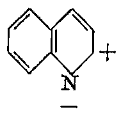
Nitration of Simple Heterocycles

Two results of interest in the study of comparative heterocyclic chemistry have been reported recently. Nitration of 4-hydroxyquinoline is said to give c. 50 per cent of 3-nitro-4-hydroxyquinoline[1], whereas quinazoline provides not less than 56 per cent of the 6-nitro-derivative[2]. In identifying the product from 4-hydroxyquinoline, the authors[1] depended on (*a*) the proved difference of its 4-chloro-derivative from 5-nitro-4-chloroquinoline, its assumed difference from 8-nitro-[3] and 6-nitro-4-chloroquinoline[3], and (*b*) the assumed identity of the derived aminoquinoline, m.p. 94°, with 3-aminoquinoline[4]. We find that the chloro-derivative of the chief nitration product gives a strong mixed melting point depression with genuine 3-nitro-4-chloroquinoline[5]. Further, whereas the former may be crystallized from methanol, such treatment hydrolyses the latter. By analogy with 4-hydroxycinnoline[6] and 4-hydroxyquinazoline[7], we expected kynurin to give chiefly 6-nitro-4-hydroxyquinoline on nitration. In fact, the nitro-chloroquinoline, m.p. 144–145°, prepared as described by Mosher *et al.*[1], gave no melting point depression on admixture with genuine 6-nitro-4-chloroquinoline, m.p. 144–145° [3]. The derived 4-phenoxy-compounds, m.p. 117–118°, were also identical (found for genuin 6-nitro-4-phenoxyquinoline: C, 66·6; H, 4·0; N 11·4; $C_{15}H_{10}O_3N_2$ requires C, 67·6; H, 3·8; N, 10· per cent).

With regard to quinazoline, we have obtaine additional confirmation for the orientation of th main nitration product by converting it to 6-chloroquinazoline, m.p. 142–143°, identical with the compound prepared by Riedel's method[8] from 2-nitro-5-chlorobenzaldehyde (found: C, 58·4; H, 3·3 $C_8H_5N_2Cl$ requires C, 58·4; H, 3·1 per cent).

The theoretical interest of the last result is considerable. In the cases of quinoline and *iso*quinolin both simple resonance considerations of structures types I and II, and semi-quantitative molecul orbital treatment[9] are in agreement with experimen in predicting formation of 8-nitroquinoline and nitro*iso*quinoline. But they do not explain why i quinoline C_6, and in *iso*quinoline C_7, are by-passe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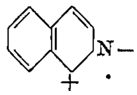
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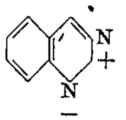
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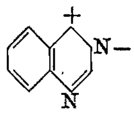
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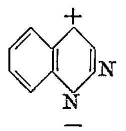
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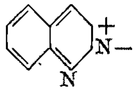
VI

in favour of C_5 and C_8 respectively. Steric effects at these positions are not easy to visualize, and in the quinoline C_8 position at least, the adjacent bonds are similar to those around the acridine C_3 atom, a position which is attacked in nitration[8]. For quinazoline and cinnoline no quantitative calculations have been made, but the qualitative picture in the first case, based on structures of type III and IV, leads us to expect nitration at C_6 and C_8. This is partly borne out by experiment, and it remains to be seen whether the 8-isomer can be detected in the nitration product. For cinnoline, whereas structures V would lead to nitration at C_6 and C_8, the inclusion of types VI would produce deactivation at these positions also. However, since N_1 appears to be the basic centre[10], C_6 and C_8 are the probable points of attack.

It is clear that no adequate explanation of nitration orientation in heterocycles has yet been given, even if we leave aside the variations produced by different reagents[11].

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Electrokinetic Potential and Surface Structure of Barium Sulphate

While there are many investigations on the influence of electrolytes on the electrokinetic or ζ-potential of solids, very few authors have considered the relation between the ζ-potential and the structure and composition of the solid itself. This is partly due to the fact that in many systems the potential-determining ions are foreign to the solid.

We are at present investigating the ζ-potential of sparingly soluble ionic solids such as barium sulphate against their saturated solution by the streaming potential method. In this case, the potential-determining ions originate from the solid. Precipitated barium sulphate is unsuitable for investigation, because the validity of the electrokinetic equations is limited to systems in which the diameter of the 'pores' of a plug is greater than the thickness of the electric double layer. We therefore prepared larger crystals (up to 2 mm.), which could be ground afterwards to any desired size, by recrystallizing barium sulphate from hot concentrated sulphuric acid and subsequent ignition. The following results are typical:

	ζ in mV.
Recrystallized barium sulphate, sample 1	+ 24·2
Recrystallized barium sulphate, sample 3	+ 25·0 ; 24·3
Recrystallized barium sulphate, sample 4	+ 26·6 ; 27·1
Natural barite, sample *B*, ignited	+ 5·4 ; 5·3
Natural barite, sample *C*, ignited	+ 8·4

In spite of the fact that during preparation of recrystallized barium sulphate there was always an excess of sulphate ion, the potential is *positive* and well reproducible within 1 mV. for each sample. The ignition temperature (500–1,000° C.) has no influence on the potential. Most electrolytes change the potential reversibly at room temperature; barium salts increase it, sulphates decrease it; but when, after treatment with the electrolyte solution, the potential is then measured against a saturated barium sulphate solution, the original value is always obtained. This value must therefore be regarded as a property of the sample. This behaviour is shown both by recrystallized barium sulphate and natural barite.

There is, however, a striking difference between the high potential of recrystallized barium sulphate and the much lower potential of natural barite. Spectroscopic analysis of our samples revealed that natural barite contains strontium and traces of calcium as impurities. However, these impurities cannot be responsible for the difference in potential. We incorporated such impurities into the recrystallized barium sulphate (during recrystallization); but, as a result, the potential was slightly increased, never decreased. Moreover, when natural barite is recrystallized from sulphuric acid, a high potential (27 mV.) is obtained.

These and similar observations, which will be discussed in more detail elsewhere, lead us to the conclusion that the difference in potential between recrystallized barium sulphate and natural barite is not due to a difference in composition. The most likely cause is a difference in structure (geometrical or otherwise) of the surface. Natural barite, even after crushing, has even crystal surfaces, whereas recrystallized barium sulphate has very irregular surfaces. This is shown by an investigation in an optical as well as in an electron microscope (for the latter we are indebted to Dr. A. L. G. Rees and Mr. A. J. Hodge of the Division of Industrial Chemistry of the Council for Scientific and Industrial Research). It is likely that the field of force is less well balanced in an irregular surface than in an even one.

Bikerman[1] suggested that the ζ-potential of a rough surface should be different from that of a smooth one for purely geometrical reasons. However, the distortion of the field of force in the surface as a factor influencing the electric potential at a surface is a somewhat unfamiliar concept in the field of electrokinetics. Nevertheless, besides our own observations, there are several findings of other investigators[2,3] which suggest that the ζ-potential of a crystalline solid is not solely determined by the composition of the system.

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INHIBITION OF SH ENZYMES BY METHYL BROMIDE

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THE high toxicity of methyl bromide to man, and the insidious character of its action, particularly at low concentrations, were not realized when this compound was first introduced as a fumigant and as a fire-extinguishing agent, but are now well established and have been emphasized in a pamphlet recently issued by the Home Office[1]. Yet its mode of action has remained obscure. It has been frequently suggested that this action results from an accumulation of the products of hydrolysis[2,3], but the experimental evidence does not support this view[4], unless the hydrolysis takes place intracellularly[5]; a theory which would not explain the close parallelism between the symptoms of poisoning by methyl bromide and methyl chloride[6,7].

During an investigation carried out at this Laboratory on the nature of the bromide residue in wheat flour fumigated with methyl bromide, it became apparent that the protein fraction of the flour was mainly responsible for the sorption and decomposition of the methyl bromide[8,9]. Other workers have shown that when aqueous suspensions of wool, silk fibroin, collagen and gelatin are treated with liquid methyl bromide, methylation of carboxyl groups and peptide linkages occurs[10,11]. Similarly, the SH groups in bisulphited wool are readily methylated by such treatment, and S-methyl-cysteine has been isolated from the hydrolysate[12].

In order to determine whether these reactions occur when methyl bromide is present in low concentrations, buffered solutions of cysteine and reduced glutathione were exposed to methyl bromide vapour for periods up to four hours. Oxidation was eliminated so far as possible by exposing the solutions in an atmosphere of nitrogen, or by the addition of cyanide. The number of SH groups remaining after treatment was determined by the reduction of ferricyanide[13], and the ionizable bromide, resulting from the decomposition of methyl bromide, by the method of Kolthoff and Yutzy[14]. The results in Table 1 show that there is a progressive decrease in the number of SH groups and a corresponding increase in the non-volatile bromide in the solutions. Similar tests with oxidized glutathione showed no such increase in the bromide content of the solutions. This suggests therefore that, under the conditions described above, methyl bromide reacts preferentially with the SH group.

The most probable reaction is :

$$R\text{—SH} + \text{CH}_3\text{Br} \rightarrow R\text{—S—CH}_3 + \text{HBr} ;$$

and on this assumption the bromide content of the solutions, to be expected as a result of this reaction, has been calculated from the decrease in the number of SH groups (Table 1). The fact that more SH groups have reacted than can be accounted for by the bromide determined is probably due to some oxidation during the exposure or subsequent manipulation. Similarly, when solutions of reduced keratin, prepared by the method of Goddard and Michaelis[15], were exposed at pH 7·5 to methyl bromide at a concentration of 400 mgm. per litre, there was a progressive reduction of the strong nitroprusside reaction given by this protein. After two hours exposure, the reaction was almost completely abolished. It appears therefore that, although methyl bromide can react with a number of groups in protein molecules, under the conditions of these tests the reaction with SH groups is particularly rapid.

TABLE 1

	Time of treatment (min.)	Concentration of methyl bromide vapour (mgm./litre)	Mgm. of SH compound reacted	Non-volatile bromide (mgm. Br′)	
				Determined	Calculated
Cysteine hydrochloride 25° C. pH 7·0	60 90 240	400 380 360	2·1 2·75 4·0	0·93 1·26 1·85	1·06 1·40 2·03
Cysteine hydrochloride 37·5° C. pH 7·4	30 120 240	114 106 98	1·7 3·75 5·0	0·67 1·45 2·00	0·86 1·80 2·55
Glutathione 37·5° C. pH 7·4	20 40 80	200 200 200	0·6 1·0 1·45	0·135 0·202 0·380	0·151 0·270 0·380

The toxic action of a number of substances has been attributed to their ability to inactivate enzyme systems in the body by combination with SH groups in enzyme molecules. The work of Peters and his co-workers on the inhibition of brain pyruvate oxidase by arsenic compounds affords a particularly good example[16]. The toxicity of methyl bromide might similarly arise from its capacity for reacting with protein SH groups under physiological conditions of temperature and pH.

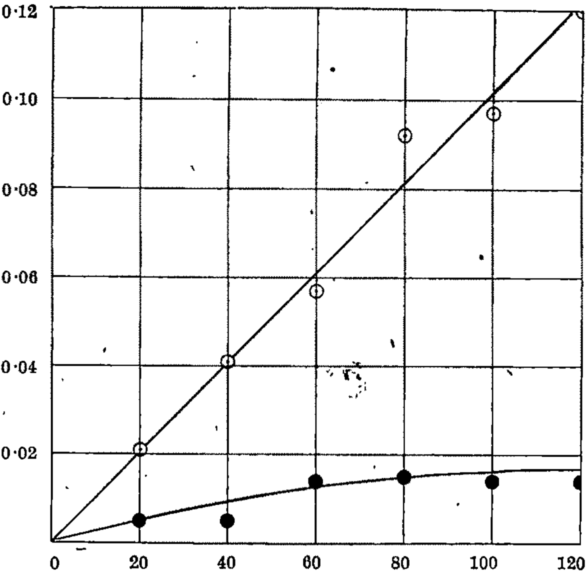
As a result of the above evidence, tests were carried out on some of those enzyme systems known to require the presence of SH groups for their activity. In each of the following tests the enzyme suspensions contained in all-glass flasks were exposed to known concentrations of methyl bromide at 37° C. At the end of each exposure, the free methyl bromide was removed by evacuation and 'air washing'. In each of the following systems, where free SH groups were present, exposure to methyl bromide vapour produced a progressive and irreversible inhibition.

Urease. A 1 per cent urease suspension, prepared from B.D.H. urease tablets, was used as a source of enzyme, and the activity after exposure to methyl bromide was measured by the method of Sumner[17].

Succinic dehydrogenase. An active extract of heart muscle was prepared and dissolved in phosphate buffer pH 7·4. After exposure to methyl bromide, the activity of the preparation was determined by measuring the oxygen uptake in the presence of 0·05 *M* sodium succinate. That the cytochrome oxidase portion of the system is not inhibited was shown by the fact that the addition of methylene blue did not increase the rate of oxygen uptake.

Papain. A 0·1 per cent aqueous extract of B.D.H. papain was treated with methyl bromide when in the reduced and also in the oxidized form. In each case the enzyme was activated with 2*M* sodium cyanide immediately before measurement of activity by the method of Anson[18]. The enzyme was rapidly inactivated by methyl bromide when exposed in the reduced form, but almost unaffected when oxidized. Simultaneous determinations of non-volatile bromide showed that the methyl bromide only reacted with the enzyme when the latter was in the reduced form (see graph).

Yeast (respiration). Fresh yeast suspended in buffered saline solution was exposed to methy



REACTION OF METHYL BROMIDE WITH PAPAIN, *p*H 7·4, TEMP. 37° C. CONCENTRATION OF METHYL BROMIDE IN AIR, 200 MGM./LITRE; —○—, REDUCED PAPAIN; —●—, OXIDIZED PAPAIN

bromide for periods up to 15 hours. After washing in isotonic saline, the oxygen uptake in the presence of glucose was measured. The reduction in oxygen uptake was accompanied by a rapid accumulation of acetaldehyde, which was readily detectable in the respiration flasks.

A few typical results obtained in the above tests are given in Table 2, together with the molar concentrations of methyl bromide dissolved in the solutions.

Enzyme systems containing essential SH groups show considerable variation in their sensitivity to inactivating agents, and it is not possible, therefore, to make direct comparisons between different systems. If the toxicity of methyl bromide to animal and plant ife is to be attributed to its ability to inactivate SH enzymes, some system forming an essential link in the chain of metabolic processes must be shown to be nhibited. Evidence of such inhibition in carbohydrate metabolism has been provided by Dixon[19], who has shown that hexokinase, which is present in the brain[20], is inhibited by methyl bromide. It is hoped that further work on this and other systems such as pyruvate oxidase will provide further information. The present findings do show, however, that methyl bromide is capable of combining with SH groups and producing a progressive and irreversible inhibition of those enzymes which have been tested. Such inhibition of an enzyme system in the brain would readily produce functional disturbances such as those associated with methyl bromide poisoning.

TABLE 2

Enzyme	Concentration of methyl bromide in air (mgm./litre)	Molar concentration of methyl bromide in solution	*p*H	Time of treatment (hr.)	Percentage inhibition
Urease	420	0·012	9·0	1	24
	420	0·012	9·0	2	52
	420	0·012	7·74	1	12
	420	0·012	7·74	2	29
Succinic dehydrogenase	500	0·014	7·4	1	41·5
	500	0·014	7·4	2	81·0
Papain (reduced)	400	0·011	9·0	1/3	100
	400	0·011	7·4	1	67
	400	0·011	7·4	2	100
	190	0·0054	7·4	1	49
	190	0·0054	7·4	2	75
Papain (oxidized)	400	0·011	9·0	2	7
Yeast (respiration)	35	0·001	5·3	15	66
	22	0·0006	5·3	11	50
	165	0·0046	7·1	1	55
	165	0·0046	7·1	2	70

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DETERMINATION OF RADIOACTIVE AND STABLE TRACER ISOTOPES

A MEETING of the Physical Methods Group of the Society of Public Analysts and other Analytical Chemists was held at the University of Birmingham on April 2. During the afternoon, about forty members visited the Physics Department at Edgbaston. Prof. P. B. Moon gave a short preliminary talk on the cyclotron and the synchrotron, and after a second short talk on target chemistry by Dr. F. E. Whitmore, parties were shown over the laboratories where the 60-inch cyclotron, now almost completed, was on view. The method of constructing the 800-ton magnet of the new synchrotron was explained in detail, and in smaller research laboratories several demonstrations had been arranged of experiments in radioactivity. After tea in the refectory at Mason's College, Edmund Street, the main business of the meeting was conducted under the chairmanship of Dr. J. G. A. Griffiths. Prof. M. Stacey welcomed the Physical Methods Group to Birmingham and stressed the importance of isotope measurements in a wide variety of fields.

A short symposium on "The Determination of Radioactive and Stable Tracer Isotopes" was opened by Dr. A. G. Maddock with a paper on problems in the measurement of β-activity, such as are met with in everyday practice. In spite of the development of ionization chambers connected to electroscopes or to electrometer valve circuits, and even of the more recent use of photomultiplier tube counters, the Geiger–Müller counter remains the most sensitive measuring device for β-rays. After mentioning briefly the working of such a counter, Dr. Maddock discussed the characteristics of the best counters and the means of avoiding spurious counts by using a quenching circuit such as that of Getting. Reduction of the background count of a Geiger–Müller tube can be very important where low activities are to be measured, and Dr. Maddock advocated careful selection of lead for 'castles' to shield counters and satisfactory design of both 'castle' and radioactive sample holder. That part of the background count—about half of it—which is due to cosmic radiation can be eliminated by the use of a second counter directly above the first and connected to it in an anticoincidence circuit.

If samples for counting are neither infinitely thin nor infinitely thick, a correction must be applied for self-absorption of β-rays in the sample. In a series of experiments when the same radioisotope is always used, it is worth constructing an empirical correction curve. Where several different isotopes are in use, however, corrections for self-absorption can be made with reasonable accuracy through the use of a nomogram connecting thickness of sample with half-absorption thickness of the isotope involved.

Dr. F. E. Whitmore followed, with a paper in which he considered the accurate estimation of radioisotopes the decay schemes of which are more complicated than those of a simple β-active isotope. Zinc 65, for example, has an exceptionally complicated decay scheme involving positrons with their accompanying annihilation γ-radiation and, in addition, γ-rays and X-rays arising from *K*-capture. All these types of radiation will affect a Geiger counter, but with differing efficiencies. Dr. Whitmore described an arrangement of two counters such that effectively one is sensitive only to γ-rays and the other only to β-rays, counts being measurable from each separately and the two in coincidence. In the case of an isotope decaying with β- and γ-rays simultaneously, the absolute number of disintegrations per second occurring in the sample can be found in terms of these counts only, independently of the β- and γ-efficiencies of the counters.

A further possible use of coincidence counting was suggested by Dr. Whitmore, in that two counters in coincidence are directional for γ-rays and might be used for the location of γ-active material in a living body, in place of the present arrangement whereby a single counter is used at the end of a long hole in a lead block.

The subject of measurement of the relative abundances of inactive isotopes was introduced by Dr. E. R. S. Winter, who first described briefly the development of the mass spectrometer and then, in greater detail, the construction of a modern mass spectrometer of the Nier 60° type. The instrument was considered in its three main parts of ion source, magnetic analyser and collector cup. By means of a block diagram, the equipment ancillary to the mass spectrometer tube was clearly demonstrated, and Dr. Winter explained the importance of slit widths and alignment in determining resolving power and the shape of mass peaks. There must be adequate separation between peaks over the mass range in which the instrument is being used, and if the tops of the peaks are flat, accurate measurement of mass abundance is made much easier. Dr. Winter pointed out the virtues of the mass spectrometer, this being a remarkably flexible and accurate instrument and much the best means of measuring isotopic abundances.

The feasibility of methods of stable isotope analysis using apparatus other than the mass spectrometer was the subject of a paper by Dr. E. R. Roberts. The high cost and complexity of mass spectrometers make it worth while to examine methods less elegant and more tedious which may yet be used in tracer experiments with stable material. Such methods include density measurements in both gas and liquid phases, and measurement of thermal conductivity in gases.

Quartz buoyancy balances similar to those used in the determination of the molecular weights of the rare gases can be used in the estimation of deuterium in hydrogen–deuterium mixtures. Accuracy is good in the case of hydrogen and deuterium; but improvements in technique may be necessary if heavier elements are to be used.

Several different liquid density methods have been used, again mostly for estimation of deuterium oxide in water. The most accurate is the determination of flotation temperature using a silica float calibrated with known water–heavy water mixtures. Determination of density by micro-pyknometer is also satisfactory, and in both these cases rigid chemical purification of the water is necessary. Another method of density determination is the falling-drop method, where drops of water fall through a very pure liquid in which they are non-miscible and which is of known density. Dr. Roberts also described the method of comparison of thermal conductivities, which has the advantage of requiring only very small quantities of sample.

Some examples of the use of tracer isotopes in the biological field were presented by Dr. W. J. Arrol, who did not attempt a survey of all the isotopes which have been used, but considered only iodine 131 of half-life 8 days. The uptake of iodine into the thyroids of human patients can be followed by placing a γ-counter over the gland and plotting activity of the gland against time after a single dose of radioiodide has been administered. The curve obtained can be used to diagnose departures from normal conditions both qualitatively and to some extent quantitatively, and more applications of tracer methods to diagnostic problems can be expected.

Two matters of importance to biochemists are the positive identification of the compound in which a tracer atom is combined, and the identification of the biological precursor of a compound. Dr. Arrol quoted in the first case the method used by Morton and Chaikoff in confirming the presence of radioiodine, from radiodide incubated with thyroid tissue, in thyroxine and diiodotyrosine extracted from the tissue. The radioactive residue extracted by an ordinary procedure is mixed with pure inactive compound and repeatedly crystallized. If the specific activity of the crystals remains constant, the radioactive residue is not chemically distinct from the pure compound with which it was mixed.

If a number of different 'labelled' compounds are administered to an animal, and one is found to be converted to a particular compound with greater efficiency than the others, it is quite likely to be the direct biological precursor. In a few cases, more evidence is obtainable by applying the criterion of Zilversmit, Entenman and Fishler, whereby variation of specific activity of a compound in a tissue with time and the variation with time of its immediate precursor are in a definite relationship with one another.

Dr. Arrol described the technique of making radioautographs and mentioned that recent improvements meant that accumulations of 8-day radioiodine 2·5 microns apart in a sample could be resolved in the radioautograph.

It was unfortunate that lack of time prevented any discussion on the papers, particularly as members were unable to bring up questions concerning the application of tracer methods to their own problems. The full text of the papers will be published in *The Analyst* in due course.

INTERNATIONAL RADIO CONFERENCES

TWO international radio conferences are being held in Stockholm during July. One of these will deal with the more fundamental aspects of radio science, while the other will be concerned with technical problems which form the basis of the practice of telecommunications. The two bodies, under the auspices of which these conferences are held, are in a sense complementary to one another in their functions; but there is naturally a good deal of common ground in their activities, and the choice of an arrangement of concurrent meetings this summer would appear to be a very happy one.

(1) *Union Radio Scientifique Internationale* (*U.R.S.I.*). The object of the International Scientific Radio Union is to promote scientific research in radio technique, particularly in those fields in which international co-operation is desirable or necessary. The Union is a constituent body of the International Council of Scientific Unions. Its headquarters and general secretariat are situated in Brussels, and the president is Sir Edward Appleton. The Union has held general assemblies in Washington, Brussels, Copenhagen, London, Venice (1938) and Paris (1946), at each of which a British delegation participated. The next general assembly will be held in Stockholm during July 12–22.

The work of the Union is divided between four Commissions, the titles and presidents of which are as follow: (I) Standards and Measurements, Dr. J. H. Dellinger (United States); (II) Propagation of Waves, Sir Edward Appleton (Great Britain); (III) Radio Noise, M. R. Bureau (France); (IV) Radio Physics, Prof. van der Pol (Netherlands). In addition o dealing with affairs at the general assemblies, these Commissions, together with any sub-commissions appointed from time to time, deal by correspondence, between the successive general assemblies, with work in the fields indicated by their titles.

The British National Committee for Scientific Radio is organised under the auspices of the Royal Society, as a constituent member body of Union Radio Scientifique. It comprises a few members ppointed by the Royal Society, and in addition epresentatives of the Department of Scientific and Industrial Research, the Radio Research Board, the National Physical Laboratory, General Post Office, British Broadcasting Corporation, Wireless Telegraphy Board, Meteorological Office, Institution of Electrical Engineers, Physical Society, Royal Society of Edinburgh and Royal Irish Academy.

It is customary for the various national committees to submit to each general assembly progress reports reviewing the advances made within their own countries in each of the fields of research designated by the above Commissions, and to submit any proposals for international action, which may include theoretical and experimental research, and, where desirable, standardization of equipment and nomenclature. As two examples of subjects in which this type of international action has been of great benefit to both the science and practice of telecommunications, those of frequency measurement and standardization and the study of the characteristics of the ionosphere may be quoted. In the former case, the connexions available through the Union have been instrumental in obtaining international agreement on the standards of frequency to a very high order of accuracy; while, in addition, the very advanced state of our knowledge of the ionosphere and of its influence on radio wave propagation owes much to the agreement obtained through the Union as to the essential quantities to be measured and the techniques used in doing so.

In addition to the preparation and submission of progress reports, the Union welcomes at its assemblies brief accounts of any outstanding and novel lines of recent research. In this case, the Union does not act as an alternative means of securing original publication, but rather as a forum for the discussion of appropriate items of work published in the normal manner elsewhere; and its own published account of such items is limited to about five hundred words.

The progress reports and the abstracts of original work referred to above are published by the Union in documents which contain also the proceedings and resolutions of each general assembly.

(2) *Comité Consultatif International des Radio-Communications* (*C.C.I.R.*). The International Advisory Committee for Radio is one of three technical committees which advise the International Telecommunications Union (I.T.U.) on all aspects of radiocommunication. The other two corresponding bodies are concerned with land-line telegraphy and telephony respectively.

The Committee is organised under the auspices of the Bureau of the International Telecommunications Union, with headquarters and secretariat at Berne. The Union itself is concerned with the framing of the general regulations which govern radiocommunication on an international basis and with the allocation of the frequencies required by different countries for various services in all parts of the world. For this purpose conferences of the Union were held at Cairo in 1938 and at Atlantic City in 1947; and the duty of the International Committee, which last met at Bucharest in 1937, is to study the technical problems associated with radiocommunication particularly in regard to its international aspects and to make appropriate recommendations to the Union for regulation.

It will thus be clear that the Committee is concerned with the technical problems which arise in the practice and operation of radiocommunication, and its members are the various national administrations controlling such communications. In the United Kingdom, the General Post Office is the appropriate administration for arranging for a delegation to participate in meetings of the International Advisory Committee; and for this purpose, that department organises a committee, with appropriate study groups, to prepare the documents to be submitted to the international conference. The committee contains representatives of all bodies, including Government departments and industrial organisations, concerned with the technical aspects of radio communication.

The next conference of the International Committee will be held in Stockholm during July 12–31, and among the subjects being studied in preparation for this are: (*a*) separation between frequencies assigned to radio stations; (*b*) international co-ordination of investigations on propagation; (*c*) methods of measurement of the field-strength of signals and of noise; (*d*) standard frequency and time-signal broadcasts; (*e*) monitoring of communication services; (*f*) distress signals.

INDIAN RESEARCH FUND ASSOCIATION

THE report of the Scientific Advisory Board of the Indian Research Fund Association (New Delhi) for the year ended December 31, 1946, gives some account of the researches carried out during the year on cholera, malaria, nutrition, leprosy, plague, pharmacology, maternity and child welfare, filariasis and other subjects, and includes the reports of the advisory committees as well as a list of papers published under the auspices of the Association, and the programme of researches and miscellaneous grants recommended for the financial year 1947–48. A cholera inquiry commenced at the Central Research Institute, Kasauli, is concerned with the substance and variability of the vibrios which may affect the efficiency of the vaccine used in cholera prophylaxis. The insecticide and mosquito repellent inquiry under the director of the Malaria Institute of India, Delhi, has covered the preparation of D.D.T. emulsion concentrates and aqueous suspensions, and field trials of D.D.T. solution, emulsions and suspensions and of 'Gammexane' solutions as residual sprays, as well as of turpentine, turpentine–toluene, and turpentine–rosin soap emulsions. A mammalian malaria inquiry covered studies of the experimental mosquito transmission of *Plasmodium cynomolgi* to *Macaca muletta* monkeys and the course of the infection and of the transmission of *P. cynomolgi* by blood and tissue sub-inoculation during the incubation period following sporozoite injection. An investigation of adult *Anopheles stephensi* was initiated at the School of Tropical Medicine, Calcutta, and another on the control of sand-flies, *Phlebotomus argentipes*, by spraying with D.D.T.

Nutrition researches under Dr. V. N. Patwardham at Coonoor have included studies of the vitamins of the B complex and the supplementary value of groundnut and coconut oil cakes in poor rice diets. Under Dr. B. N. Ghosh, at the University College of Science and Technology, Calcutta, studies of the biosynthesis of ascorbic acid by the rat have continued, as well as the inquiry into the chemical nature and nutritional availability of iron in foods; and the formation, function and variations of plasma proteins in health and disease have been investigated at the Grant Medical College, Bombay. The nutrition research unit at the University of Dacca has studied the metabolism of fat, the vitamin B complex, the relation between carbohydrate metabolism and nicotinic acid, the effect of soy-bean milk on growth; the similar unit at Seth G.S. Medical College, Bombay, in addition to fat metabolism, vitamin D and the enzymic liberation of nicotinic acid, has studied the nutritive value of pure-bred strains of cereals and pulses. In the laboratories of the Council of Scientific and Industrial Research at Delhi, a more exact determination has been made of the vitamin A activity of eighty-seven foodstuffs on the basis of individual carotenoids present. At the Women's Christian College, Madras, poor rice diets and food preparations in common use in South India have been investigated, and the evaluation of proteins in terms of hæmopoietic activity and the relation of dietary protein to blood and muscle hæmoglobin has been studied at the Biochemical Laboratory, University of Madras. The preparation of anti-rachitic substances and the nutritive value of soy-bean milk have also been studied at Poona and at Bangalore, respectively.

Leprosy research during the year at the School of Tropical Medicine, Calcutta, has included studies of promin, diasone, hydnocarpic derivatives of sulphonamides and aspergillin for the treatment of leprosy; work with stilbamidine has been continued and work with streptomycin has been concerned with its production from *Actinomyces griseus*. Some clinical, bacteriological and immunological work is also reported. Plague researches at the Haffkine Institute have included the effect of D.D.T. dust on the breeding of the Indian rat-fleas, *Xenopsylla cheopis* and *X. astia*; fumigation work with 'Cyanogas' and experiments with D.D.T. as pulicide are also described. Among the chemical researches reported may be mentioned that on Naga sore at the Pasteur Institute, Shillong, on hypoproteinæmia and other conditions associated with malnutrition and on erythroblastosis fœtalis and its association with the *Rh* factor at the School of Tropical Medicine, Calcutta, and the study of the anatomy of the foot with reference to infections of the foot at Stanley Hospital, Madras.

In pharmacology, the indigenous drugs inquiry has included studies of the effect of different methods of drying and of the age of the plants on the pyrethrum content of pyrethrum flower-heads, and on essential oil-bearing plants of the Kashmir valley. In the filariasis inquiry at the School of Tropical Medicine, Calcutta, the study of the action of the antimony compounds stibatin and anthiomaline was continued while the hæmatological unit studied the blood picture and protein content of healthy Indian vegetarians Chemotherapeutic investigations on kala-azar, the production of penicillin, anthelmintic trials of indigenous drugs against hookworm and ascaris infestation, the serological diagnosis of typhus fever by the Weil–Felix reaction and isolation of rickettsia strains, anaerobic wound infections, the manufacture of influenza virus A vaccine, the behaviour of membrane vaccine lymph in the field and the effect of cobra venom on the aerobic oxidation of *d*-glutami acid are among the miscellaneous researches reported.

The reports of the advisory committees cover much the same ground but include a number of important appendixes. Among these may be mentioned a summary of work done on cholera at the Haffkin Institute, a note of the recommendations for the fortification of staple foodstuffs from the Food Fortification Sub-Committee of the Nutrition Advisory Sub-Committee, and a note on the nutritiv value of 'Vanaspati' or hydrogenated vegetable oils.

scheme for the investigation of lathyrism, and notes on suggested lines of work on shock, the segregation and treatment of cases of tetanus with the view of clinical trials of V-187 in India, on the classification of clinical tetanus, and on a technique for removal of the brain and spinal cord in cases of lathyrism are also given. There are also reports on the distribution of typhus fever in the army in India, 1943–46, and of the sub-committee appointed to examine the possibility of maintaining sickness absenteeism records in Indian industries.

LATIN AMERICAN CULTURES

THE Institute of Social Anthropology, which has recently been formed within the Smithsonian nstitution, has started to issue an important series of monographs*. The five which have so far appeared deal with Latin America and have a very wide range. Their object is both scientific and practical, and the co-operation afforded by the national authorities both in Mexico and in Peru is a measure of the importance which they ascribe to the work. Leaving aside No. 1, on houses and house use of the Sierra Tarascans, which was published so long ago as 1944, he following brief comments are intended to give some indication of the nature of the series.

Nos. 2 and 3 are detailed studies of a small highland town in Mexico and of a coastal town of the same rder of magnitude on the coast of Peru. Although the people of Cherán are Tarascan Indians, with little white blood, speaking their native language and living principally by agriculture like their forefathers, the conclusion is reached that most traits of their culture are derived from Europe. This is not to say that it is a European culture, since the contact with indigenus Tarascan elements has caused it to develop into omething distinct from either; in fact, into what Mr. Gillin, in his monograph on Moche, would describe as a Creole culture.

Moche is by comparison a drab place, as the useful eries of photographs in each publication will show, but Mr. Gillin's analysis proves that its culture ontains a far higher proportion of indigenous lements. The town lies almost under the shadow of the two great pyramids of Moche, and, like them, ves its name to the ancient Mochica culture; but his had at least two successors before the Spanish onquest, so it must not be expected that much of has survived unmodified to the present time, as Mr. Gillin is careful to point out; and the remaining original elements are common to a number of e-Colombian cultures rather than specific to the Mochica. The difference between the two towns is ell illustrated by the accounts given of witchcraft each of them. The data for Cherán are far from omplete, but what there are have a completely uropean aspect, whereas those for Moche, which are ller, have a predominantly shamanistic comexion. In spite of the aboriginal survivals, however, he author shows that Moche has a Creole culture ather than an Indian one, but considers it likely hat it has changed considerably in this sense during he past generation.

No. 5 is a preliminary study, undertaken in order to choose a suitable place for more detailed work. It brings out the great variety in degree of change from Indian to white culture which is found in the Central Andes of Peru. One of its most illuminating features is a discussion of what constitutes an Indian, showing that racial criteria are so difficult to apply that a cultural definition is generally the only practicable one. In addition to introductory matter, which includes general accounts of the geography and the population, the paper contains interesting brief descriptions of most of the places visited. The town of Sicaya was chosen for further study, on the ground that it demonstrated best the process by which an Indian acquires a Mestizo culture and the Mestizo a white culture.

No. 4 is a voluminous and well-illustrated work, containing the geographical materials which an anthropologist needs to build on, particularly with regard to the use of land, and which he too often has to neglect owing to lack of specialized training. It will, presumably, be followed up by more purely anthropological studies.

G. H. S. BUSHNELL

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2. Cherán: A Sierra Tarascan Village. By Ralph L. Beals. x+225+8 plates. 3. Moche: a Peruvian Coastal Community. John Gillin. Pp. vii+166+26 plates. 4. Cultural and Historical ography of Southwest Guatemala. By Felix Webster McBryde. xv+184+47 plates. 5. Highland Communities of Central Peru: egional Survey. By Harry Tschopik, Jr. Pp. viii+56+15 plates. cents each. (Pub. 2–5 of the Institute of Social Anthropology, ithsonian Institution, Washington, D.C.)

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, May 1

BRITISH PSYCHOLOGICAL SOCIETY (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. David Katz: "Gestalt Laws of the Body Scheme".

Monday, May 3

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Lord Teviot: "The Lucas Report".

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE (at Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. Frank H. Knight: "Economic Theory and the Good Society". (Further Lectures on May 10, 24, 31, June 7 and 14.)*

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. T. Winter: "The Development of the Jet Propulsion Engine".

CHEMICAL SOCIETY, LEEDS SECTION (in the Chemistry Department, The University, Leeds), at 6.30 p.m.—Prof. Linus C. Pauling, For. Mem.R.S.: "The Valence of Metals and the Structure of Intermetallic Compounds".

SOCIETY OF CHEMICAL INDUSTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting: Mr. B. A. Southgate: "The Treatment and Disposal of Waste Waters from Industry".

Monday, May 3—Friday, May 7

LIBRARY ASSOCIATION (in the Spa Grand Hall, Scarborough).—Annual Conference.

Tuesday, May 4

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND (at the Royal Institution of Chartered Surveyors, 12 Great George Street, London, S.W.1), at 2.30 p.m.—Annual General Meeting.

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Annual General Meeting.

ROYAL ANTHROPOLOGICAL INSTITUTE (joint meeting with the INTERNATIONAL AFRICAN INSTITUTE, at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Max Gluckman, Mr. J. H. Barnes and Mr. J. C. Mitchell: "The Village Headman in British Central Africa".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. N. Pring: "Modern Propellants Employed in British Ordnance".

Wednesday, May 5

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. F. G. Mann, F.R.S.: "Recent Advances in Stereochemistry" (Pope Memorial Lecture).

PHYSICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 4 p.m.—Annual General Meeting; at 5 p.m.—Prof. Yves Rocard: "Sur les conditions d'autooscillation des systèmes vibrants" (Third Holweck Discourse).

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (at the Portico Library, Manchester), at 5.30 p.m.—Prof. J. A. Hawgood: "Education in Germany".*

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Wednesday, May 5—Thursday, May 6

IRON AND STEEL INSTITUTE (at the Royal Institution of Chartered Surveyors, 12 Great George Street, London, S.W.1).—Annual General Meeting.

Wednesday, May 5

At 9.45 a.m.—Morning Session; at 2.30 p.m.—Afternoon Session; at 8.30 p.m.—Prof. Robert F. Mehl: "The Decomposition of Austenite by Nucleation and Growth Processes" (Third Hatfield Memorial Lecture).

Thursday, May 6

At 9.30 a.m.—Morning Session.

Thursday, May 6

ROYAL SOCIETY OF ARTS, INDIA, PAKISTAN AND BURMA SECTION (joint meeting with the EAST INDIA ASSOCIATION, at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Frederick E. James: "Tatas—a Story of 60 Years' Industrial Development in India".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

CHEMICAL SOCIETY, MANCHESTER SECTION (in the Chemistry Department, The University, Manchester), at 6.30 p.m.—Prof. Linus C. Pauling, For.Mem.R.S.: "The Chemical Bond".

CHEMICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 7.30 p.m.—Sir John Lennard-Jones, F.R.S.: "The Molecular Orbital Theory of Valency".

Saturday, May 8

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, DIVISION FOR SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE (at the Assembly Hall, Leamington Spa), at 2 p.m.—Conference on "Human Factors in Industry".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURERS IN MATHEMATICS, a LECTURER IN PHYSICS, a LECTURER IN CHEMISTRY, a LECTURER IN BIOLOGY, SENIOR ASSISTANTS (2) to teach CIVIL AND MECHANICAL ENGINEERING subjects to Honours degree standard, LECTURERS IN ENGINEERING to teach in some selected branch of Civil or Mechanical Engineering up to Degree standard, LECTURERS IN ENGINEERING to teach classes of a Workshop and Production Engineering character up to Higher National Certificate, and a LECTURER IN ELECTRICAL ENGINEERING—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (May 8).

PRINCIPAL RESEARCH OFFICER to supervise the Electronics, Acoustics and Electrical Standards Sections of the Electro-Technical Division of the South African National Physical Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (May 10).

LECTURER IN AGRICULTURE (HEAD OF THE DEPARTMENT)—The Director of Agriculture, School of Agriculture, Houghall, Durham (May 10).

SPECIALIST IN VISUAL AIDS at the Ministry of Education—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2158 (May 13).

LECTURER (Grade III) IN MECHANICAL ENGINEERING—The Registrar, Queen Mary College, Mile End Road, London, E.1 (May 14).

LECTURER IN CHEMISTRY with special reference to Electrochemistry, and a RESEARCH ASSISTANT IN THE ZOOLOGY DEPARTMENT for work on Neurotoxic Insecticides with reference to problems of Locust Control—The Secretary of University Court, The University, Glasgow (May 15).

LECTURER (Grade II) IN STATISTICS, and an ASSISTANT LECTURER (Grade III) IN APPLIED MATHEMATICS—The Registrar, The University, Liverpool (May 15).

LECTURER IN THE MATHEMATICS DEPARTMENT—The Principal, Heriot-Watt College, Edinburgh (May 15).

LECTURER IN NATURAL PHILOSOPHY IN UNIVERSITY COLLEGE Dundee—The Secretary, The University, St. Andrews (May 15).

LECTURER IN CHEMISTRY—The Secretary, The University, Aberdeen (May 17).

LECTURER IN GEOGRAPHY—The Registrar, The University, Reading (May 24).

PRINCIPAL SCIENTIFIC OFFICER for Accidents Investigation in the Royal Aircraft Establishment, South Farnborough—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2153 (May 25).

PRINCIPAL SCIENTIFIC OFFICER, and a SENIOR SCIENTIFIC OFFICER, in the Ministry of Agriculture and Fisheries for employment at the Plant Pathology Laboratory, Harpenden—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2151 (May 26).

LECTURER IN APPLIED MATHEMATICS—The Secretary, The University, 38 North Bailey, Durham (May 29).

LECTURER IN THE TECHNICAL DEPARTMENT (for City and Guilds Telecommunications up to Grade 5)—The Technical Officer, University College, Southampton (June 12).

ASSISTANT LECTURERS (2. Grade III), mainly for research in Plankton and Algology, at the Port Erin Marine Biological Station—The Registrar, The University, Liverpool (July 15).

DESIGN ENGINEERS (Instruments), and STANDARDS ENGINEERS, IN THE DEPARTMENT OF ATOMIC ENERGY (Production)—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

LECTURER IN THE MATHEMATICS DEPARTMENT—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER IN STATISTICS, a LECTURER (Grade I) IN PHYSICS, and a LECTURER (Grade II) IN PHYSICS—The Registrar, The University, Reading.

LECTURER IN ANATOMY (to take charge of dental and massage classes), in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

LECTURER IN CHARGE OF AGRICULTURAL CHEMISTRY DEPARTMENT—The Secretary and Bursar, Seale-Hayne Agricultural College, Newton Abbot, Devon.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Vision. (Published 3 times a year). No. 1: Autumn. Pp. 36 (London: Association of Optical Practitioners, 1947.) 1*s*. [161

British Journal of Nutrition. (Quarterly.) Vol. 1, No. 1, September Pp. ii + 108. (Cambridge: At the University Press, 1947.) 20*s*. net annual subscription, £3. [211

Rubber Developments. Vol. 1, No. 1, September. Pp. 40. (London British Rubber Development Board, 1947.) [211

Ministry of Fuel and Power. Report on the Petroleum and Syntheti Oil Industry of Germany to the Rt. Hon. Emanuel Shinwell. By a Mission from the Ministry of Fuel and Power. Pp. v + 134. (London H.M. Stationery Office, 1947.) 10*s*. net. [201

Air Transport and Geography. By W. G. V. Balchin. Pp. 23 (London: Royal Geographical Society, 1947.) 1*s*. [1

British Journal of Radiology. Supplement No. 1: Report of Londo Conference held May 13–14, 1946, on Certain Aspects of the Action o Radiation on Living Cells. Edited by F. G. Spear. Pp. 146. (London British Institute of Radiology, 1947.) 15*s*. 6*d*. [1

Other Countries

The Round Earth on Flat Paper. Map Projections used b Cartographers, by Wellman Chamberlin; Map Services of the Nationa Geographic Society, by Gilbert Grosvenor. Pp. 126. (Washington D.C.: National Geographic Society, 1947.) 60 cents. [19

The Indian Archives. (Quarterly.) Vol. 1, No. 1, January 194 Pp. 96. (New Delhi: Imperial Record Department, 1947.) 2 rupees annual subscription, 8 rupees. [26

Evolution: International Journal of Organic Evolution. Publishe quarterly by the Society for the Study of Evolution. Vol. 1, Nos. 1– March-June. Pp. 112. (Chicago: Society for the Study o Evolution, c/o Chicago Natural History Museum, 1947.) Singl Nos., 1.50 dollars; 6 dollars per vol. [26

D.D.T. for Control of Household Pests. Pp. 16. (Washingto D.C.: Government Printing Office, 1947.) 5 cents. [26

Surgery. Being Section 9 of Excerpta Medica. Vol. 1, No. 1, Septem ber. Pp. 122. (Amsterdam: N.V. Excerpta Medica, 1947.) 25 dollars £6 4*s*., per year. [15

Endocrinology (Experimental and Clinical). Being Section 3 Excerpta Medica. Vol. 1, No. 1, August. Pp. 66. (Amsterdam: N.V Excerpta Medica, 1947.) 15 dollars; £3 15*s*., per year. [151

Unasylva. A magazine of Forestry and Forest Products publishe bi-monthly. Vol. 1, No. 1, July–August. Pp. 64. (Washington, D.C. Food and Agriculture Organization of the United Nations, 1947 65 cents; 3.50 dollars per year. [16

The Tropic Proofing of Optical Instruments. By Prof. J. S. Turne Assoc. Prof. Ethel I. McLennan and J. S. Rogers. Pp. 80 + 7 plate (Melbourne: Prof. J. S. Turner, Botany Department, The Universit 1947.) [16

Information: Journal of the Association of Special Libraries ar Information Services. Vol. 1, No. 1, June. Pp. 32. (Melbourn Association of Special Libraries and Information Services, 194 25*s*. per year. [21

Marriage Hygiene, Second Series. (Published quarterly.) Vol. No. 1, August. Pp. 64. (Bombay: Whiteaway Building, Horn Road, 1947.) 3.8 rupees, 6*s*.; 12 rupees, 22*s*., per year. [21

Science, Government and Industry. Inaugural of the Arthur Deh Little Memorial Lectures at the Massachusetts Institute of Technolog at Cambridge, Massachusetts, November 19, 1946. By Sir Edward Appleton. Pp. 38. (Cambridge, Mass.: Massachusetts Institute Technology, 1946.) [22

Catalogues

Galvanometer Suspension Strip. (Publication 2537.) Pp. Permanent Scales and Marks on Glass. (Publication 2572.) Pp. (London: Johnson, Matthey and Co., Ltd., 1947.)

Hydrogen Ions: pH Measurement with particular reference to t Glass Electrode. Pp. iv + 44. (St. Albans: Marconi Instrumen Ltd., 1947.)

The Aluminium Courier. No. 1, August. Pp. 8. (London: Alum ium Development Association, 1947.)

Chemicals. Pp. 16. (West Bromwich: Robinson Brothers, Lt 1947.)

A Catalogue of Books and Manuscripts issued to commemorate t One Hundredth Anniversary of the Firm of Bernard Quaritch, 18 1947. Pp. xvii + 91 + 20 plates. (London: Bernard Quaritch, Lt 1947.)

Winter Washes and Spraying Programmes. Pp. 20. (Wheathan stead: The Murphy Chemical Co., Ltd., 1947.)

Muirhead-Wigan Decade Oscillator, Type D-105-A. (Bulle B-528-D.) Pp. 2. (Beckenham: Muirhead and Co., Ltd., 1947.)

A Catalogue of Scientific Apparatus for Lecture and Laborat Use in the Study of Physics, Chemistry, Biology and General Scie for University and other Examinations. (Catalogue 52 AB.). Pp. vi 616. (London: Griffin and Tatlock, Ltd., 1947.)

Sciex Bulletin. No. 1 Technical Series. Pp. 16. (London: Scient Exports (Great Britain), Ltd., 1947.)

A Miscellany of Books from the 16th to the 20th Century. (Catalo No. 504.) Pp. 42. (Cambridge: Bowes and Bowes, 1947.)

Self Centring Lens Edging Machine; Toric Ophthalmic L Grinding Machine. Pp. 4. (Leicester: Adcock and Shipley, L 1947.)

NATURE

No. 4097 SATURDAY, MAY 8, 1948 Vol. 161

CONTENTS

Page
Scientific Research and Industrial Development 699
Early English Country Life. By Sir John Russell, O.B.E., F.R.S. . 701
Electronics. By Dr. T. E. Allibone, F.R.S. 702
Progress in the Oil Industry during the War-Years. By H. B. Milner 703
Potential Theory of Aerofoils. By Prof. W. J. Duncan, F.R.S. . . 703
Plant Geography. By Sir Edward Salisbury, C.B.E., F.R.S. . . 704
Optics in Holland. By S. Weintroub 704
Nature of Forces Between Large Molecules of Biological Interest. By Prof. Linus Pauling 707
Synoptic Weather Maps for the Antarctic 709
World Forestry and Forest Products. By Prof. E. P. Stebbing . 710
Calculating Machines 712
Obituary :
  Prof. James McIntosh. By Prof. E. C. Dodds, M.V.O., F.R.S. . 713
News and Views 714
Letters to the Editors :
  Curare-like Action of Polymethylene *bis*-Quaternary Ammonium Salts.—Dr. R. B. Barlow and Dr. H. R. Ing ; Dr. W. D. M. Paton and Dr. E. J. Zaimis 718
  Antibiotic Substances from the Heart Wood of *Thuja plicata* Don.—Prof. Holger Erdtman and Dr. Jarl Gripenberg . . 719
  Separation and Identification of Methylated Sugars on the Paper Chromatogram.—F. Brown, Prof. E. L. Hirst, F.R.S., L. Hough, Dr. J. K. N. Jones and H. Wadman 720
  Electrophoretic Behaviour of Modified Ovalbumins.—Gertrude E. Perlmann 720
  Reductone and the Synthesis of Pteridines.—Dr. H. S. Forrest and Dr. James Walker 721
  Stereochemistry of Trimeric Thioaldehydes.—Prof. Alexander Schönberg and Mohamed Zaki Barakat ; Dr. G. M. Bennett, C.B., F.R.S. 722
  The Sommelet Reaction.—Dr. S. J. Angyal and R. C. Rassack . 723
  Chemistry of Visual Processes.—Dr. M. H. Pirenne . . . 724
  Variation of the Force Constant with the Ionization Potential and the Polarizability for some Halogen Compounds.—P. Torkington 724
  The Melanin Problem : a Synthesis of 5 : 6-Dihydroxy-indole and its Derivatives.—Prof. H. Burton and Miss J. A. Duffield 725
  Bond-Strength of C–Cd in Cadmium Methyl and of C–I in Methyl Iodide.—A. S. Carson, K. Hartley and Dr. H. A. Skinner 725
  Atomic Oxygen and Dissociation in Flame Gases.—Prof. W. T. David, C. Rounthwaite and N. Carpenter 726
  Scattering of 100-MeV. Neutrons by Protons.—F. C. Barker . 726
  Comparison of Cross-sections for the Capture of 220 and 900 keV. Neutrons.—R. Allen, G. R. Bishop, P. Demers and Dr. H. Halban 727
  Rate of Wear in the Region of the Validity of Amontons' Law. —Henry James Bezer and Dr. Robert Schnurmann . . 728
  Optical Transmission of a Colloidal Solution in a Magnetic Field.—F. D. Stott and Dr. A. von Engel 728
  Dielectric Constant of Diamond.—Prof. S. Bhagavantam and D. A. A. S. Narayana Rao 729
  Delayed Fracture of Glass under Tension, Torsion and Radial Pressure.—C. Gurney 729
  Northern Hemisphere Surface Pressure and Climatic Fluctuations and Vegetation Growth in Northern Finland.—G. W. Brier . 730
  Dissociation Energies.—Dr. A. G. Gaydon 731
  The Swimming of Dolphins.—Dr. L. Harrison Matthews . . 731
  References in Scientific Literature.—Prof. R. A. Peters, F.R.S. . 731
British Scientific Instruments. By Dr. A. B. Wood 732
Critical British Groups of Flowering Plants. By J. E. Lousley . 733
Emission of Li^8 in the Explosive Disintegration of Nuclei. By C. Franzinetti and R. M. Payne 735
Rheology in the Textile Industries. By L. Peters 737
Recent Research in Marine Biology. By Dr. N. B. Eales . . . 737
Naples Zoological Station 738
Electrical Stimulation of the Neurohypophysis in the Conscious Animal 739

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SCIENTIFIC RESEARCH AND INDUSTRIAL DEVELOPMENT

IN opening a discussion, over which Sir John Anderson presided, at the centenary meeting in 1931 of the British Association, Sir Arthur Fleming urged the establishment of a national organisation to provide means of analysing the possibilities which new ideas afford of developing new lines of manufacture. Since that time, there has been frequent consideration of the means of bridging the gap between the birth of an idea and its industrial application. Reporting back to the Economic Advisory Council in 1932, the Committee of New Industrial Development rejected the proposal for a national organisation, on the ground that there was no evidence of an important gap in the existing arrangements for industrial research. Various reports during the last decade, however, have emphasized the difficulties and expensiveness of pilot-plant development, and it has been a main objective of a sub-committee of the Parliamentary and Scientific Committee since 1943 to secure some modification of taxation policy in this connexion, and to promote a national organisation for the purpose.

In a debate in the House of Commons on April 19, 1944, Mr. C. R. Attlee, then Lord President of the Council, said that the Coalition Government recognized the need for the establishment of some fund to meet the cost of developing new inventions and of providing facilities for testing new ideas for industry. The same idea was in the minds of many members of Parliament of all parties when they tabled an amendment to the Investment Control and Guarantee Bill in 1945, and in subsequent discussions with the Lord President of the Council and the Chancellor of the Exchequer. That amendment and those discussions, it should be noted, were subsequent to the important changes in taxation policy, introducing special relief on account of obsolescence as well as for depreciation, which Sir John Anderson announced in introducing the Budget in April 1944.

In a valuable Statement on Problems of Scientific and Industrial Research in 1944, Nuffield College suggested that a special development fund might be desirable from which grants could be made in suitable cases for the large-scale experimental work required for the commercial development of discoveries in applied science. The statement also visualized the establishment of an institution on the lines of the Research Corporation in the United States, to act for the universities and technical colleges collectively in the matter of patents arising out of discoveries of commercial value made in the course of academic research, and to license the use of such patents in return for royalties. In a report on Industry and Research, in October 1943, the Industrial Research Committee of the Federation of British Industries likewise recommended the careful investigation of the desirability of creating such machinery; but favoured the creation of an independent and not a Government organisation for the purpose.

Still more recently, in its Final Report on the Patents and Designs Acts last September, the Swan Committee, in considering the development and exploitation of inventions of value in the public interest, expressed the opinion that the right policy is to treat all patents in respect of State-owned or State-subsidized inventions as a public asset and to vest them in a single central body, suitably organised, and with a staff competent to estimate the potential value of the inventions concerned and able to decide upon and take such steps as are necessary to develop and make full use of them in British industry. In the past, the policy adopted by Government departments in dealing with patents has varied widely, both in regard to the exploitation and disposal of the patent rights and in regard to the remuneration of the inventor. On the latter point, the Swan Committee, while noting the complexity and difficulty of determining what, if any, reward should be given to the originator for inventions evolved in the State service or with the aid of public money, observes that only for inventions of exceptional brilliancy or utility, or for some other special reason, can any award be justified. Whether this task should be entrusted to a distinct or independent body, such as the Central Awards Committee, or to a panel of assessors forming an integral part of the holding and exploiting organisation, is a matter for decision when the scope and function of such an organisation are considered in detail.

This is the background against which the Development of Inventions Bill (London: H.M. Stationery Office, 1948. 4*d*. net), which received its first reading in the House of Lords on April 13, must be considered. The Bill provides for the establishment of a National Research Development Corporation, which would have as one function the acquisition, holding, disposition and granting of rights in connexion with inventions resulting from such public research and, where the public interest is involved, in connexion with inventions resulting from other sources. The second function of the Corporation would be that of securing, where the public interest so requires, the development or exploitation of inventions resulting from public research, and of any other invention that, in the view of the Corporation, appears not to be sufficiently developed or exploited. In pursuance of this function the Corporation would be empowered to carry on any activity which may be advantageous or convenient for the purpose, and, in particular, to carry on or facilitate the carrying on by other persons of any business. Where such activities, however, involve the carrying out of any project for manufacture, the construction of works or provision of services, the provision of financial assistance in development or exploitation of any invention, or the acquisition of any undertaking, entire or in part, the approval of the Board of Trade is required.

The Corporation would consist of a chairman and managing director appointed by the Board of Trade, and not less than four or more than ten other members also appointed by the Board from those possessing experience and capacity in matters relating to science, technology, industry, finance, administration or the acquisition and disposal of rights in inventions. The Board of Trade would be authorized to make advances to the Corporation up to a total of £5 millions during the five years from the establishment of the Corporation, and temporary borrowing powers up to a limit of £250,000 are also proposed for the Corporation. The normal procedure envisaged is the licensing of a particular process or invention to an industrial undertaking, the Corporation fixing the royalty to be paid. The Corporation would be expected as soon as possible to meet its expenditure out of income; but repayment of interest on advances made by the Board of Trade might be waived during the first five years.

It will be seen, therefore, that there is already a large measure of support from all political parties in Britain as well as from independent opinion for the two main purposes of the proposed National Research Development Corporation. It is recognized that some uniform method is required in dealing with the growing number of inventions made by persons or groups of persons carrying out research work in the Government service, or engaged in research which is in some way subsidized by the State. This obviously includes the problem of academic research to which the Nuffield College Statement referred; while in its second function of developing any neglected invention or scientific discovery likely to lead to the creation of a valuable new industry or industrial process, the new Corporation should give a much fairer prospect of success to the inventor who has no capital resources of his own and who, in Great Britain, has often been notoriously unsuccessful in obtaining commercial backing.

The assumption by the Government of such special risk-bearing functions on behalf of the public is appropriate at a time when not only is new development of such vital importance to Britain's recovery, but also when the Government is doing much to encourage the taking of risks by the private individual. It is this positive aspect of the Corporation's work that requires emphasis. It was never contemplated in the protracted discussions over the last fifteen years, out of which the project has been born, that the Corporation should limit its activities to the discouragement or redress of restrictive practices. On the contrary, the proposed new body is to cover every range of industry in which for any reason a scientific invention had been neglected.

The National Research Development Corporation, being clearly the body envisaged by the Swan Committee, may possibly be expected to deal, *inter alia*, with the elimination of restrictive practices. This Committee, in its second interim report, recorded the opinion that the deliberate suppression of invention had been much exaggerated, and it could find no satisfactory evidence of particular examples of such practice. Nevertheless, even if this is only a minor activity of the Corporation, the relation of the Corporation to the Monopoly Commission which would be set up by another Bill already before the House of Commons should be made clear.

Recognizing that the Corporation is not intended to be unfairly competitive with British industry, but rather to assist industry to hold a leading place in industrial development, it is still true that the exact mechanism by which the Corporation is to achieve its purpose will require careful scrutiny. The idea of an independent organisation, supported by public funds, as suggested by the Federation of British Industries, has certain advantages which deserve careful consideration, especially where the powers of erecting and running pilot plants at the public expense are concerned. Without questioning the genuineness of the intentions of the present Government, the possibility must be borne in mind that at some time or other the powers of a Government corporation might be abused.

It should not be necessary to emphasize the importance, in view of the large measure of agreement on the value of creating such a Corporation which already exists, of discussion on amendments or the introduction of safeguards proceeding on objective and not on party lines. If the Corporation is to succeed, it will have to work in close co-operation with such bodies as the Federation of British Industries, the new development councils, the Trade Union Congress, and the various research organisations of different types. Moreover, although there are *prima facie* reasons for the Corporation reporting to the Board of Trade and coming under the surveillance of that department, its position with regard to the research effort of Great Britain may involve close relations with departments under the Lord President of the Council, such as the Department of Scientific and Industrial Research, as well as with the Advisory Council on Scientific Policy.

Much will obviously depend on securing the right men, not only for posts of chairman and managing director, but also for the ordinary membership of the Corporation. Everything will rest on their judgment, ability and vision. In any event, the new proposal must clearly be considered first of all in relation to the general research organisation of Britain; in this connexion the factors concerned include aspects of taxation policy already noted, the adequacy of existing types of organisation for industrial research, and the potentialities of new types on the pattern of the Mellon Institute and the Armour Research Foundation, to which also the Swan Committee referred. It should be remembered that at the present time the research development programmes of many enterprising British firms are seriously hampered by delays in the grant of licences and by the lack of either man-power or materials. Such factors may well hinder the activities of the new Corporation, and it were well to consider whether there is not some risk that by competing with existing industry for the available supplies it may indirectly accentuate such difficulties.

The proposed National Research Development Corporation, if it is established, will be launched in difficult times, and unless directed with imagination as well as wisdom its influence will not necessarily be wholly good. In order to achieve its objectives it may well need considerably more than the five million pounds proposed for the first five years; indeed, it may be necessary to reconsider the whole of the financial aspect.

In recommending the establishment of a research corporation to handle the matter of patents arising out of discoveries of commercial value made in the course of academic research and to license the use of such patents in return for royalties, the Nuffield Foundation was apparently thinking less of the expensive pilot-plant stage of development than of the application of the resulting revenues in payments to the universities for the furtherance of fresh research. The proposal was made as a means of avoiding any temptation to the universities to regard scientific work as a possible source of profit, while at the same time preventing academic research being made a source of unmerited profit to others or running to waste where it holds the prospect of real benefit to the public. The Nuffield Foundation statement noted that in the twelve years ending in June 1941, the Research Corporation in the United States had spent well over a million dollars in support of scientific and industrial research; hence from this point of view alone the present proposal for a National Research Development Corporation merits careful examination.

Fundamentally, as we have already indicated, the proposal raises the question of the adequacy of the whole structure of the organisation for scientific and industrial research in Great Britain, and as such it is important that there should be ample time for close and objective scrutiny of all aspects of the situation. It is to be hoped that neither in Parliament nor elsewhere will there be any attempt either to curtail that study and discussion, or to force a decision on party lines when so much has already been done to prepare the way for an impartial verdict.

EARLY ENGLISH COUNTRY LIFE

Village Life in the Eighteenth Century

By G. E. Fussell. Pp. 84+11 plates. (Worcester: Littlebury and Co., Ltd., n.d.) 9*s*. 6*d*. net.

AFTER an active official life, Mr. G. E. Fussell set himself to continue and develop the historical studies which had long made him known to all interested in English country life, and in this little book he has brought together in compact but very readable form a connected account of the English village as it was in the eighteenth century. It was an important period for our agriculture; during the first half Jethro Tull, by the introduction of the seed drill and the horse hoe, and Lord Townshend, by developing the method of crop rotation, were laying the foundations for the change from the old to the new agriculture which was brought about in the latter part of the century by Coke of Norfolk, Bakewell of Dishley and others. The author begins by describing the lay-out of the village, the three classes of people—landlord, tenant and labourer—the mode of government, how the people lived and what work they had to do in the various seasons of the year, their social life, the village trade and commerce.

There is nothing fanciful in the matter, and nothing sentimental or nostalgic in its presentation, but a plain unvarnished account of how the village would appear to us if we could go back through the years and see it. Work was long and arduous, though the pace was slow; pleasures consisted in visiting, sitting round the fire and drinking, the local ale-house being also the local club; there were numerous outdoor sports, some so cruel that they were later suppressed, for example, cock-fighting, bull-baiting, etc. Festivals and holidays were no longer as numerous as in the pre-Puritan days; but a number still survived, and the tradition of a 'Merrie England' is not altogether unfounded. The villagers were on the whole well clad; the poorer ones ate but little meat and had to live on bread and cheese, the bread often being made of mixed rye and wheat. Those better off could have a weekly dish of salted pork or bacon, often eaten with a hard ball of barley meal instead of bread. Milk and small beer were available, and for those who could afford it, tea and ale. At the other end of the social scale large quantities of meat were eaten, and the 'roast beef of Old England' was a reality.

The inadequate dietary and lack of sanitation resulted in widespread scurvy, skin diseases, small-pox, etc., and epidemics spread with alarming rapidity. The winter was terribly dreary; the cottages were cold, damp and draughty, the food was monotonous: the salt meat became worse and worse as the months went by, and only the more fortunate had any attractive food. Spring was welcomed with great joy—how great is testified by all the early poets.

The old agriculture is sufficiently described and also the management of the livestock. The student might wish for more actual references instead of the phrase "a contemporary writer", and it would have been interesting if Mr. Fussell could have told us of some of the ways in which the ingenious village women used wild plants and other natural resources. But these are small details: the book is full of interest, and it has some well-chosen and unusual illustrations. We can commend it to all interested in English country life. E. JOHN RUSSELL

ELECTRONICS

Electronics and their Application in Industry and Research

Edited by Dr. Bernard Lovell. Pp. xvi+675. (London: Pilot Press, Ltd., 1947.) 42*s.* net.

> "If seven maids with seven mops
> Swept it for half a year,
> Do you suppose", the Walrus said,
> "That they could get it clear?"

THE editor of a book on electronics might well assess his task as almost impossible and be excused if, in desperation, he shed a bitter tear. The subject is not only enormous; it has grown extremely rapidly at a period of our history when there has been no time for the writing of text-books. It is even doubtful whether any one writer could do justice to the whole of the subject without taking so long a time that the beginning of the book would be out of date when the last page was written. Dr. Lovell has wisely spread the load over fourteen colleagues, each one a specialist in the section of electronics in which he writes. The result, in the absence of drastic editing, gives the impression the old lady had when she read the dictionary—"Somewhat disconnected, though very interesting"; but at least Dr. Lovell has produced a good book thereby in a short time. The information cannot in general be found in any other book or books, it has hitherto been available only in numerous scientific papers; indeed, two months before the book was published, I was in need of some information on electronics for the jubilee celebrations of the discovery of the electron and was obliged to read more than fifty papers to glean what I wanted. All of it can be found within the pages of this compendium.

The book is not primarily about electronic engineering and the application of electronic control aids to industry; for that the reader might be referred to Dr. H. A. Thomas's paper in the *Journal of the Institution of Electrical Engineers* (1947). It concerns an old science revitalized; 'how to use electrons' as distinct from 'how to use thermionic valves'. One beautiful illustration of this is the television camera, described by Dr. J. M. McGee. Electrons are ejected by photo-emission, are focused by electron optics, and produce others by secondary emission; an electron gun employing the latest ideas of electron trajectories is used, together with an electron multiplier to make the apparatus a little more complicated—but a superb example of the electronic art.

The fundamental physical processes of electron emission are nicely, if perhaps too briefly, dealt with by Dr. F. A. Vick. This is one of the chapters that will have to be supplemented by much additional reading for the serious student of electronics; but for many engineers and physicists the details given are sufficient to explain the modern concept of the potential barrier and the factors which influence the escape of electrons from a surface. One very small omission here might be confusing to readers of Millikan: Dr. Vick states that the photo-electric threshold of all metals is in the ultra-violet; but readers will recall Millikan's work on sodium and potassium surfaces sensitive to visible light. The practical details of Dr. Vick's subject are fairly fully reviewed by Dr. H. G. Lubszynski and Dr. A. Elliott. I suspect that much of the Admiralty work on infra-red sensitive photo-cells is described here for the first time in public print, and this feature has been a special aim of Dr. Lovell, namely, to describe significant developments of the past decade not so far dealt with elsewhere.

There are some other great chapters in the book: Dr. V. E. Cosslett's is a model essay on electron microscopy written in the simple language of the Prayer Book of Edward VI. Even to a specialist it is delightful and extremely well illustrated. Dr. McGee's article on television is good, though too much space is devoted to earlier developments already well written up in popular language elsewhere. The account of servo-mechanisms is very exhaustive, but is much more akin to electronic engineering than the previously mentioned essays; in fact, there are two or three other chapters which could have been transferred to electronic engineering. The magnetron is not given the attention it deserves; an essay twice as long would not have been too much for one of the biggest developments of the war years. The chapter on high-frequency heating contains no reference to what, I thought, was almost the starting-point of this subject: Burch and Davis's book "Induction Heating". Dr. R. J. Pumphrey's article on electronics in zoology is frankly disappointing: the language could have been much more carefully chosen for an audience of catholic interests.

Other chapters will find general favour; on radar, on the betatron, etc. Indeed, I read the book from cover to cover with keen interest and am certain scientific men of a variety of callings will do the same.

T. E. Allibone

PROGRESS IN THE OIL INDUSTRY DURING THE WAR-YEARS

Reviews of Petroleum Technology

Vol. 7 (covering 1941–45). Pp. viii+535. (London: Institute of Petroleum, 1947.) 21*s*.

THE last volume in this series (for 1940) appeared in 1941, since when the exigencies of war prevented publication as hitherto. The present volume covers the quinquennial period 1941–45—critical war years—and its contents thus reflect the trend of petroleum technology over a wide field during the most abnormal times the industry has ever passed through.

The format has not changed substantially. Reviews of subjects, each written by an acknowledged specialist in the particular field chosen, follow precedent. Petroleum geology covers origin, migration and accumulation, sedimentation, salt-domes and search for oil. Geophysics ranges from seismic methods to radioactivity. Drilling deals with recent progress, well hydrology, records and completion factors. Incidentally, an oil-well depth record of more than 16,600 ft. was established in Texas in 1945. Production engineering is concerned chiefly with reservoir engineering and control and well engineering generally. Oil transportation includes an account of war-time activities in the United States, and data on pumping stations, pipeline welding and corrosion. Refinery process developments are perhaps the most striking features of the whole technology; there is much that is new and of great future importance in this section, which discusses varied treatments, refinery conversion and integrations, aviation fuel, fuel suitable for jet propulsion, toluene and cumine production, synthetic rubber and lubricants. A chapter on modern analytical and testing methods is followed by more theoretical reviews of the chemistry and physics of petroleum. Natural gas and benzole production are dealt with conventionally, and followed by a full survey of advances made in alternative fields including developments in hydrogenation, the Fischer–Tropsch process, low- and medium-temperature carbonization and other substitute fuels. There is a section on specifications for service fuels with details of aviation, pool, transport spirits (including detector dye), diesel and fuel oils; this has particular interest in the light of recent proposals concerning commercial petrol in Great Britain. A separate chapter on diesel fuels and gas oils, biased to research and development both in British and foreign (including Russian and German) spheres, throws some light on efforts made to combat shortages which were known to be prevalent during the later stages of the War and, for that matter, still continue so to be.

There are short reviews on war-time specifications for lubricants, asphaltic bitumen and road materials; the chapter on special products is comprehensive, ranging from derived chemicals and special hydrocarbon products to synthetic resins and rubber. The volume is rounded off with a chapter on petroleum literature, concluding with a name and subject index.

The following items find no special place here: gasoline, light distillates and furnace fuel oils, measurement, plant instrumentation, crude oil, petroleum and other waxes, insulating and hydraulic oils, engines and automotive equipment, legislation and statistics for Great Britain; these will be included in the volume for 1946 now in active preparation.

This volume represents a prodigious amount of bibliographical research into international literature published during the war period and reflects the greatest credit on all concerned. As a current work of reference on the aspects of the technology with which it is concerned, it is invaluable. The only blemish is the quality of the paper employed; but that, we are sure, is not the choice of the Institute of Petroleum.

H. B. Milner

POTENTIAL THEORY OF AEROFOILS

Theoretical Aerodynamics

By Prof. L. M. Milne-Thomson. Pp. xix+363. (London: Macmillan and Co., Ltd., 1948.) 40*s*. net.

AERODYNAMICS is the science of the motion of gases and is of great intrinsic interest; but the present importance of the science lies largely in its applications, for it provides the rational basis for the design of aircraft. The subject is growing rapidly and is already so large that it cannot be adequately covered, even at an elementary level, in a single text-book. Some of the major branches are: theory of aerofoils and of control surfaces, the boundary layer, turbulent flow, flow at speeds near and above the speed of sound, flow at extremely low pressures, heat transfer, theory of aircraft performance, theory of the stability, control and flutter of aircraft, aerodynamics of propulsion including the internal aerodynamics of propelling machinery. However, the theory of the irrotational or 'potential' flow of fluids about aerofoils holds a central position in applied aerodynamics, and it is based on classical hydrodynamics. The book now under review is almost wholly concerned with the theory of aerofoils and with the hydrodynamic basis. The subjects of viscosity and turbulence are not seriously discussed.

The author says in his preface that the book is based on lectures to junior members of the Royal Corps of Naval Constructors, and it is stated on the dust cover that the general standard of the book is that of a first-year university course. This is certainly much too modest; but it is true to say that the book is so clearly and pleasantly written that it could be read with profit by a bright 'freshman' or even by an advanced schoolboy. The author has evidently taken great pains over the exposition and has succeeded in avoiding difficult mathematics. The notation and treatment are, in general, similar to those used in the author's "Theoretical Hydrodynamics". Special features of the book deserving mention are chapters on lifting surface theory, on wind tunnel corrections, on subsonic and supersonic flow, and, notably, a treatment of the design of aerofoils for given pressure distributions. There are about 320 exercises, some of which are extracted from recent research papers.

To the reviewer it appears that the three chapters dealing with simple flight problems, moments and stability are so slight that they might well have been omitted, thus permitting the rather high price of the book to be reduced. The nomenclature does not always agree with that now current. Thus, the point which the author calls the focus of an aerofoil is usually known as the aerodynamic centre, and it is not correct that the quarter-chord point is called the aerodynamic centre. Also, the author uses the term 'adiabatic' when the more precise 'isentropic' would be preferable, and the symbol *I* for internal energy in place of enthalpy. The argument on p. 79 for using the principal value of the integral for the downwash is not adequate, as the author must be aware.

In conclusion, this is the most comprehensive and up-to-date book extant on the theory of aerofoils in steady motion, and is a very welcome addition to the text-book literature of aerodynamics. The printing of the book is excellent. W. J. Duncan

PLANT GEOGRAPHY

The Geography of the Flowering Plants

By Prof. Ronald Good. Pp. 403+25 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 30*s*. net.

THIS book, as the author himself states, "is devoted to plant geography in the narrower sense", plant ecology being outside its scope. As a consequence, the treatment is essentially factual in character rather than causal, and static rather than dynamic. The difficulties of any attempt at such restriction are at once apparent, despite the inclusion of chapters on geological history and plant distribution and a section devoted to the factors of distribution. However, within these limits the author has collected together many of the facts concerning the distribution of taxonomic aggregates over the earth's surface which will be a welcome addition to the botanist's library, the more so that much of the literature of the subject is widely scattered. More than a third of the text is devoted to salient facts of the distribution of families, genera and species, where many of the striking features of extended range, discontinuity and endemism are assembled and illustrated with more than forty maps portraying various types of occurrence, from the extended tropical range of the Palmæ and the cosmopolitan genus *Drosera*, to the discontinuity of the Magnoliaceæ or that of *Saxifraga geum* and *Dabœcia polifolium*.

The limitations of the method of approach are nowhere better seen than in the chapter on the dispersal of plants, which is a brief summary of the familiar facts without critical consideration of the bearing of these upon the problems of distribution. The value of special mechanisms of dispersal is assessed adversely on the grounds that "it can be said quite categorically that there is no real evidence that species possessing such mechanisms are more widely distributed"—a statement that embodies the wholly gratuitous assumption that area is a measure of dispersal efficiency and a confusion of thought between the significance of space and time.

Most of the text is concerned with the extent of distribution; but the occurrence of species within the county of Dorset is the subject of a chapter that aims at treating the intensity of distribution, and here Prof. Good extends beyond his allotted scope. This excursion contains much that is of interest from the author's own observations, such as the extension in recent years of *Bartsia viscosa* and the frequency gradients of species within the area; yet not only in this section but also in that devoted to the history and distribution of the British flora, one is rather left with the feeling of too little or too much.

It is, indeed, as a factual presentation that this book will find its chief use, and it is no doubt the realization of this that accounts for the provision of an index of plant names and another of persons and places, but not one of subjects. E. J. Salisbury

OPTICS IN HOLLAND

Achievements in Optics

By A. Bouwers. (Monographs on the Progress of Research in Holland during the War.) Pp. viii+135. (New York and Amsterdam: Elsevier Publishing Co., Inc., 1946.) 6 fl.

THIS is the first of a series of monographs, under the general editorship of Drs. R. Houwink and J. A. A. Katelaar, to be published on the progress of research in Holland during the five years of German occupation. Most of the material was, for obvious reasons, kept secret during the War. Though prepared in secret, the text of "Achievements in Optics", which gives a survey of optical work in the Netherlands immediately prior to and during the War, was actually ready for printing before the liberation. Technical difficulties delayed its appearance until a year later. As a result, no consideration is given, or reference made, to similar work in Allied countries, and it is difficult to appreciate how much of the work described in the monograph predates similar work which has appeared in scientific periodicals during the last few years. For example, both in the U.S.S.R. (notably by Maksutov) and in Great Britain, optical systems consisting of spherical mirrors and meniscus lenses have been investigated and developed. It speaks highly for the Dutch, however, that they, in spite of their isolation from other scientific workers, should have, simultaneously, made advances in both geometrical and physical optics of such fundamental importance. The descriptions of their new optical systems and instruments given in the monograph are, therefore, worthy of the closest study.

The monograph is divided into four main sections, and in the first, on new optical systems, the Schmidt camera and its aberrations, and the advantages o spherical mirror systems, several devised by Bouwers himself, are described in detail. The excellent optical properties of these mirror systems have been applied to the design of new cameras, a new microscope and new telescopes. The telescopes have a reduced overall length as a result of the great admissible aperture ratio, almost complete absence of chromatic aberration even at the border of the field of view, and little or no 'false light'. The physical optics section consists of two papers, the first by B. R. A. Nijboer, a pupil of Prof. F. Zernike, dealing with the diffraction theory of aberrations, and the second, by Prof Zernike himself, on the subject of phase contras microscopy.

The illustrations and diagrams are very clear, and the monograph is excellently printed. The flimsy cardboard covers are rather a pity, because the monograph will be in great demand for reference and intensive study. S. Weintroub

An Introduction to Analytical Geometry

By A. Robson. Vol. 2. Pp. viii+215. (Cambridge: At the University Press, 1947.) 10*s.* 6*d.*

THIS is a continuation of an earlier volume published in 1940. The most original part of Vol. 2 is Chapter 19, on general geometry. This, with its references to G_5, G_6 and G_7, is at first sight difficult to understand, but becomes clear and very interesting if we refer back to Chapter 8 of Vol. 1. The leading idea, expanded from a suggestion of the late Prof. G. H. Hardy, is that what is usually called analytical geometry of two dimensions is not one subject, but several. The simplest kind, called G_2, corresponds closely to Euclidean geometry G_1. G_3 is similar to G_2, but regards a 'point' as merely a term for an ordered pair of real numbers x and y. In G_4 these numbers are no longer real, but complex. In G_5 we keep the pair real, and supplement them by a third real number z, introduced to make the equations homogeneous. Points at which $z = 0$ are called points of infinity. G_6 has triplets of *complex* numbers, thus combining the advantages of G_4 and G_5. In both G_5 and G_6 the points of infinity and the line on which they lie are exceptional. In G_7 all points and lines are on an equal footing. Theorems which are true in one kind of geometry may be untrue or even absurd in another. This discussion clears up the paradoxes which used to puzzle us concerning lines at right angles to themselves and separate points the distance apart of which is zero. However, the schoolboy, for whom the author professes to write, may not find this part of the book easy.

The other chapters of Vol. 2 deal respectively with homography, involution, ranges on a conic, systems of conics, reciprocation, the general cartesian conic, foci and confocals, normals and evolutes, and special homogeneous co-ordinates. The amount of space given to trilinear and areal co-ordinates is much less than in the older books, in which these were often applied, at great length, to metrical problems for which they were unsuited. There is a good stock of examples, of varying degrees of difficulty. At first sight there appears to be an ugly misprint on p. 14, but on reference to the beginning of Vol. 1 it will be discovered that "wo" is not a misprint, but an abbreviation for "with respect to".

Teachers should examine the book carefully, for the freshness of the outlook will throw new light on several parts of what used to be looked upon as a stereotyped subject. H. T. H. PIAGGIO

A Bibliographic Classification

Extended by Systematic Auxiliary Schedules for Composite Specification and Notation. By Henry Evelyn Bliss. Vol. 2: Classes H—K; the Human Sciences. Pp. vii+344. (New York: H. W. Wilson Company, 1947.) 7.50 dollars.

THIS volume sets forth the specifications and schedules in Bliss's classification for anthropology and the medical sciences, psychology (including psychiatry), education and sociology, including ethnology, folk-lore, ethnography and human geography. The expansions for the medical sciences have been compiled with the assistance of Mr. C. C. Barnard, and those for physiology, medicine and surgery have more recently been revised by Dr. R. B. Singer. The classification for psychology has been compiled in collaboration with Dr. C. M. Louttit, while the schedules for sociology, social ethnology and folk-lore have been revised by Miss Beverly Stamm. Although Bliss's classification is little known outside the ranks of librarians and bibliographers, the scholarly introduction to this volume will be read with appreciation by many who are interested in the more comprehensive human sciences. Its interest is not so much in the explanation of the principles of the classification itself as in the discussion of the various complications involved, including questions of terminology, where an admirable and forceful plea for greater precision is advanced. Particularly in what he has to say on sociology, Dr. Bliss makes a valuable contribution to greater precision in the use of terms and in the relation of concepts and ideas which should be welcomed by all serious students in this field, independent of whether or not they adopt his classification as a convenient working tool. R. B.

The Graduate School Research and Publications

Edited with a Foreword by Prof. Edgar W. Knight and Agatha Boyd Adams. (University of North Carolina: Sesquicentennial Publications.) Pp. viii+461. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1946.) 22*s.* net.

THIS further volume in the imposing series issued in celebration of the sesquicentenary of the University of North Carolina records the development of the graduate school and describes the resources for research which the University possesses in its library, research laboratories, its permanent institutes, its learned societies and clubs and its various learned journals and allied periodicals. The library resources have already been described more fully in an earlier volume in this series, but the present volume also includes an account of the activities of the University press. Apart from Prof. Pierson's discussion of the future of the graduate school and the relations between teaching and research, in which that twin function of a university is firmly upheld, these parts of the volume are chiefly of historical interest. The greater part of the volume, however, is occupied by a comprehensive list of the individual publications of the faculty, the administrative officers and other members of the University staff from the founding of the University, arranged alphabetically by name and classified according to the various administrative offices and faculties, departments or schools.

Industrial Research, 1947

Advisory Editor: Dr. Percy Dunsheath. Pp. 535. (London and New York: Todd Reference Books, Ltd., 1947.) 25*s.* net.

THE second edition of this book represents a considerable advance on the first. The extraneous and redundant material has been largely eliminated, and a readable and adequate survey of progress in industrial research in Britain during 1946–47 by Dr. B. J. A. Bard replaces the hotch-potch of essays included in the first edition. The statements from Government and public bodies and from private organisations are properly classified, as is the information on university laboratories and the research laboratories of private firms. The sections on officially appointed committees and reports and on books, periodicals and films have also been improved, and the latter list, limited to books published in 1946 or in preparation in 1947, is much more useful than the earlier list. The report from the Industrial Research Committee of the Federation of British Industries on industrial research in technical colleges is given in full, and there are brief summaries of some of the reports from the Working Parties of the Board of Trade in so far as they touch research.

Generally the book shows evidence of balance and of planning which were sadly lacking in the earlier edition. If the editor would direct a little more attention to the last section, "Who's Who in Industrial Research", and include in that a reasonable proportion of the men responsible for the management and the actual conduct of industrial research, instead of the overwhelming preponderance of academic, consultant or government entries which at present characterizes it, he would come well within sight of the goal of a reference book which everyone concerned with the conduct or direction of research would wish to have on his desk, both for ready reference and as a convenient guide to sources of authoritative information in regular demand.

R. BRIGHTMAN

Smoke

The Problem of Coal and the Atmosphere. By Arnold Marsh. Pp. 306+21 plates. (London: Faber and Faber, Ltd., 1947.) 21*s.* net.

THE author of this book is a red-hot zealot; his cause is certainly a good one. Briefly, his thesis amounts to this—the smoke nuisance *can* be abolished, and it *must* be abolished. The question before us at the moment, however, is this. How far will this volume help to spread the gospel? It is difficult to be sure. If something, however rational and desirable in itself, is said too much, too often, and a little too loudly, a boomerang action sets in, and the reader's sympathy, if not lost, is perceptibly reduced. Maybe Mr. Marsh will see the yellow light; it is to be hoped that he will. Everybody will agree with him that drastic action is needed to deal with the ill-effects of atmospheric pollution upon works of art; but the efforts of the Ministry of Works and the National Gallery in 1937 receive no mention, though given considerable publicity at the time. However, smoke and toil seem synonymous—unluckily—in men's minds: witness those telling lines (my italics) originally composed for the Potteries:

"Where the busy sounds of labour
Rise, the best of human *incense*,
To the Throne of the Creator".

F. I. G. RAWLINS

Radio Engineering

By Dr. E. K. Sandeman. Vol. 1. Pp. xxiv+775. (London: Chapman and Hall, Ltd., 1947.) 45*s.* net.

THOSE who have come into contact with the author would expect the fresh and 'breezy' treatment given to the practice of radio here presented. In attempting to bring the novice up to the standard of the expert (not defined), the author dashes through all the subtleties of the academic teacher, collects an immense amount of information from his colleagues in the British Broadcasting Corporation, fills in many gaps, contributes much original thought, bends charts and methods to his will, and leaves one rather breathless at the prospect of what one is supposed to know, in addition to a flair for designing and costing, in order to be a modern radio engineer. Even so, we are warned that all this is only an approach if one desires to attain to the higher flights of radar and television.

The method has a disadvantage in that the practical applications of radio theory are those which are designed to meet the problems of the B.B.C., weighted somewhat by the views of one who has done creative work in that organisation for many years. With these slight reservations, one concludes that this text (including Volume 2 to come), so clearly printed and illustrated, bears comparison very well with recent American texts, and from many points of view is superior, in its decimal lay-out, and as a reference book for many topics.

L. E. C. HUGHES

Las heladas y la necrosis fria de las plantas

Por Plutarco Naranjo V. Pp. 126+14 plates. (Quito: Imp. de la Universidad, 1947.) n.p.

ALTHOUGH some attention is given to the physical aspects of frost occurrence, this welcome survey is chiefly concerned with the nature of the biological damage caused to plants by the occasional radiation frosts that occur at altitudes of 2,000 m. or more in Ecuador. A review of contemporary weather data confirms experience elsewhere that radiation frosts occur on nights of little or no cloud when the air and the surface soil are dry.

Freezing of the cell sap was not observed, and damage to the tissues by expansion of the sap is dismissed as a possible effect of frost. The damage is attributed to an increase in the acidity of the cellular protoplasm, a change in *p*H of about one unit taking place when the respiratory quotient is decreased at low temperatures. When plants were damaged, it was because this shift was sufficient to bring the protoplasm to its iso-electric point, and coagulation set in. A number of photomicrographs and photographs illustrate the effect of frost on the cells and on the plants.

Suggested preventive measures include: (i) formation of dense clouds of smoke over crops; (ii) watering seed beds on occasions when frost is forecast; (iii) initiation of research on the breeding of frost-resistant varieties of plants.

H. L. P.

A Book of Spiders

By Dr. W. S. Bristowe. (King Penguin Books, K.35.) Pp. 34+24 plates. (Harmondsworth and New York: Penguin Books, Ltd., 1947.) 2*s.* net.

THIS very pleasant essay will reveal to many readers details of the spider's life with which they were previously unacquainted. After an introduction which deals with some medieval opinions about spiders, Dr. Bristowe describes many striking devices by which these animals feed and protect themselves, and some remarkable examples of their conjugal and parental habits. He writes chiefly of the spectacular and the quaint; but, avoiding mere 'wonder-mongering', succeeds in emphasizing the diversity of the ways in which spiders have chosen, or been driven, to live.

A point of some significance emerges from his discussion of the spider fauna of small islands. He tells us that in an islet with some half-dozen species nearly every one belongs to a different family: in other words, there is one representative of each type of specialist—"the maximum number of species with the minimum amount of competition". It would be interesting to know whether students of other groups have recorded a similar phenomenon.

Dr. Bristowe has been able to use as coloured plates a most attractive set of water-colour drawings made in 1867–70 by A. T. Hollick for a supplement planned by Pickard-Cambridge, to Blackwall's grea work on British spiders. In rescuing these from oblivion, the Penguin Books have performed notable service to arachnology.

T. H. S.

NATURE OF FORCES BETWEEN LARGE MOLECULES OF BIOLOGICAL INTEREST*

By Prof. LINUS PAULING
California Institute of Technology

As I look at a living organism, I see reminders of many questions that need to be answered. Not all these questions are obviously important, nor would their answers be useful—but we want them answered. Thomas Wright in 1601 said, "Nothing is so curious and thirsty after knowledge of dark and obscure matters as the nature of man"—of scientific men especially, he might have said.

What is skin, fingernail ? How do fingernails grow ? How do I feel things ? How are nerves built and how do they function ? How do I see things ? How can I smell things, and why does benzene have one smell and *iso*-octane another ? Why is sugar sweet and vinegar sour ? How does the hæmoglobin in my blood do its job of carrying oxygen from the lungs to the tissues ? How do the enzymes in my body break up the food that I eat, burn it to keep me warm and to permit me to do work, and build new tissues for me from the food fragments ? Why do I catch cold when exposed through contact with an ailing person, get pneumonia, and then recover after treatment with a specific antiserum or a sulpha drug ? How does penicillin carry out its wonderful function of fighting disease ? Why am I immune to measles, whooping cough, poliomyelitis, smallpox, whereas some other people are not ? And finally, why is it that my children, as they grow and develop, become human beings, and show characteristics similar to mine, and their mother's—how have these characters been transmitted to them ?

The basic answers to all these questions are not to be found in books. Even though Chaucer said

"For out of olde feldes, as men seith,
Cometh al this newe corn fro yeer to yere ;
And out of olde bokes, in good feith,
Cometh al this newe science that men lere",

he was before long corrected by Francis Bacon :

"Books must follow sciences, and not sciences books".

To understand all these great biological phenomena we need to understand atoms, and the molecules that they form by bonding together ; and we must not be satisfied with an understanding of simple molecules—nitrous oxide, NNO, that Davy used to produce hysteria ; benzène, C_6H_6, discovered by Faraday ; penicillin, containing forty atoms in its molecule. We must also learn about the structure of the giant molecules in living organisms, such as insulin, with ,000 atoms in its molecule, hæmoglobin, with about 0,000, the disease-producing viruses, a thousand imes larger still.

Just two thousand years ago the Roman poet Lucretius wrote

> "Wine flows easily because its particles are smooth and round and roll easily over one another, whereas he sluggish olive oil hangs back because it is composed of particles more hooked and entangled one with another".

This is essentially the modern point of view, expressed by Lucretius, of course, only as a surmise, whereas to us it is a fact, of which we have a detailed understanding. Lucretius went beyond us in interpreting the taste also of substances in terms of the shape of their molecules, writing

> "There is this, too, that the liquids of honey and milk give a pleasant sensation of the tongue, when rolled in the mouth ; but on the other hand the loathsome nature of wormwood and biting centaury set the mouth awry by their noisome taste ; so that you may easily know that those things which can touch the senses pleasantly are made of smooth and round bodies, but that on the other hand all things which seem to be bitter and harsh, these are held together with particles more hooked".

I shall now present a detailed discussion of the shapes of molecules, and the forces between molecules, in order to show the extent to which this surmise, too, of Lucretius is substantiated.

Even though hæmoglobin is spoken of as a large molecule, the molecule is very small in comparison with our usual scale. If I look at my hand or watch a few feet away, the atoms subtend the same angle that oranges would on the surface of the moon. The molecules might thus be described as an aggregate of oranges, held together by bonds which in actual molecules are electrons circulating between the atoms. On this scale of 250,000,000-fold linear magnification, the nitrous oxide molecule of Davy's laughing gas consists of three atoms in line, N–N–O, the distance between the two nitrogen atoms being about 1·12 in. and between the nitrogen and oxygen atoms 1·19 in. (in the molecules themselves 1·12 A. and 1·19 A., where 1 A. is 1/100,000,000 cm.). Faraday's benzene molecule consists of twelve atoms: six carbon atoms arranged at the corners of a regular hexagon, with the carbon-carbon distance 1·39 A., and six hydrogen atoms, in the same plane, at the corners of a larger hexagon, the distance of each hydrogen atom to the carbon atom to which it is attached being 1·06 A. The structure of penicillin, determined by Mrs. Hodgkin and her collaborators, is also known, as are the structures of many hundreds of simpler molecules.

As yet the detailed atomic structure of no protein molecule has been determined ; but the vigour of the attack that is being made and the increasing power of the marvellous methods of investigation used in structural study permit the confident hope that the next decade or two will bring the solution of this great problem.

Much information is already available, however, about the general sizes and shapes of large molecules of biological importance, and also about their function. The most striking general property of these molecules is the specificity of their activity. For example, hæmoglobin, the red protein in the red cells of the blood, has the specific property of combining with oxygen in the lungs, and then releasing this oxygen in the tissues, thus making it available for the oxidation of foods. There is no other substance known that is able to combine with oxygen and release so large a fraction of the combined oxygen reversibly with the small change in partial pressure of oxygen existing between the lungs and the tissues. Then there are the enzymes, such as those involved in the catalysis of the processes of degradation and oxidation of foodstuffs. These substances all show a high degree of specificity in their action : in general, a particular enzyme serves the purpose of speeding up a particular single chemical reaction in the body.

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* Friday Evening Discourse at the Royal Institution, delivered on February 27.

Specificity is shown in a striking way by antibodies. These are substances produced in the living body in response to its invasion by foreign organic material, such as viruses or bacteria. They have the power of combining specifically with the material (the antigen) that led to their production, and of neutralizing or incapacitating the antigen. Thus an antitoxin is able to neutralize its homologous toxin; an antibody against a virus or bacterium is able to prevent the virus or bacterium from reproducing, and thus to aid in the control of disease. An unfortunate incidental effect of this protective mechanism of the body is the occasional production of protein sensitization, leading to asthma and hay fever. Sufferers from protein sensitization, such as those people who are sensitive to egg white (ovalbumin), can testify as to the specificity of the reaction and to its delicacy.

The specificity of serological reactions can be shown by simple serological tests carried out in the laboratory. Thus if a minute amount of ovalbumin is injected into a rabbit, it is found that after a week or two the serum of the rabbit's blood will produce a precipitate when mixed with a solution of ovalbumin, whereas the serum of an uninoculated rabbit will not produce such a precipitate. The precipitate contains ovalbumin from the ovalbumin solution that is added to the serum, and antibody molecules from the serum of the rabbit. These antibody molecules are protein molecules, with molecular weight about 160,000, corresponding to the presence in the molecule of about 20,000 atoms. These anti-ovalbumin molecules have the power of combining with molecules of ovalbumin, but in general not with molecules of other substances. Only if another substance is extremely closely similar in its structure to the ovalbumin with which the rabbit was originally injected can the antibody combine with it. Thus a precipitate, somewhat smaller in amount than with hen ovalbumin, is formed by antibodies produced by hen ovalbumin when mixed with a solution of duck ovalbumin; but no precipitate is formed when these antibodies are mixed with a solution of ovalbumin from the eggs of birds of other species.

Dr. Karl Landsteiner showed by his experiments that animals are able to manufacture antibodies specific to chemical groups that do not exist in Nature. The power of formation of antibodies able to combine only with an injected antigen is hence not a power that was developed in the course of evolution, in response to interaction with this antigen at some earlier age, and in a particular individual called into operation by the inoculating injection; but is instead a general power, which enables the animal to cope with a foreign material, even of completely foreign nature to the animal and its ancestors throughout its course of evolution.

I became interested in the problem of the structure of antibodies in 1936, as the result of conversations with Dr. Landsteiner. I found that the complex phenomena of immunology could be clarified and brought into order by a theory of the structure of antibodies based upon the idea of the folding of the basic polypeptide chain of the protein precursor of the antibody into the most stable of the configurations accessible to it. This theory of the structure and process of formation of antibodies involves the acceptance of the suggestion that antibody and antigen have molecular structures that are mutually complementary, originally made by Breinl and Haurowitz, Jerome Alexander, and Stuart Mudd. If the molecule of gamma globulin that might become an antibody is considered to consist of a chain that might fold up into any one of a large number of configurations, with essentially the same stability, then in the presence of a molecule of antigen that configuration would be selected which is stabilized by interaction with the antigen. The configuration that would be stabilized is the one in which there is the greatest force of attraction between the folded polypeptide chain and the molecule of antigen; and this greatest force of attraction would result from the assumption by the folding polypeptide chain of a configuration which permits the parts of the chain to approach as closely as possible to a portion of the surface of the antigen molecule, and which also brings positive charges in the chain in close proximity to negative charges in the antigen, and brings hydrogen-bond-forming groups in the chain into juxtaposition with their complementary hydrogen-bond-forming groups in the antigen. A very high degree of specificity can be obtained if the surface area over which the complementariness of structure is exercised is great enough to include a good number of interacting structural units.

Experiments carried out with antibodies and antigens have shown that the configuration of the antibody molecules is very closely complementary to that of the surface of the homologous antigen; the antibody reflects or reproduces, in a negative way, the shape of the surface of the immunizing antigen to within about 1 A., that is, to within about one-half or one-quarter of the diameter of an atom. The forces that lead to the production of the specific bonds between antibody and antigen are thus interatomic forces that operate between atoms essentially in contact with one another, and are not long-range specific forces of attraction operating through great distances (on the atomic scale) through space.

There is a highly specific phenomenon of the chemistry of simpler substances that is closely analogous in its nature and its cause to the highly specific phenomenon of serological interaction; namely, the phenomenon of crystallization. Chemists are accustomed to using the process of crystallization as a method of purification: a crystal growing in a complex mixture of molecules is able to select from the mixture just the molecules of one kind, rejecting all others. Thus pure crystals of sugar may deposit from a jam in which there are molecules of thousands of different substances. The specificity of crystallization is the result of the same striving toward complementariness and the operation of the same interatomic and intermolecular forces that are responsible for the specificity of antibodies. A molecular crystal has the structure that gives it the greatest stability, which would result from the maximum amount of attraction for each molecule in the crystal and the surrounding molecules. Each molecule in the crystal is then in a cavity that conforms in shape to the shape of the molecule itself. The molecule may be described as complementary in structure to the remainder of the crystal; and other molecules, with different shape and structure, would not fit into this cavity nearly so well, and in general would not be incorporated in the growing crystal. We may hence say that life has borrowed from inanimate processes the same basic mechanism used in producing those striking structures that are crystals, with their beautiful plane faces their unfailingly constant interfacial angles, and their wonderfully complex geometrical forms.

I believe that the same mechanism, dependent on a detailed complementariness in molecular structure, is responsible for all biological specificity. I think that enzymes are molecules that are complementary in structure to the activated complexes of the reactions that they catalyse, that is, to the molecular configuration that is intermediate between the reacting substances and the products of reaction for these catalysed processes. The attraction of the enzyme molecule for the activated complex would thus lead to a decrease in its energy, and hence to a decrease in the energy of activation of the reaction, and to an increase in the rate of the reaction. Although convincing evidence is not yet at hand, I believe that it will be found that the highly specific powers of self-duplication shown by genes and viruses are due to the same intermolecular forces, dependent upon atomic contact, and the same processes of replica formation through complementariness in structure as are operative in the formation of antibodies under the influence of an antigen. I believe that it is molecular size and shape, on the atomic scale, that are of primary importance in these phenomena, rather than the ordinary chemical properties of the substances, involving their power of entering into reactions in which ordinary chemical bonds are broken and formed.

Even though the general picture of some important biological processes is becoming clear, our present knowledge of the detailed structure of the complex substances of biological importance is vague. We may expect that as more precise information about the structure of these molecules is obtained in the future, a more penetrating understanding of biological reactions will develop, and that this understanding will lead to great progress in the fields of biology and medicine.

SYNOPTIC WEATHER MAPS FOR THE ANTARCTIC

THE publication in 1946 of volume 6 of the Scientific Reports, Series B, dealing with the meteorology of the Australasian Antarctic Expedition 1911–14, and, more recently, of vol. 7 of the same series (Sydney: Gov. Printer, 1947. 40*s*.), is understood to complete the scientific literature dealing with this Expedition. Sir Douglas Mawson, its leader, was fortunate enough to secure the services of the late Dr. Edward Kidson, formerly director of the New Zealand Meteorological Office, for the writing of these two reports. Unfortunately, Dr. Kidson died suddenly before his work was quite completed, and for this reason chapter 1 of vol. 6, which was to have been an introductory chapter of a general nature, is missing, together with a final section that was to have dealt with the meteorological records of sledging parties. Vol. 7 was, however, fortunately complete.

Volume 6 is entitled "Discussions of Observations at Adélie Land, Queen Mary Land and Macquarie Island". The base in Adélie Land was in Commonwealth Bay, in about lat. 67° S., long. 143° E. At this base two factors combined to make temperature rather high for a land station in these latitudes, and to make the variations comparatively moderate. These factors were the presence throughout the year of open sea for more than fifty miles to eastward and more than a hundred miles to westward, and the considerable downward slope of the interior to the coast, which last prevented any stagnation of cold surface air such as was observed often enough at McMurdo Sound and to an even greater degree at Amundsen's headquarters at Framheim, still farther to the east. Much has been written about the violence and frequency here of katabatic gales from a direction slightly east of south, which represent the gravitational flow of the cold air from the high interior of Antarctica, and gave a mean annual speed of 43 miles per hour, and a monthly average of about 55 miles per hour in May 1912 and July 1913. Dr. Kidson discusses these winds in Chapter 4 of this report.

The base in Queen Mary Land was on a floating tongue of ice with a level top, and was about 14 miles from the shore of the Antarctic continent, in about lat. 66° S., long. 95° E. In place of the open sea off the base at Commonwealth Bay, there was the extensive pack-ice belt; although there was a steep slope from the interior to the coast, the absence of open water prevented there being the very great thermal contrast across the coast inevitable at Commonwealth Bay, and the extreme violence of the wind was absent; while there was nothing to prevent the formation in quiet winter weather of a shallow layer of very cold air. As a result of this difference, the average diurnal variation of temperature at the Queen Mary Land base was nearly double that at Commonwealth Bay, and much lower extremes were recorded.

The weather at Macquarie Island, which is 22 miles long but only 3½ miles wide at the widest point, was dominated by the influence of the Southern Ocean. The latitude being about 55° S., the island lies well within the belt of stormy westerly winds that encircle the globe between about latitudes 40° S. and 60° S.; and since the station was on an isthmus only about 200 yards wide, and the island was treeless, it was much exposed to these winds. A large part of the space devoted to the observations is taken up with an analysis of these winds, which, at least partly as a result of the local topography, were much more often from north-west than from south-west. Directions from between south-south-east and north-north-east had a total frequency of only 8 per cent.

The seventh and last of the Scientific Reports, Series B, is entitled "Daily Weather Charts extending from Australia and New Zealand to the Antarctic Continent". These cover the period February 2, 1912, to January 31, 1913, and occupy most of the volume; but several subjects of great interest and importance are also discussed in the 31 pages of introductory and explanatory matter which precede them. Among them is that of the ring of anticyclones which encircle the southern hemisphere in about latitude 35° S. As Dr. Kidson points out, the regular procession of these from west to east has attracted attention ever since daily weather charts were first drawn for the Australian region. They are shown to be closely connected with the depressions and fronts of high southern latitudes, and have to be taken into account when daily charts are drawn to include the Antarctic continent. After giving a statistical analysis of the movements of these anticyclones between long. 120° E. and 170° E., and a discussion of the difficulties that arise in this connexion from the apparent temporary disappearance of a particular anticyclone, or from its division into two, or junction with another anticyclone, the view is put forward that the moving anticyclones originate as some periodic function either of the upper atmosphere or of the whole atmosphere, which is continually tending to produce them at intervals of about 45° of longitude.

Perhaps the most important conclusion reached by Sir George Simpson in the first report of this series, which appeared in 1919, is that relating to the travel of pressure changes in the Ross Sea region, deduced from synchronous observations made at Framheim, Cape Evans and Cape Adare. He concluded that it is only quite exceptionally that the barometric maxima and minima at these places are caused by travelling cyclones and anticyclones, and that as a rule they are due to "long and deep pressure waves radiating out from the Antarctic continent and extending over the Southern Ocean to some unknown distance from the Continent, traces of which can still be seen in the pressure curves for Kerguelen". He obtained evidence to show that the centre from which the waves radiated was not at the Pole but in about lat. 80° S., long. 120° W. With these conclusions Dr. Kidson, it appears, is not in agreement, largely as a result of the construction of the daily weather charts reproduced in this seventh report. He subjects the data used by Simpson to a fresh analysis and remarks, when discussing the times of occurrence of pressure changes at Cape Evans, Adélie Land and Queen Mary Land, that it seems quite impossible to reconcile these with the idea that the pressure maxima are caused by pressure waves as described by Simpson.

It may seem at first sight rather surprising that after such thorough analysis of the meteorological observations of this Expedition, there should be disagreement on such a fundamental point; but many of Dr. Kidson's daily weather charts show a feature that may partly account for this state of affairs, and that is the extent to which the fronts are bent towards a west–east orientation as they reach high latitudes, with an accompanying diminution in the temperature contrasts between the cold and warm air. This tends to make identification of fronts difficult; moreover, when the front is bent almost to an east–west orientation, the intervals of time separating its eastward passage across stations in different longitudes can be greatly affected by small differences between the latitudes of such stations. It is, however, a matter that can scarcely fail to be settled as the number of observing stations is increased.

WORLD FORESTRY AND FOREST PRODUCTS

A PRELIMINARY investigation of the greatest importance has been carried out by the Forestry Section of the Food and Agriculture Organisation in connexion with the examination of the world's resources in forests*, and a consideration of improved methods by which these resources should be utilized and improved. It is stated that this investigation could only be a preliminary one.

Almost one-third of the earth's surface, 4,000 million hectares, is classified as forest soil. These soils occupy twice as much area as all the land under cultivation, but their contribution to human welfare, while very great, could be increased many times if the 500 million hectares now denuded and useless could be restored, and if the 2,000 million hectares yet untouched could be opened and put under good management. Only one-third of the world's forest area has so far been brought into use, and less than 300 million hectares are under systematic forest management. The other thousand million hectares which constitute the overwhelming bulk of all forests in use are cut with little or no regard to their continued productivity. In other words, forest management is still fairly limited, since it extends at best to one-fourth of all forests in use, and to less than 10 per cent of the world's forest soils.

The preface of this report is written by Sir John Boyd Orr, director-general of the Food and Agriculture Organisation, and he commences by saying: "In dedicating itself to the goal of freedom from want, F.A.O. must devote a major effort to restoration of the world's forests, and to the effective use of their products". With the appointment of Marcel Leloup, formerly director-general of the Départment des Eaux et Forêts in France, as director of forestry and forest products in the Organisation, the first step in making international forestry an accomplished fact was taken. As this brochure displays, already a certain amount of world forest statistics had been gathered together but, as Boyd Orr says: "The goal before the Branch lies far beyond initiating statistics and collecting information. Forestry in F.A.O. will take an active part in helping Member Governments deal with their forest problems and in advising them on their forest policies."

One of the studies already made is the result of war's impact on forests, particularly in Europe. Here the direct effects were found to be far less damaging than had been expected. Land and aerial warfare inflicted serious local damage only in the areas of actual fighting. With the exception of the forests of Greece and Poland, which were badly devastated, European forests emerged from the War practically intact. On the other hand, over-cutting in the accessible forests throughout the world, enhanced during the War, has been very serious, and post-war requirements, especially perhaps building requirements in Western Europe, including Britain, are placing an added burden on the forests in which already excess fellings have been made.

Some of the causes of the present scarcity, such as insufficient man-power, disorganised transport and inadequate equipment, are only temporary factors which can be got over; but the basic ones are more serious, and include deforestation, inadequate forest management, failure to develop mature forests, incomplete utilization and insufficient technical personnel.

On the subject of deforestation, it is well known that in large portions of the world continuous mismanagement, fire and unrestricted grazing have led to complete destruction of the original forest cover. Vast denuded areas, deprived of the productive forest, have become wind-swept deserts, barren mountain slopes, and eroded valleys, where agriculture is almost impossible, and living standards have remained at starvation levels for hundreds of millions.

In connexion with insufficient technical personnel, a suggestion might be made that the Food and Agriculture Organisation should create a corps of trained technical officers and foresters. In Great Britain, at least, during the past two years, considerable numbers of young men from the Forces—far too many to be accepted in the existing space in the universities—have been applying to follow forestry courses given at the universities, and at the forestry technical schools training staff of subordinate ranks.

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* Food and Agriculture Organisation Forestry and Forest Products. World Situation 1937–1946. Pp. 93. (Washington, D.C., 1946.)

If the Food and Agriculture Organisation took advantage of this opportunity, it might be possible to have at its disposal a trained international body able to help member governments whose forestry is very far behind the position which it should occupy. It is difficult to see how the Organisation will otherwise obtain a technical trained staff to send out to member governments; most of those with forest departments are themselves very short of staff and have considerable recruiting to do.

It has already been stated that 2,000 million hectares of forest are still left untouched, and constitute perhaps the last remaining opportunity for advancing the frontiers of modern civilization (Boyd Orr's words). These are the world's wood reservoirs; the last great bodies of renewable resources, and they must not be allowed to suffer the fate that has ravaged the forests of many older countries. To help keep them permanently productive must be one of the tasks of the Organisation. There are other tasks. "The afforestation of treeless expanses in China, south eastern Asia, the Inner and Middle East, presents a challenge so vast that only an international effort can hope to answer it. Yet here, forest restoration is the first step to stable agriculture, and to a decent nutrition level for over a thousand million people. In these regions, expanding economy and freedom from want can be little more than phrases until afforestation brings wood for fuel and forests to protect the land against erosive forces, against wind and rain, and against the hot sun. To state the world's forest problem in broad terms is not difficult. There is a shortage of wood, despite the fact that the world has more than enough forest soil to provide wood for the earth's peoples, even under an expanding economy."

On the subject of wood and its importance, and the yearly multiplication of new wood products, Boyd Orr is interesting. "In the Laboratory," he says, "under electronic microscopes, and in test tubes, wood that yesterday was looked upon only as lumber or fuel is being taken apart and its character profoundly altered. The chemical possibilities have barely been touched, and fibre chemistry is opening up an entirely new field of plastics and textiles, and permits the economic pulping of almost any wood species, and of waste from the saw mills. Large factories are being built to convert sawdust and wood unsuitable for lumber and pulp into ethyl alcohol, cattle food and chemicals. Scientists believe that they may soon duplicate in minutes what Nature took millions of years to do, and by converting wood into hydrocarbons, enable the renewable forests to augment the non-renewable reserves of oil." "Our immediate task," says Boyd Orr, "is to increase the available supply of food: our long-range task is to create a world better fed and better sheltered through a wiser use of land, and for both these tasks we must call upon an indispensable ally of agriculture—the forest."

At the present day, afforestation presents another major opportunity for creating forest values over vast areas. The denuded landscapes of south-east Asia and the Middle East, the thousands of millions of miles of desert, the continuous advance of which has never been arrested, can be transformed by tree planting, or by strict closure of large areas of scrub or savanna forest, into fertile lands, capable of supporting large populations. These should be direct profitable objectives, capable of achieving success. But the value of the forest to human welfare has other objectives, for all forests are not measurable in terms of cubic feet of timber, or producers of other marketable commodities. There are great forest influences not capable of being translated into statistical terms, but which have vast importance to the life of the earth's peoples. Even if not productive as a source of wood, forests have still an indispensable function as stabilizers of water flow, protectors of soil and agricultural crops and, especially in the tropics, as sources of food. In many regions afforestation or the maintenance of existing forests is not so much prompted by a need for local wood supplies as it is to stabilize agriculture, shelter livestock, and prevent damaging floods. In the case of wheat or corn, world production is largely a function of area planted. In the case of forests it is not so simple. Millions of acres of forest, because of their protective influences, may have little value as producers of wood, and cannot be included as contributing to the wood supplies of the world: but their loss would endanger, and in many cases destroy, agricultural values; and in some sections make human habitation impossible, as has so often been the case in past times.

A nation, therefore, in assessing its requirements in terms of forest area, must appraise its needs both in terms of forest products and of the protective influences of the forest. This need of protective forest varies with topography and geographical location, and the area required may or may not provide a sufficient quantity of forest products for national needs; but it should be regarded as the minimum to be maintained as forest in order to avoid the economic losses that attend prolonged droughts, floods and lowering of the water table. The report under notice puts the matter in a nutshell: "The world's true balance sheet, then, must take into account more than cubic metres of wood and hectares of forest per caput. The human need for forests cannot be limited to a need for raw materials. Forest policy must be directed to a dual goal—first, sufficient areas of forest to ensure the benefit of their protective influences, and second, whatever forest area may be necessary as a continuing source of raw materials for satisfactory living standards." It should be the task of the Food and Agriculture Organisation to assist governments in attaining this dual goal.

It is not possible to follow the very full statements with reference to what is termed the 'lumber situation' and the lumber shortage in different parts of the world, and the urgent requirements of timber for reconstruction purposes—house rebuilding and building purposes we may say—in most parts of the world, but the Forestry Section of the Organisation has already arrived at a very close appreciation of the seriousness of the present-day position.

The report says: "As far as pulpwood is concerned, no scarcity exists. There are sufficient amounts in the world to meet all present requirements." In Great Britain many would like to know where these amounts exist, as the rationing of paper has been one of the troubles which has probably affected the population, and especially publishers and newspapers, almost as much as the rationing of food.

Perhaps the two most interesting points, apart from the important survey of the world's forest resources and the enormous waste areas carrying neither forest nor agriculture of any value, are that more than 75 per cent of the forests now in use are cut without expert supervision, with no regard for their permanent productivity, and receive no protection against fire, and that large areas of virgin forest still remain untapped. In this connexion the Latin American forests receive very considerable notice in the report, and information never before available is disclosed.

The report puts forward some general recommendations which, summarized, deal with: legislation; the introduction of advanced sylvicultural methods; increased yields; orderly development and management of virgin forests; systematic afforestation of all denuded soils suitable for forest growth; introduction of better utilization, conversion and manufacturing methods; and the stimulation of research in the various branches of forestry, including the development of educational facilities, and the necessity of providing adequate supplies of professional foresters.

In the last paragraph it is stated: "Planned management of the world's forests and planned use of the world's forest soils is the only way to forestall the danger of temporary wood shortages and surpluses. Properly applied, F.A.O.'s world programme will ensure that the world's forests and forest products make their full and permanent contribution toward the emergence of a world free from want."

E. P. STEBBING

CALCULATING MACHINES

A DISCUSSION on calculating machines was held at the meeting of the Royal Society on March 4. In opening the discussion, Prof. M. H. A. Newman (University of Manchester) said that it would be confined to machines which are automatic, that is, require no human intervention at any stage; digital, that is, such that separate digits of each number are stored in the machine at every stage (in contrast to 'analogy' machines such as the differential analyser where the numbers are represented by directly measured physical quantities); and 'general-purpose', that is, able without modification to carry out any of a wide variety of computing jobs.

Prof. D. R. Hartree (University of Cambridge) was prevented by illness from attending, and his paper was read by Mr. P. Noble. The general ideas for a large automatic calculating machine are to be found in the designs of Charles Babbage for an 'analytical engine', published more than a century ago. It was to work by means of plungers passing through punched cards, and was to contain a 'store' for numbers, a 'mill' for carrying out arithmetical operations, and a control unit for determining the sequence of operations. The machine would at that time have had to be purely mechanical.

The main components of any digital computing machine were then described. It must have arithmetical units, such as adders and multipliers, which in electrical machines may operate in times of the order of a millisecond. There must be a store to hold numbers and instructions; an input for accepting data, and an output for furnishing final results; a means of transferring numbers between different parts of the machine; and a control mechanism which will cause the arithmetical operations to be carried out in the appropriate order. Finally, there must be means of deciding, at any stage, which of two or more alternative procedures shall be adopted, according to some given criterion. It is interesting to note that Babbage clearly recognized the importance of providing this facility.

The first large automatic digital machine built was developed by Prof. H. H. Aiken and the I.B.M. Company, and is now at Harvard. Prof. Hartree gave a brief description of its action, which is partly mechanical and partly electrical. The sequence of computing operations is specified by a punched tape, and is controlled by electric relays. In another group of machines, which have been developed largely by the Bell Telephone Laboratory, the storage is on relays, and the arithmetic is done through connexions between groups of relays. The first machine to operate with electronic circuits was the ENIAC, developed at the Moore School of Engineers at Philadelphia [see *Nature*, **157**, 527 (1946)]. It is in some ways an electric analogue of the Harvard machine. An important unit in the machine is the 'master programmer', which controls the sequence not of individual arithmetical operations but of large operations treated as units. This enables the machine to be provided with the discriminating faculty mentioned above.

Prof. Newman said that the idea of a 'universal' machine was introduced in modern times independently of Babbage's work by A. M. Turing, in connexion with certain logical problems. Automatic computing machines have been in use for some years for doing such special jobs as solving algebraic equations, factorizing large integers, making tables of a specified function, etc. A 'universal' machine is one which, when given suitable instructions, will do any of the jobs that can be done by these special-purpose machines. The machines now being made in Great Britain and the United States will be universal in this sense. In all these machines there is provision for storing numbers, say in the scale of 2, in certain places or 'houses'; and when the 'attention' of the machine is directed to certain of these rows of 0's and 1's, they are read as instructions.

For the machine to have practical utility, the number of orders set up by hand must be very much less than the number of operations to be done, or there will be no saving of time over the use of small desk-machines. This is possible owing to the recurrence in mathematical computations of the same series of operations done over and over again on different data (inductive processes). To take advantage of this, the machine has the power, when so instructed, to shift control to an arbitrary order. This is used to perform repeatedly orders number a, $a + 1, \ldots a + b$, the data in the relevant 'houses' having meanwhile changed. In order to stop the process at a suitable point, *conditional* change of control is needed, to take place if the content of a certain 'house' is positive, but not otherwise. Since exact multiplication of two n-figure numbers gives a $2n$-figure number, a stage will eventually be reached when part of the answer has to be thrown away. This leads to the accumulation of 'rounding-off' errors which, when the number of operations is large, may consume the whole answer unless precautions are taken. The difficult problems that arise in this connexion in the inversion of large matrices have been investigated by J. von Neumann and H. H. Goldstine[1], and also by A. M. Turing[2]. Reference was also made to the importance of providing methods of checking and quickly locating the causes of errors.

Dr. M. V. Wilkes (director of the Mathematical Laboratory, Cambridge) gave a description of the machine EDSAC now under construction at Cambridge. The project was started in 1946, after Dr. Wilkes had returned from attending a course at the

Moore School of Engineering in Philadelphia, where Dr. Mauchly and Dr. Eckert, designers of the ENIAC, were instructors. At that time only one type of high-speed memory was envisaged, the mercury delay-line carrying a train of pulses. The EDSAC will be a serial machine working in the scale of 2, with a capacity of 500 ten-decimal-digit numbers, some of which will act as orders. This should enable a start to be made on the applications contemplated. The machine will perform the arithmetical operations at an average rate of 15,000 a minute, assuming that 25 per cent of them are multiplications.

In view of the great advance in speed obtainable by electronic methods, Dr. Wilkes does not consider that the time has come to attempt the highest possible speeds. About two thirds of EDSAC's operating time will be spent in waiting for numbers to come out of the memory, so that an instantaneous memory with the same pulse length would be three times as quick. An upper speed limit for an electronic machine using conventional elements seems to be 6 million operations a second, 450 times the speed of EDSAC; but this figure is not in sight at present.

Prof. F. C. Williams (University of Manchester) described a method of storage he has designed, using an ordinary cathode ray tube. When a beam of cathode rays strikes an insulating surface capable of secondary emission, the potential of the spot bombarded is modified relative to the potential of the adjacent spots. Changes in the potential distribution on the inner surface of a cathode ray tube screen due to this effect give a measurable signal by capacitance coupling of an external pick-up plate. The signals depend on the change of potential distribution on the screen just before the beam was turned on—the essential requirement for a memory system. The individual digits to be stored correspond to a series of square waves applied to the brilliance control electrode, giving a row of bright spots on the screen. It has been found possible to store 32 rows of 64 dots on 12-inch diameter tubes. The two elements representing 0 and 1 are 'dot' (single spot) and 'dash', formed by adding an additional period of brilliance to the short pulse producing the dot. When this display has been 'written' in one sweep of the spot, subsequent sweeps of the beam 'read' the line by delivering signals characteristic of the pattern, namely, a negative pulse for a dot and a positive pulse for a dash.

A charge distribution on a cathode ray tube surface tends to 'spread' and leak away within about a second. This effect is neutralized by 're-writing' the record at regular intervals, short compared with the leakage time. It is proposed to devote alternate line-sweeps to reading an arbitrary line for computing purposes, and reading the lines in a regular order for regeneration purposes. Regeneration will take place every 20 milliseconds on this plan. Recognizable patterns have been set up and stored without change for periods of 4½ hours. The time-scale of the storage is 8μsec. per digit (making allowance for the time spent in regeneration). This is slower than the projected 'delay-tank' systems, but time is saved by the greater accessibility. The slower time-scale has also the advantage that the various circuits can operate more slowly, permitting some under-running of the valves.

Mr. J. H. Wilkinson (Mathematics Division, National Physical Laboratory) spoke on the machine, ACE, which is being made at the National Physical Laboratory. He compared the effective speed of mercury-tank delay line and cathode ray storage. If instructions are suitably disposed in the delay lines, and if there are some short lines holding one instruction each, there need be no waiting for the right instructions to come round. The fact that a large proportion of the operations performed are devoted to counting the lengths of induction-cycles or applying discrimination tests makes it less important that a number is stored as one of thirty-two items in a long tank; and the fact that whole sequences of numbers can be transferred by one order introduces a positive simplification in the coding.

The detailed coding, depending on the type of machine, is likely to be a small job compared with the more mathematical side of the preparation of problems; for example, arranging that the numbers involved stay in the permissible range. By preliminary work of the kind now being done at the National Physical Laboratory, it is hoped to reduce this mathematical part of the preparatory work by providing standard units which can be inserted whole into larger routines. Practical numerical investigations are being carried out with ordinary desk machines, which often reveal difficulties that might otherwise be overlooked.

Mr. J. D. Booth described a parallel-operation machine which is in course of construction at Birkbeck College, in which the storage is a rotating magnetic drum, having a capacity of about 4,000 numbers, each of forty digits. Mr. Aughtie (Mathematics Division, National Physical Laboratory) spoke on the problem of input and output, namely, loading the machine with the data and instructions for a problem, and extracting the final answer in convenient form.

A detailed report of the discussion will be published in the *Proceedings of the Royal Society* in due course.

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[1] von Neumann, J., and Goldstine, H. H., *Bull. Amer. Math. Soc.*, 53, 1021 (1947).

[2] To be published shortly.

OBITUARIES

Prof. James McIntosh

MANY readers will have learned with regret of the death of Prof. James McIntosh, which occurred on April 5 at his home in Aberdeen. He was at the time of his death professor of pathology in the University of London and director of the Bland-Sutton Institute of Pathology, at the Middlesex Hospital, a post which he had held since 1920.

The purpose of an obituary notice is to give the reader a picture of the man as he was when at work, and to try to give some idea of his personality. The formal facts of McIntosh's career can always be found in standard works of reference, and therefore only a brief summary need be given here. He was born in Aberdeen and educated at the Robert Gordon College and at the University of Aberdeen, where he qualified in 1905 after a brilliant career as a student. In 1906 he was awarded the Alexander Anderson Scholarship, and this enabled him to spend the next two years at the Pasteur Institute working under Levaditi. It was here that his life-long interest in virus diseases first became aroused.

McIntosh's first studies were concerned with the etiology and chemotherapy of syphilis. He began these in Paris and continued them on his return to

Aberdeen and later at the London Hospital, where he worked in collaboration with Fildes. He also carried out some work on the etiology of acute anterior poliomyelitis. During the First World War he did invaluable work on the isolation, recognition and classification of the anaerobic bacteria of war wounds, and the results were outlined in a special report to the Medical Research Committee. His interest in virus diseases continued after his appointment as director of the Bland-Sutton Institute, and he made a special study of the virus infections of the central nervous system. The experiments of Gye and Barnard on the Rous filterable sarcoma turned his attention to the possible connexion between virus infection and cancer. His most important work in this direction was the production of filterable tumours by means of chemical carcinogens. This work may prove to be of the greatest significance and, in fact, to be a turning point in the history of cancer research.

In appearance McIntosh was a shortish man with black hair turning to grey in later years, with slightly rounded shoulders, which he himself attributed to having spent the greater part of his life looking down a microscope. He had a curious offhand way of speaking which gave the mistaken impression that he was not particularly interested in what one was saying. This characteristic was displayed at meetings, when he would apparently go off at a tangent and introduce what seemed to be a lot of irrelevant material. Frequently his points would be dismissed as being of no importance; but almost invariably McIntosh would come back and secure a complete victory for his views, before his opponents had realized what had happened. At scientific meetings he gave the impression of being difficult; but people in his own laboratory were always struck with his kindness to them and knew they could rely on his continued help and interest.

In conclusion, one must say that McIntosh's scientific career was a stormy one, as he wished it to be. But in whatever he touched, however, whether it be vaccinia, anaerobes, syphilis or the etiology of malignant disease, he stirred up a controversy necessitating a great deal of experimental work, and this work will go on for a very long time. E. C. DODDS

WE regret to announce the following deaths:

Dr. Vaughan Cornish, president in 1928 of the Geographical Association, on May 1, aged eighty-five.

Dr. J. G. Parker, sometime principal of the Leathersellers' Technical College, London, honorary secretary during 1897–1912 of the International Association of Leather Trades' Chemists, on April 30, aged seventy-eight.

NEWS and VIEWS

Plant Breeding Institute, Cambridge

BY agreement between the University of Cambridge, the Ministry of Agriculture and the Agricultural Research Council, it has been decided that, as soon as conditions become favourable, the Plant Breeding Institute at Cambridge shall be transferred from its existing site on the University Farm to one offering greater facilities to an increased staff. When the move is made, management by the University will be transferred to an independent body comparable with those which govern such agricultural research institutes as Rothamsted and East Malling. Meanwhile, the Plant Breeding Institute will remain attached to the School of Agriculture at Cambridge as at present. The future expansion in plant breeding which is envisaged is a notable part of the general programme of development of agricultural research in Great Britain, financed by the Ministry of Agriculture in consultation with the Agricultural Research Council. The Institute will concern itself with the full range of arable and pasture crops grown in the eastern and drier parts of Britain, although the interests of other regions in certain crops will not be neglected. It already handles wheat, barley, oats, potatoes, sugar beet, beans, peas, lucerne and sainfoin, and in addition to expanding the work on these crops, others such as rapes, kales and certain herbage plants will be included. Fundamental breeding problems are envisaged as an important part of the Institute's programme in the future.

Since the Cambridge Plant Breeding Institute was established with Sir Rowland Biffen as first director, several new varieties of crop plants, which are now well known and commercially successful, have been produced, including 'Little Joss' and 'Yeoman' wheats (by Sir Rowland Biffen), 'Holdfast' and 'Steadfast' wheats (by Sir Frank Engledow), and 'Picton' oat and 'Camton' barley (by Dr. H. Hunter). Sir Rowland Biffen was succeeded as director by Dr. Hunter, who retired in 1946. Dr. G. D. H. Bell was then appointed acting director and he has now been confirmed as director of the Institute, which, as indicated above, is to be expanded and established as a separate research organisation.

Dr. G. D. H. Bell

DR. BELL, the new director of the Plant Breeding Institute, is a fellow of Selwyn College and University lecturer in agricultural botany, and has been a member of the staff of the Plant Breeding Institute since 1932. He received his early scientific training at University College, Bangor, whence he obtained an agricultural scholarship for postgraduate study in genetics and plant breeding at Cambridge and in the United States. He has travelled extensively in western and northern Europe and in the West Indies. His teaching duties are now confined to lecturing to graduate classes on agricultural botany, with particular reference to problems of crop improvement; but these teaching duties will be reduced as his responsibilities as director of the Plant Breeding Institute increase. He will shortly publish a book on "Cultivated Plants of the Farm". His investigations have been centred on the breeding of barley, field peas and sugar beet; but he is now also interested in wheat and oats. He has produced two new varieties of barley, already on the market, 'Prefect' and 'Pioneer', the latter being the first winter-hardy malting barley to be bred in Great Britain. Much of his time during the War was occupied with problems concerning sugar beet. With regard to general crop improvement in Britain, he is anxious to increase the effective range of varietal types so that the area of successful cultivation can be increased. This involves the creation of a wider range of varieties adapted to particular environments. Last summer he organised very successfully at Cambridge the first conference of British directors of plant breeding institutes and their staffs. He has published papers on plant breeding, developmental studies in relation to yield, the classification of barley varieties, inheritance in barley, and vernalization in cereals. He has been a regular contributor to the *Journal of the Royal Agricultural Society* for many years.

New Vegetable Research Station: Dr. J. Philp

Dr. James Philp has been appointed director of the Vegetable Research Station to be set up in due course in Britain. He will serve on the staff of the Ministry of Agriculture until the governing body of the new Station is legally constituted and will at first be engaged on the search for a suitable site. Dr. Philp was educated at the Universities of Glasgow and London. He was a cytogeneticist on the staff of the John Innes Horticultural Institution, Merton, during 1927–34. He then became director of the Cereal Division of the Egyptian Ministry of Agriculture. In 1942 he was appointed forest geneticist with the South African Department of Forestry, and established a tree-breeding station. He has been director of the South African Wattle Research Institute (which he established) at Pietermaritzburg from 1944 until 1947. Dr. Philp is the joint author with Dr. F. W. Sansome of "Recent Advances in Plant Genetics", and the author of many scientific papers on agricultural and horticultural plants and on trees.

Chemistry at the University of Liverpool: Dr. C. E. H. Bawn

Dr. C. E. H. Bawn, who has been appointed to the Grant–Brunner chair of physical and inorganic chemistry in the University of Liverpool, is a Bristolian who graduated and carried out his first researches at the University of Bristol. His first university appointment was as assistant lecturer at the University of Manchester in 1931, where he owed much to the inspiration of Prof. M. Polanyi, under whom he worked on alkali metal flames and on the theory of chemical kinetics. He returned to Bristol in 1938 as a lecturer in physical chemistry and became reader in 1945. During the War he was engaged on extra-mural work for the Ministry of Supply, mainly on problems arising from the manufacture of explosives, and in 1943 was appointed principal scientific officer in charge of a physico-chemical section in the Armament Research Department, Ministry of Supply. Dr. Bawn's interest in research lies in chemical kinetics. During the War he carried out pioneer work on the stability and kinetics of decomposition of high explosives and pyrotechnics, evolving special technique for the purpose. His main work has, however, been based on the chemistry of free radicals, studying their methods of production and stability and the kinetics of their reactions. He has advanced our knowledge of biradicals, and of the decomposition of metal alkyls. Recently he has extended his work to the kinetics of polymerization reactions, particularly on the initiation of polymerization by free radicals, and has written a book on polymerization shortly to be published.

Theoretical Physics at Liverpool: Dr. H. Fröhlich

The appointment of Dr. H. Fröhlich to the chair of theoretical physics at the University of Liverpool has recently been announced. Dr. Fröhlich has been associated with Prof. N. F. Mott since 1935 in building up the school of theoretical physics at Bristol. He has specialized in nuclear physics, where he has made important contributions to the theory of the meson and to nuclear binding forces, and on dielectrics, where his work on the mechanisms of breakdown and loss are well known. In the latter field Dr. Fröhlich has been prominent in developing those parts of theoretical physics of interest to industry, and has taken a large part in the well-known Bristol 'summer schools'; his knowledge of nuclear physics, also, makes him particularly fitted to collaborate with the group at Liverpool working under Sir James Chadwick.

Chemistry at University College, Dundee: Dr. D. H. Everett

The chair of chemistry at University College, Dundee, which became vacant last year when Prof. Wynne-Jones went to King's College, Newcastle-upon-Tyne, has been filled by the appointment of Dr. D. H. Everett, fellow of Exeter College, Oxford. Dr. Everett was educated at the University of Reading under Prof. Wynne-Jones, and his first research work was done there and at Dundee on the electrochemistry of non-aqueous solutions. In 1939 he was elected to a Ramsay fellowship and went to Balliol College, Oxford, to work on reaction kinetics with Mr. R. P. Bell. This programme was interrupted by the War, and Dr. Everett took an active part in scientific war-work, at first in a team of workers in Oxford and later in other fields of work which took him eventually to India. He returned to Oxford with an Imperial Chemical Industries fellowship, and after a short period as a lecturer in Dundee was elected to an official fellowship at Exeter College, Oxford, in 1947. He has already done distinguished work on the physical chemistry of both aqueous and non-aqueous solutions, and will thus continue the tradition established by Prof. Wynne-Jones in Dundee.

Scientific Research (Defence): Dr. F. J. Wilkins

Dr. F. J. Wilkins has been appointed principal director of scientific research (defence) in succession to Dr. E. T. Paris. Under the Controller of Supplies (Munitions) and the Chief Scientist, he will be responsible for research on munitions and allied equipment. Dr. Wilkins joined the Ministry of Supply from Imperial Chemical Industries, Ltd., in 1941, and was appointed regional development officer (western region) for the Royal Ordnance filling factories. In 1944 he was appointed assistant director of Filling Factories and later deputy chief superintendent of armament research at the Ministry. Since April 1946, he has been director of chemical research and development.

Meldola Medal, 1947: Dr. J. Baddiley

On the recommendation of the Council of the Royal Institute of Chemistry, the Society of Maccabæans has awarded the Meldola Medal for 1947 to Dr. James Baddiley in recognition of the outstanding contributions he has made to knowledge in the field of nucleoside chemistry and related subjects. Educated at the Manchester Grammar School, Baddiley proceeded to the University of Manchester. Work with Prof. A. R. Todd on a synthetic approach to the study of nucleosides involved the development of new methods for the synthesis of purines and their 9-substituted derivatives and a general, unambiguous synthesis of 9-glycosidopurines. Application of these methods to the synthesis of 9-*d*-ribosidoadenine gave a product which differed only in the size of the sugar ring from the important naturally occurring nucleoside adenosine. He was awarded the degrees of M.Sc. (1942) and Ph.D. (1944) of the University of Manchester on the results of these investigations. After a period of work on penicillin chemistry under a grant from the Medical Research Council, he was awarded an I.C.I. fellowship and resumed work with Prof. Todd at Cambridge on the chemistry of the nucleotides, particularly those possessing coenzyme function. By the application of a new phosphorylating reagent, dibenzyl chlorophosphonate, muscle adenylic acid and adenosine diphosphate were synthesized from adenosine in good yield, thereby enabling these important biological substances to become more accessible for biochemical study and, at the same time, proving their structures beyond doubt. Since then, Dr. Baddiley has been engaged on a total synthesis of adenosine triphosphate and is at present spending a year at the Wenner Grens Institut, Stockholm, to extend his knowledge of nucleotides on the biological side and to acquire tracer technique for his future investigations. The Meldola Medal is the gift of the Society of Maccabæans and is normally awarded annually to the chemist who, being a British subject and less than thirty years of age, shows the most promise as indicated by his or her published chemical work.

Royal Society of Edinburgh : Awards

The council of the Royal Society of Edinburgh has awarded the Keith Prize for the period 1945–47 to Dr. Charlotte Auerbach, of the Institute of Animal Genetics, University of Edinburgh, for her contributions to genetics published in the Society's *Proceedings*, during the period of the award and previously. The Neill Prize for the period 1945–47 has been awarded to Dr. Robert Broom, for his contributions to our knowledge of the fossil vertebrates of the Karroo Beds of South Africa. At the ordinary meeting of the Society held on May 3, David Anderson-Berry Prizes were presented to Dr. Ralston Paterson, director of the Holt Radium Institute, Manchester, for his book on radiotherapy; and to Dr. P. C. Koller, of the Royal Cancer Hospital, London, for his researches on the effect of radiation by X-rays on experimental and pathological material.

Royal Institute of Chemistry : Anniversary Meeting

For the first time in the history of the Royal Institute of Chemistry, the annual general meeting was held this year outside London, the Birmingham and Midlands Section of the Institute having invited the Council to hold the anniversary meetings in Birmingham during April 15–17. An exhibition entitled "The Chemist in the Midlands", which was opened by the president of the Institute, Dr. G. Roche Lynch, on April 15 at the Central Technical College, afforded a remarkable demonstration of the present-day activities of chemists in research, industrial production and the public services in the Midlands, and of the organisation and development of scientific and technical education and research in the area. The exhibition was open to the public during the following two days and special arrangements were made for visits by parties of school-children. Later the officers of the Institute received a civic welcome from the Deputy Mayor of Birmingham (Alderman A. F. Bradbeer). The general proceedings of the meeting included a lecture by Prof. R. P. Linstead on "The Chemical Research Laboratory, Teddington", and a lecture by Prof. M. Stacey on "The New Fluorocarbon Chemistry". At the annual general meeting, two special resolutions, moved by the president, were passed: one authorizing the Council to submit to the Privy Council a petition for a new charter for the Institute; the other consenting to the raising, as from January 1, 1949, of the annual subscriptions of fellows and of associates. The following were elected officers for 1948–49: *President:* Dr. Gerald Roche Lynch; *Vice-Presidents:* Prof. H. V. A. Briscoe, Prof. F. Challenger, Mr. G. E. Dodds, Prof. Alexander Findlay, Mr. E. T. Osborne, Mr. A. J. Prince; *Hon. Treasurer:* Dr. D. W. Kent-Jones.

American Awards to British Scientific Workers

The United States Military Attaché in London, Major-General Clayton L. Bissell, presented United States awards and decorations to eighteen British citizens, one Canadian and one Australian, on April 29, for services during the Second World War. Among the awards were the following: *Medal of Freedom with Silver Palm:* Prof. S. Zuckerman, professor of anatomy, University of Birmingham, scientific adviser to the Deputy Commanding General of Allied Force Headquarters and to Supreme Headquarters Allied Expeditionary Force, from January 1943 until May 1945; *Medal of Freedom:* Prof. W. Norman Thomas, professor of engineering, University College, Cardiff, head of the *RE*2/4 Division of the Research and Experiments Department, Ministry of Home Security; *Bronze Star:* Miss Peggy Furse, civilian personnel officer, Personnel Section, Psychological Warfare Division, Supreme Headquarters Allied Expeditionary Force (Rear Echelon), from March 1944 until July 1945.

Royal Botanic Gardens, Kew : Recent Acquisitions

Mr. W. R. Sherrin has presented to the Herbarium of the Royal Botanic Gardens, Kew, his valuable collection of bog-mosses (*Sphagnum*). The material occupies two standard-sized cabinets, and the specimens, representing approximately 4,350 separate collectings, are mounted on 1,360 sheets. The specimens have been determined with the utmost care and largely formed the basis of Mr. Sherrin's "Illustrated Handbook of the British Sphagna", published by Taylor and Francis, London, in 1927. The *Sphagna* are of considerable interest to botanists for a number of reasons and they also have economic importance. The genus is a large one (Warnstorff, in 1911, accepted 342 species, some with a considerable number of varieties and forms) and occurs all over the world; but the species thrive best in the damp, humid climates of the temperate zone in Europe, Asia and America. Typically, the species grow in bogs and other wet places where the water is more or less acid, often very highly acid. Their dead remains play an important part in the building up of the masses of peat filling such bogs. Newly dried *Sphagnum* has been used for packing material, fo making coarser kinds of paper, in horticulture, and in the manufacture of molasses feeds for livestock Taxonomically the genus is a difficult one. The differences used as key characters are often either difficult to define precisely in words or are microscopic. This enhances the value of such a collection as that made by Mr. Sherrin, which at Kew will be accessible to all *bona fide* research students.

Palæontographical Society Annual Meeting

THE hundred and first annual general meeting of the Palæontographical Society was held in the apartments of the Geological Society, London, on April 27, under the chairmanship of Prof. H. L. Hawkins, president. Following the resignation of Dr. C. J. Stubblefield from the office of secretary after fourteen years service, it was considered that the routine financial duties which for many years have been undertaken by successive secretaries should devolve upon the treasurer. Since, however, the present treasurer was unable to take over additional responsibilities, his offer to resign was accepted. The meeting then elected Mr. L. Bairstow, of the British Museum (Natural History), as treasurer, and Mr. R. V. Melville, of H.M. Geological Survey and Museum, as secretary. The new members of council elected were Dr. A. J. Bull, Mr. C. P. Chatwin, Mr. M. A. C. Hinton and Dr. C. J. Stubblefield in place of Messrs. C. H. Dinham, G. A. Kellaway, R. V. Melville and Dr. Vernon Wilson. In view of the increased cost of printing, it was decided that all annual volumes, of whatever date, will now be charged at £2 2*s*., except for the volume sent to members in the year of issue, which will remain at one guinea, or £1 2*s*. 6*d*. if delivered overseas. The prices of publications issued before 1919 will be double those given in the Society's list dated November 1947. Except for the annual volumes, the prices of publications issued after 1918 will remain as listed, and members will receive, as hitherto, discount on past publications ordered through the secretary.

"Precise Measurement for Engineers"

"PRECISE Measurement for Engineers" is the first of a group of films which is being produced to illustrate the relationship of the work of the various divisions of the National Physical Laboratory to industry, as part of a series arranged by the Department of Scientific and Industrial Research under the general title of "Science in the Service of the Nation". The film shows the part played by the Metrology Division of the National Physical Laboratory in the field of precise measurement for engineers and is designed to portray the scientific basis of interchangeable engineering production. The film opens with views in a factory in the Midlands in which agricultural tractors are being produced in large quantities, the emphasis being on accuracy in the size of components and the significance of tolerance limits. The film illustrates the checking of size, (1) by means of limit gauges and (2) by measurement under a system of quality control. It then shows the importance of standardizing gauges and measuring equipment in the factories to secure universal interchangeability of components, and how this standardization depends ultimately upon the work at the National Physical Laboratory, where, in the Metrology Division, standards of length suitable for engineers are derived from the Imperial Standard Yard. The film also demonstrates the work of the Metrology Division over a large range of precise measurement, including that of screw gauges, gears, surface finish and the measurement of angles.

Summer School in Relaxation Methods

IN the long vacation of the last three years, Summer Schools in 'Relaxation Methods' have been held at the Imperial College of Science and Technology, London, S.W.7. Their success has encouraged the provision of a similar course in the coming long vacation, and this is now planned for the four weeks July 6–30. It would seem that there is no great difficulty in acquiring such knowledge of the relaxational technique as is required to solve ordinary engineering problems (frameworks, electrical networks, etc.), but that for partial differential equations in two independent variables, although techniques have been described in published papers, these have necessarily been made too concise to meet the needs of readers working without supervision. Accordingly, it is proposed to concentrate on problems of this second kind. The course will consist of more or less formal lectures with numerous examples to be solved under supervision. Lectures will be given on Tuesdays–Fridays only, with facilities for practical work on Mondays; the inaugural lecture will be delivered on July 6. Further particulars can be obtained from D. N. de G. Allen, Imperial College, London, S.W.7.

Royal Institution

THE anniversary meeting of the members of the Royal Institution was held on May 1, Lord Brabazon, president, in the chair. The annual report of the visitors was received and adopted at the meeting. The following officers were elected: *President*, Lord Brabazon of Tara; *Secretary*, Prof. A. O. Rankine; *Treasurer*, Dr. R. E. Slade; *Managers*, Prof. E. N. da C. Andrade, Prof. H. V. A. Briscoe, Prof. H. Dingle, Dr. P. Dunsheath, Sir Alfred Egerton, Dr. E. V. Evans, Sir William Halcrow, Prof. F. L. Hopwood, Prof. L. C. Martin, Sir Clifford Paterson, Prof. H. J. Plenderleith, Sir Geoffrey Taylor, Sir George Thomson, Prof. A. M. Tyndall, Mr. Frank Wakeham. *Visitors*, Mr. J. J. Abraham, Lieut.-Colonel S. J. M. Auld, Dr. J. H. Brinkworth, Dr. H. E. Cox, Mr. F. P. Dunn, Dr. H. J. T. Ellingham, Dr. A. T. Fraser, Dr. R. E. Gibbs, Mr. A. C. Hartley, Mr. J. Henshilwood, Dr. D. C. Martin, Mr. D. Northall-Laurie, Dr. E. Talbot Paris, Mr. J. W. Ryde, Dr. H. Shaw.

Announcements

THE American Association for the Advancement of Science celebrates its centenary this year; the meeting will be held at Washington, D.C., during September 13–17.

THE National Physical Laboratory at Teddington is having an 'Open Day' on June 21, 2.30–6.0 p.m., to which representatives of industrial organisations are being invited. Although the wide range of scientific research and investigation undertaken at the Laboratory is already well known to industry, there may still be a number of firms with which it has no contact. A number of invitations is accordingly being reserved to enable such firms to visit the Laboratory. Accredited representatives of industrial organisations are invited to apply to the Director, National Physical Laboratory, Teddington, Middlesex, not later than June 5.

DR. KENNETH CARTER, recently research liaison officer and secretary to the Therapeutic Research Corporation of Great Britain, Ltd., has been made a director of Laboratorios Glaxo (Argentina) S.A., and will reside in Buenos Aires.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Curare-like Action of Polymethylene *bis*-Quaternary Ammonium Salts

TUBOCURARINE chloride is a *bis*-tetrahydro*iso*quinoline alkaloid containing two quaternary nitrogen atoms[1], and its extraordinary potency in blocking neuromuscular transmission, compared with that of simple quaternary ammonium salts, might conceivably be due in part to the presence of two such cationic groups at some optimal distance apart. With this in mind, we have prepared and tested for curare-like activity a number of simple *bis*-quaternary ammonium salts in which the nitrogen atoms were separated by polymethylene chains of different lengths.

Among the salts prepared were polymethylene *bis*-trimethyl- and *bis*-triethyl-ammonium dibromides with chain-lengths of from two to five and seven to thirteen carbon atoms, and a smaller group of polymethylene *bis*-quinolinium and *bis*-strychninium dibromides; they were obtained by heating polymethylene dibromides with the appropriate tertiary bases, and were tested on the phrenic nerve-diaphragm preparation of the rat.

In the *bis*-trimethylammonium series, the ethylene member (C_2 chain) was about twice as active as tetramethylammonium; it might be considered to contain twice the number of effective blocking groups per molecule. The salts with C_3, C_4 and C_5 chains were only feebly active; but there was a progressive rise in activity from the C_7 to the C_9 member; activity remained fairly constant from C_9 to C_{12} and fell slightly at C_{13}. In the *bis*-triethylammonium series activity rose steadily from C_4 to C_{13}, the last member being more active than the *bis*-trimethyl C_9 member. None of these compounds was more than two-fifths as active as tubocurarine chloride.

Superficially, these results suggest that the *bis*-quaternary salts behave rather like the analogous mono-quaternary salts containing an alkyl group with (to the nearest whole number) half the number of carbon atoms in the polymethylene chain; thus in the series $Me_3N.C_nH_{2n+1}$, the least active on frog muscle are those in which $n = 2$ or 3, and cations in which $n = 4$ to 8 are all about as active as tetramethylammonium[2]; in the series $Et_3N.C_nH_{2n+1}$, activity on frog muscle increases steadily from $n = 2$ to $n = 8$[3]. However, it is doubtful whether it is legitimate to compare activities on a rat preparation with those on frog preparations.

The *bis*-quaternary ammonium salts display quite different activities in the rabbit head-drop test: in the *bis*-trimethyl series, activity rose to a pronounced maximum in the C_{10} member and fell slowly as the carbon chain was increased beyond ten carbon atoms. The C_{10} member was about three times as potent as tubocurarine chloride, 0·08 mgm./kgm. being required to produce head drop, compared with 0·26 mgm./kgm. of *d*-tubocurarine chloride. The approximate activities of the C_8 to C_{13} members in terms of tubocurarine chloride as 1 were: C_8, 0·3; C_9, 0·9; C_{10}, 3·3; C_{11}, 0·4; C_{12}, 0·3; C_{13}, 0·3. Not all our compounds have yet been tested by this method, but it is quite clear that the relative activities, and their variation within a homologous series, may be quite different in the rat diaphragm and the rabbit head-drop tests.

Nearly all the *bis*-quaternary ammonium salts produce augmentation of the contractions of the rat diaphragm, usually at concentrations slightly lower than those needed to produce inhibition. With ethylene *bis*-strychninium dibromide it was possible to observe augmentation at low doses, inhibition at higher doses and to find an intermediate dose at which the two effects cancelled each other. This augmentation resembles superficially the effect of anticholinesterase drugs, and consequently representative members were tested on the cholinesterase of caudate nucleus (dog), with acetylcholine as substrate. All the *bis*-quaternary salts so far tested in this way showed some inhibition of the enzyme at concentrations slightly lower than those needed to reduce the contractions of the rat diaphragm (10^{-8} to 10^{-5} molar); this inhibition was particularly striking in the C_{10}-*bis*-quinolinium and C_{13}-*bis*-triethylammonium salts, and less marked in the C_9-*bis*-trimethylammonium salt. Tetramethylammonium did not inhibit this enzyme, although augmentation was sometimes observed with this cation in the rat diaphragm preparation.

Our thanks are due to Dr. N. K. Dutta, who carried out the rabbit head-drop tests.

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DURING a test of octamethylene-$\alpha\omega$-*bis*-trimethylammonium chloride for the power of liberating histamine, it was observed to be remarkably effective as a cause of neuromuscular block. Accordingly, a series of straight-chain aliphatic $\alpha\omega$-*bis*-trimethylammonium iodides have been synthesized from diamines by treatment in methyl alcoholic solution with methyl iodide and sodium hydroxide, and using the insolubility of these compounds in acetone, and the solubility of sodium iodide in this solvent for their isolation. All the compounds synthesized were tested for potency, and the octamethylene derivative (C_8) was the subject of more detailed pharmacological study.

In the rabbit head-drop test for curare-like activity, potency increased from the ethylene derivative to the octamethylene derivative, and the decamethylene derivative (C_{10}) was more potent still, 0·11 mgm./kgm. of the iodide being required to produce head-drop, compared with 0·25 mgm./kgm. of *d*-tubocurarine chloride. The potency in relation to *d*-tubocurarine chloride varied, however, with the test object; thus, the approximate ratio of an effective dose of the C_8 derivative to an equipotent dose of *d*-tubocurarine chloride was, on the cat's tibialis, ⅓; on rabbit's head-drop, 3; on frog nerve-sartorius preparation, 3; on rat's diaphragm preparation, 50–100. In the cat's tibialis preparation[1], the C_8 derivative prevented the response of the muscle to stimulation of its motor nerve and to close arterial injection of acetylcholine, but not its response to direct stimulation. The conduction of impulses in nerve trunks was not affected by it.

While large doses of the C_8 derivative caused rapid neuromuscular block, moderate doses injected intravenously in the cat initially increased the response of tibialis to single maximal shocks applied to the motor nerve, and this response was followed by a small prolongation of the contraction, together with a widespread fibrillation of the musculature for 20–30 sec. not unlike that resulting from the injection of anticholinesterases. Intra-arterial injection of the C_8 derivative in a dose of 20 μgm. into the cat's tibialis itself produced a twitch before block ensued. The curare-like action was not antagonized by prostigmine in doses adequate to antagonize the effect of *d*-tubocurarine chloride, either in the cat's tibialis or in the rabbit's head-drop test.

Comparison of potency with *d*-tubocurarine chloride was complicated by the remarkable finding that while *d*-tubocurarine chloride is unaltered in potency when given after these *bis*-quaternary salts, the converse is not true; thus, following the injection of two-thirds head-drop dose, approximately twice as much of the C_{10} derivative was required to produce head-drop as was normally needed.

The results reported represent preliminary findings on a series of simple compounds, some of which have a potency which exceeds that of *d*-tubocurarine chloride. They serve to demonstrate, however, the importance of pharmacological testing of possible substitutes for *d*-tubocurarine chloride on more than one test object, and to suggest that before clinical application can be considered it is desirable to find some satisfactory antagonist to their effects.

We are much indebted to Dr. H. King, who synthesized the first compound tested, and to Dr. F. C. MacIntosh for their encouragement and advice.

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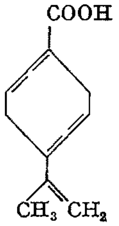
[1] Brown, G. L., *J. Physiol.*, 92, 23 P (1938).

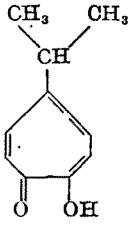
Antibiotic Substances from the Heart Wood of *Thuja plicata* Don.

THE heart-wood of western red cedar (*Thuja plicata* Don.), which possesses a low specific gravity and is very resistant towards decay, has been examined by Anderson and Sherrard[1]. The steam distillate of this wood furnished an acid, $C_{10}H_{12}O_2$, termed dehydroperillic acid, showing low toxicity, and a very toxic 'phenol', m.p. 82°, of the same composition. For dehydroperillic acid they suggest the formula (I), but the structure of the compound of m.p. 82° was not elucidated.

In a private communication Anderson describes the separation of the 'phenolic' fraction of the steam distillate into the above compound, m.p. 82°, and an oil, also $C_{10}H_{12}O_2$, which he has kindly given us the opportunity to examine. It had meanwhile partly crystallized and afforded a compound, $C_{10}H_{12}O_2$, m.p. 52–52·5°, the investigation of which will be described jointly with Dr. Anderson.

From *Thuja plicata*, grown in Sweden, we have isolated dehydroperillic acid, the compound, m.p. 82°, and a less acidic isomeride, m.p. 34°, but none of the isomeride, m.p. 52–52·5°. The ultra-violet absorption spectrum of dehydroperillic acid shows maxima at 220 and 280 mμ. This behaviour suggests a structure with a more extended conjugated system than that in (I).


I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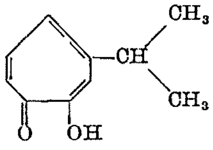
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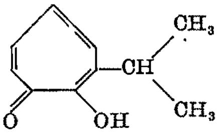
IV

The ultra-violet absorption spectra of the three isomerides, melting points 82°, 52–52·5° and 34° respectively in alcoholic solution, are very similar, with maxima at 230–240 mμ and broad absorptions between 320 and 370 mμ. These isomerides absorb four moles of hydrogen on catalytic hydrogenation. The compound, m.p. 82°, thereby yields a diol, $C_{10}H_{20}O_2$, m.p. 87–88°, and as a by-product an oil, probably a diastereoisomeride or a mixture of such. The two other isomerides only give oily hydrogenation products. The diol, m.p. 87–88°, is easily cleaved by periodic acid to a dialdehyde, $C_{10}H_{18}O_2$, characterized as its *bis*-2 : 4-dinitrophenylhydrazone, m.p. 194–195°. Oxidation with potassium permanganate yields a dicarboxylic acid, $C_{10}H_{18}O_2$, m.p. 65·5–66·5°. The barium salt of this acid on dry distillation afforded 1-*iso*propyl*cyclo*hexanone-(4), identified as the 2 : 4-dinitrophenylhydrazone, m.p. 118–119°, and semicarbazone, m.p. 188–189°; both melting points were undepressed on admixture with authentic specimens. Hence the dicarboxylic acid, m.p. 65·5–66·5°, must be γ-*iso*propylpimelic acid. Consequently, the compound, m.p. 82°, most probably possesses the structure (II). This conclusion is supported by the fact that oxidation of the compound, m.p. 82°, with chromic acid furnished *iso*butyric acid (*p*-bromophenacyl ester, m.p. 76–77°; mixed m.p. 76–77°).

The absorption spectra and other evidence make it probable that the compounds, m.p. 52–52·5° and m.p. 34°, are represented by the formulæ (III) and (IV) respectively.

The compound, m.p. 82°, is termed γ-thujaplicin because the *iso*propyl group occupies the γ-position in the *cyclo*heptatrieneolone. If our views on the structure of the compounds, m.p. 52–52·5°, and m.p. 34°, are confirmed, these should be termed β- and α-thujaplicin respectively. The structure proposed for γ-thujaplicin recalls the constitution of the azulenes, stipitatic acid according to Dewar[2], and purpurogallin according to Prof. R. D. Haworth, and to Dr. J. A. Barltrop (private communications).

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[1] Anderson and Sherrard, *J. Amer. Chem. Soc.*, 55, 3813 (1933).

[2] Dewar, *Nature*, 155, 50 (1945).

Separation and Identification of Methylated Sugars on the Paper Chromatogram

THE identification of the products of hydrolysis of a methylated polysaccharide composed of many different sugar residues is a tedious and difficult task, especially when the polysaccharide is available only in small quantities. We have found, however, that many of the methylated sugars can be readily separated and identified on the paper chromatogram, using the same apparatus and solvents as described for the separation of the simple sugars[1,2]. The chromatogram is allowed to run until the solvent has advanced about 40 cm. from the starting line. The paper is then dried and sprayed with ammoniacal silver nitrate, and on warming, the positions of the sugars are indicated by brown spots (except in the case of tetramethylfructopyranose, which reduces ammoniacal silver nitrate only very slightly). As a standard, we use tetramethyl *D*-glucose, which moves rapidly on the chromatogram. The distance the sugar travels is measured from the starting line to the centre, not the edge, of the sugar spot, since the size of the spot and its leading edge vary with the concentration of sugar solution used. The figure R_G given in the accompanying table refers to the ratio between the distance the sugar travels and the distance through which the tetramethyl *D*-glucose has moved. (We use this in preference to the R_F value, which tends to vary with the distance the sugar has advanced from the starting line.)

Substance	R_G	Substance	R_G
Galactose	0·075	2 : 3-Dimethyl arabinose	0·63
Arabinose	0·135	2 : 3 : 4-Trimethyl galactose	0·64
Xylose	0·15	2 : 4-Dimethyl xylose	0·66
4-Methyl galactose	0·165	2 : 4 : 6-Trimethyl galactose	0·67
6-Methyl galactose	0·185	2 : 3-Dimethyl xylose	0·74
Talose, lyxose	0·19	2 : 4 : 6-Trimethyl glucose	0·755
2-Methyl galactose	0·205	3 : 4 : 6-Trimethyl mannose	0·795
Ribose, fucose	0·21	2 : 3 : 6-Trimethyl glucose	0·805
3-Methyl glucose	0·265	2 : 3 : 4 : 6-Tetramethyl galactose	0·88
Rhamnose	0·30	Tetramethyl fructopyranose	0·90
3 : 4-Dimethyl galactose	0·32	2 : 3 : 4-Trimethyl xylose	0·94
2-Methyl arabinose	0·36	2 : 3 : 5-Trimethyl arabinose	0·95
3 : 6-Anhydroglucose	0·37	2 : 3 : 4 : 6-Tetramethyl mannose	0·96
2-Methyl xylose	0·385	2 : 3 : 4 : 6-Tetramethyl glucose	1·0
2 : 4-Dimethyl galactose	0·405	2 : 3 : 4-Trimethyl rhamnose	1·01
2-Methyl fucose	0·51	Raffinose	0·0*
3 : 6-Dimethyl glucose	0·51	Sucrose	0·035
4-Methyl rhamnose	0·575	β-Methyl arabinoside	0·325
3 : 4-Dimethyl mannose	0·58	α-Methyl mannoside	0·30

* No movement.

The separation of the tetramethyl derivatives of glucose, galactose and mannose is readily achieved. Furthermore, closely related pairs of substances, for example, 2 : 3-dimethyl xylose and 2 : 4-dimethylxylose, and 2 : 3 : 4-trimethyl galactose and 2 : 4 : 6-trimethyl galactose, are separable. The method renders practicable a rapid examination of the hydrolysis products obtained from small quantities of methylated polysaccharides. It will facilitate also the examination of fractions of methylated sugars produced on distillation of the products of hydrolysis of methylated polysaccharides. The presence of methylated uronic acid derivatives causes tailing on the paper chromatogram; but we find that if these are first removed with 'Amberlite Resin', 1*R*4*B*, the spots due to the various sugars may be readily differentiated in the majority of cases.

By this method we have confirmed the presence of the methylated sugar derivatives detected by the distillation procedure in methylated cherry gum[3], slippery elm mucilage[4] and sugar beet araban[5], and in some instances have found indications of the presence of other sugar derivatives. For example, 2-methyl galactose and 3 : 4 : 6-trimethylmannose were obtained from methylated cherry gum, and free rhamnose from methylated slippery elm mucilage.

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[2] Flood, A. E., Hirst, E. L., and Jones, J. K. N., *Nature*, **160**, 86 (1947).

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Electrophoretic Behaviour of Modified Ovalbumins

IT has been shown recently by Linderstrøm-Lang and Ottesen[1] that ovalbumin is transformed, by the action of a bacterial enzyme from *Bacillus subtilis*, into a protein that crystallizes as rectangular plates from ammonium sulphate. In an earlier paper[2], MacPherson, Moore and Longsworth report that an ovalbumin component, A_2 (characterized by its mobility in the electric field), increased at the expense of another one, A_1, during storage of a salt-free, isoelectric solution under toluene. It therefore seemed of interest to compare the electrophoretic behaviour of the enzyme-modified ovalbumin with the A_2-form of the original protein.

Ovalbumin recrystallized three times[3] was used as starting material. With the aid of a dry powder containing the bacterial enzyme from *Bacillus subtilis*, kindly furnished by Prof. Linderstrøm-Lang, the enzyme experiments were carried out as described by the Danish workers[1]. All the electrophoretic patterns were obtained after electrophoresis of a 1·2 per cent solution of the protein for four hours in a sodium phosphate buffer of *p*H 6·8 and 0·1 ionic strength at a potential gradient of 6·5 volts per cm. Under these conditions, superposition of the patterns permits direct comparison of the relative concentrations of the components and indicates roughly their mobilities. The patterns of the ascending boundaries are presented here because of better resolution. As a result of adjustments occurring at the δ boundary, peaks due to components having similar mobilities will not coincide precisely. The mobilities cited below were therefore computed from the descending patterns.

In Fig. 1 are superimposed the tracings of the patterns of ovalbumin before and after incubation with the bacterial enzyme, and also after recrystallization, as plates, of the enzyme-treated material. In the case of the ovalbumin before and after enzyme treatment, the qualitative appearance of the patterns is similar but the mobilities are different. Although this difference is small, it is sufficient to lead one to expect resolution of the two main components on mixing the enzyme-treated protein and ovalbumin.

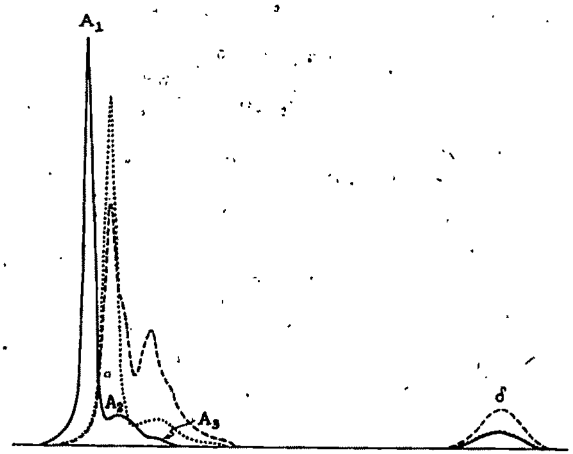

Fig. 1. SUPERIMPOSED TRACINGS OF ELECTROPHORETIC PATTERNS OF: ———, OVALBUMIN; . . . ., ENZYME-TREATED OVALBUMIN; - - - -, THRICE RECRYSTALLIZED ENZYME-TREATED PLATE-ALBUMIN

Attempts to obtain resolution of such a mixture have, however, failed thus far.

If thrice-recrystallized plates are prepared from the mixture of ovalbumin and enzyme, the electrophoretic pattern is that shown by the dashed curve of Fig. 1. It will be noted that the relative concentrations of the components, but not their mobilities, are different from those found for the freshly prepared, uncrystallized plate-albumin. Moreover, this shift in the relative concentrations of the components indicates that plate-albumin as first formed by the action of the enzyme on ovalbumin undergoes further changes with the time and crystallization. It has also been observed that urea at a concentration of 3 per cent accelerates these changes.

In Fig. 2, the full curve again represents freshly prepared ovalbumin, while the dashed curve represents the same preparation after it had been stored at room temperature under toluene as a salt-free solution for four months; the dotted curve is this material after treatment with the enzyme from *Bacillus subtilis*. The mobility, $-4{\cdot}7 \times 10^{-5}$ cm.^{2}/volt sec., of the aged sample agrees closely with that, $-4{\cdot}8 \times 10^{-5}$, of the A_2 component of the fresh ovalbumin. This suggests strongly that the 'aged' ovalbumin (A_2-form) is not the plate-albumin of Linderstrøm-Lang. It is also evident from a comparison of the full and dotted curves of Fig. 1 with the dashed and dotted curves of Fig. 2 that the enzyme acts on the A_2-form in much the same manner as on the original ovalbumin. If the decrease of mobility is due to the splitting-off of low molecular weight fragments carrying charged groups, it thus appears that those lost in the $A_1 \rightarrow A_2$ transformation differ from those affected by the enzyme.

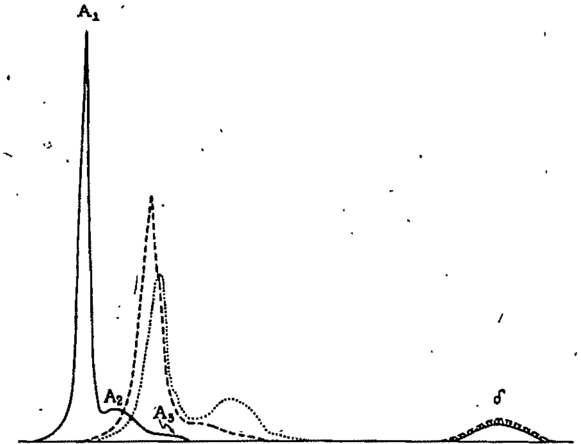

Fig. 2. SUPERIMPOSED TRACINGS OF ELECTROPHORETIC PATTERNS OF: ———, OVALBUMIN; - - - -, 'AGED' OVALBUMIN (A_2); . . . ., ENZYME-TREATED A_2

It should be noted, however, that my A_2-preparation crystallized as plates both before and after enzyme treatment, whereas the original ovalbumin crystallized as needles. During the preparation of the A_2-form, 12 per cent of the total protein was precipitated and the solubility of the remaining product in ammonium sulphate increased considerably[4]. In contrast with the behaviour of plate-albumin, 3 per cent urea has no effect on the electrophoretic patterns of the A_2-form.

At this stage of the work it seems of considerable interest to stress the fact that it is possible to transform, without serious degradation, a protein like ovalbumin into several proteins which differ from each other in at least one property—their behaviour in the electric field. Although no mechanism is suggested for the $A_1 \rightarrow A_2$ transformation, there appears to be no experimental evidence that excludes an enzymatic reaction in this case as well as in the formation of the plate albumin. Such a postulated enzyme could arise either from bacterial contamination or from the egg-white itself.

This problem was started during the tenure of a Commonwealth Fund Fellowship. I wish to thank Dr. D. A. MacInnes for the privilege of working in his laboratory, and express my sincerest thanks to Dr. L. G. Longsworth for help in preparing this note.

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[1] Linderstrøm-Lang, K., and Ottesen, M., *Nature*, **159**, 807 (1947).

[2] MacPherson, C. F. C., Moore, D. H., and Longsworth, L. G., *J. Biol. Chem.*, **156**, 381 (1944).

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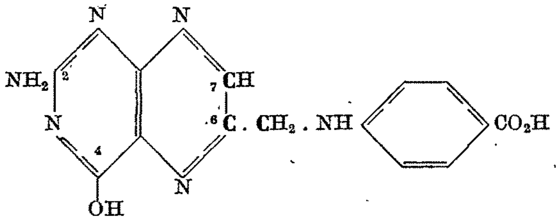
Reductone and the Synthesis of Pteridines

As we have pointed out[1] that the 3-carbon atom unit comprising the ring atoms 6 and 7 and the exocyclic carbon atom (indicated in heavy type) in pteroic acid (I) might be derived from a triose, 3-phosphoglyceraldehyde and phosphodihydroxyacetone being specifically mentioned, the suggestion by O'Meara, McNally and Nelson[2] that the strongly reducing non-sulphydryl substance found in bacterial cultures during the logarithmic phase of growth might be reductone, CHO.C(OH) : CH(OH), seemed to us to have considerable significance in that connexion. O'Meara and his colleagues suggested that p-aminobenzoic acid acts as a stabilizing agent for reductone in bacterial metabolism, enabling the cell to store reductone and to utilize it as required, presumably, from the context, after hydrolysis of the reductone – p-aminobenzoic acid condensation product to free reductone. They also showed that the reductone – p-aminobenzoic acid compound was capable of being utilized by streptococci as a source of energy for growth, and suggested that sulphonamides interfere with bacterial growth by combining with reductone and preventing it from becoming available for the use of the cell.

Another possibility which presents itself is that, in normal bacterial metabolism, *p*-aminobenzoic acid and reductone are first linked together and then incorporated into pteroic acid and the other factors of this group, such as pteroylglutamic acid, whereas, in sulphonamide bacteriostasis, the drug combines with reductone, and the condensation product is incorporated into a biologically inert analogue of pteroic acid.



I

We have examined the possibility of using reductone in the synthesis of pteridines, and it appears desirable to indicate the scope of this work in view of the recent communication by Angier *et al.*[3], who have similarly used reductone, without, however, realizing its possible biogenetic significance. In preliminary experiments[4] using reductone – *p*-aminobenzoic acid and 2 : 4 : 5-triamino-6-hydroxypyrimidine in aqueous solution, we regularly obtained evidence of the formation of the 7-isomer of pteroic acid. The use, however, of reductone – methyl *p*-aminobenzoate and 2 : 4 : 5-triamino-6-hydroxypyrimidine in 95 per cent alcohol has led to the formation of pteroic acid, identified by its ultra-violet absorption spectrum in alkaline solution, which showed maxima at 257, 275 and 365 mμ with E (1%, 1 cm.) 840, 755 and 290 respectively in good agreement with the literature[5,6], and by aerated alkaline hydrolysis to 2-amino-4-hydroxypteridine-6-carboxylic acid and *p*-aminobenzoic acid. Experiments with reductone – sulphanilamide and with reductone – *p*-methylsulphonylaniline have afforded analogous products.

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[2] O'Meara, R. A. Q., McNally, P. A., and Nelson, H. G., *Nature*, **154**, 796 (1944); *Lancet*, ii, 747 (1947).

[3] Angier, R. B., *et al.*, *J. Amer. Chem. Soc.*, **70**, 25 (1948).

[4] *J. Chem. Soc.* (in the press).

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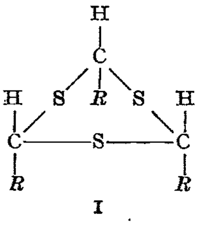
Stereochemistry of Trimeric Thioaldehydes

ACCORDING to Baumann and Fromm[1] the existence of two forms of trimeric thioaldehydes, known as α- and β-forms, is due to stereoisomerism (cf. I and II); these stereoisomers have their substituents in the *cis* and *trans* position with respect to the ring, which may be regarded as planar or nearly planar.



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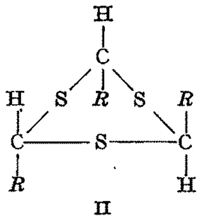

II

Some of the trimeric thioaldehydes are readily converted into their isomers; for example, trithioanisaldehyde, m.p. 127°, is changed into its isomer, m.p. 183°, in less than a minute, on treatment of its solution in benzene with a few crystals of iodine at room temperature, and the change of α- into β-trithiobenzaldehyde is almost as rapid. When α-trithiobenzaldehyde is treated with acetylchloride, crystals of the β-form begin to separate before the α-form is completely dissolved. The α-form of trithioacetaldehyde is converted into the β-form at room temperature in the presence of iodine.

Recently[2] it was pointed out that these changes are not in accordance with Baumann and Fromm's theory. In the cyclic series, interconversion of *cis – trans* isomers takes place *readily* only when there is the possibility of tautomerism; but with the compounds in question there is no such possibility. Current theory demands that in molecules such as I and II the ring structures do *not* restrict the freedom of rotation around the single bonds between the atoms of the ring; therefore, in order to support Baumann and Fromm's stereochemical conception, it must be assumed that iodine and acetylchloride can cause rapid reversible depolymerization and thus bring about the observed change of one form into the other.

The latter conclusion has lately been defended by G. M. Bennett[3], who writes: "The catalytic effect of iodine in causing interconversion of the isomeric trithioaldehydes is not surprising. The ring carbon atoms are each attached to two sulphur atoms, and a reversible rupture of a carbon–sulphur bond in these circumstances is reasonable".

No experimental evidence exists for this theory, nor can it be based on analogy. The trimeric thioaldehydes are thioacetals of aldehydes, a group of substances which are known to be remarkably stable even to alkalis and acids[4].

'Boat' and 'chair' ring isomerism. To explain the existence of α- and β-forms of isomeric trithioaldehydes and the ready conversion of the former into the latter, the following theory has been advanced[2]. The three carbon atoms and the three sulphur atoms in these 1 : 3 : 5-trithian molecules do not lie in one plane, but may be regarded as 'boat' and 'chair' substances, the interconversion then being possible *without assuming a reversible rupture of the carbon – sulphur bond.* (This is also the case if the alpha and the beta isomer has an intermediate form between the boat and the chair structure; theoretically they may have any form which fulfils the above condition.) This explanation has been attacked. Bennett writes: (*a*) "Why, if their suggestion is correct, do not two forms of the parent trimethylene trisulphide exist?" (*b*) "The authors' hypothesis requires more than two isomerides of the trithioaldehydes. . . ."

Our theory demands, indeed, a greater number of stereoisomeric trithioaldehydes than have, so far, been isolated; but Bennett seems to have overlooked the fact that in many cases the number of isomers isolated is also smaller[5] than the number expected on the basis of Baumann and Fromm's hypothesis, which he accepts as correct. This does not invalidate our theory or Baumann and Fromm's explanation; it is a fact, frequently encountered in stereochemistry, that the number of isolated isomers is smaller than the theoretical possible number (for example, polyenes, ketoximes).

Again, Bennett writes, "Chattaway and Kellett[6] succeeded in oxidizing the two trithioacetaldehydes to three isomeric monosulphones. This result is exactly that required by the classical view of the isomerism and is strong evidence of its correctness." Previously[2], we have not discussed the stereoisomerism of the sulphones obtainable by the oxidation of the trithioacetaldehydes, because it is possible that these sulphones do not exhibit 'boat' and 'chair' isomerism, *since they are not interconvertible as are the trimeric thioaldehydes*. Therefore, no conclusion can be drawn from the stereochemical structure of the ring systems of the sulphones as to the stereochemical structure of the ring systems of the trithioaldehydes from which the sulphones have been obtained, or vice versa.

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[1] *Ber.*, 24, 1429 (1891).

[2] Schönberg and Barakat, *J. Chem. Soc.*, 693 (1947).

[3] Bennett, *Nature*, **160**, 502 (1947).

[4] Schönberg, "Thioketone, Thioacetale und Athylensulphide" (Enke, Stuttgart, 1933). Tetramethylthiomethane $C(SMe)_4$, a substance in which the carbon atom is attached, not to *two* sulphur atoms as is the case with the trimeric thioaldehydes, but to *four*, is according to Gibson (*Chem. Rev.*, 14, 454; 1934) "quite remarkable" for its inertness.

[5] Campaigne (*Chem. Rev.*, 39, 1; 1946) enumerates ten trimeric thioaldehydes of the aromatic series of which, so far, only one form has been isolated. Moreover, model molecules built up with Fisher – Hirschfelder – Taylor atom models demonstrate that the existence of some of the theoretical possible forms of the trimeric thioaldehydes is highly improbable in consequence of steric hindrance. Bennett has overlooked this point.

[6] *J. Chem. Soc.*, 1352 (1930).

THE validity of Baumann and Fromm's view of this case of isomerism depends on the relative position of the radicals *R* with respect to the *general* plane of the ring. The concept of the puckered ring was introduced later, and it would now be generally assumed that such rings are in fact puckered. Prof. Schönberg contends that the isomerism is due to two forms of puckering rather than the *cis – trans* arrangement of the radicals.

It is unnecessary to discuss his arguments in detail because crucial experimental evidence is now available. Prof. O. Hassell, of the University of Oslo, has directed my attention to his recent publication with H. Viervoll[1], which I had not seen at the time of writing last summer. This paper describes an electron diffraction examination of trithian and of the α- and β-trithioacetaldehydes. The results show definitely that all three substances have similar puckered rings of the 'chair' type, and the authors also conclude that the methyl groups in the two trithioaldehydes are in the *trans*- and *cis*-positions respectively, as deduced by Chattaway and Kellett.

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March 4.

[1] *Acta Chemica Scandinavica*, 1, 149 (1947).

The Sommelet Reaction

IN 1913 Sommelet[1] observed that when the quaternary compound from benzyl chloride and hexamine is heated in water, or in aqueous alcohol, it is converted in good yield to benzaldehyde. This reaction has become general for the preparation of aromatic aldehydes. Sommelet isolated methylamine as a by-product, and suggested that the reaction mechanism is such that the quaternary compound first hydrolyses to methylene-benzylamine, which then isomerizes to benzylidene methylamine; and that the benzaldehyde and methylamine are derived from the hydrolysis of the latter:

$$[C_6H_5.CH_2.C_6H_{12}N_4]^+Cl^- \rightarrow C_6H_5.CH_2.N{=}CH_2 \rightarrow C_6H_5.CH{=}N.CH_3 \rightarrow C_6H_5.CHO + NH_2.CH_3. \quad (1)$$

No further studies of the reaction mechanism appear to have been carried out until 1945, when Graymore and Davies[2] showed that methylene-benzylamine (or a mixture of benzylamine and formaldehyde) gives benzaldehyde in 70 per cent yield on heating in solution with hexamine, thus apparently supporting Sommelet's mechanism. However, the vital role taken by the hexamine in the reaction was not explained.

We have studied this reaction, and our results may be briefly summarized as follows. Contrary to Graymore and Davies' findings, benzaldehyde can be obtained by allowing benzylamine hydrochloride to react with formaldehyde in the absence of hexamine, but only in poor yield (20–25 per cent). The main product is methylbenzylamine. Not methylamine but ammonia is produced in quantities equivalent to the benzaldehyde formed.

The reaction, therefore, contrary to the supposition of Sommelet, does not consist of a double-bond shift, but is an oxidation-reduction process represented by the equation:

$$C_6H_5.CH_2NH_2 + C_6H_5.CH_2.N{=}CH_2 + H_2O = C_6H_5.CHO + NH_3 + C_6H_5.CH_2NH.CH_3, \quad (2)$$

where $C_6H_5.CH{=}NH$ is probably an intermediate.

In the absence of hexamine, only half the benzylamine is available for conversion to benzaldehyde. The yield of aldehyde, however, is still further reduced by the inevitable side-reaction in which some methylene-benzylamine is reduced by formaldehyde (Plöchl-methylation[3]):

$$C_6H_5.CH_2.N{=}CH_2 + HCHO + H_2O = C_6H_5.CH_2NH.CH_3 + HCOOH. \quad (3)$$

Quantitative determinations of the reaction products show the correctness of these equations. Thus, in a typical run with benzylamine hydrochloride (1 mol.) and formaldehyde (1·38 mol.), 56 per cent of the amine reacted according to 2 (giving 28 per cent benzaldehyde), 33 per cent according to (3), and 11 per cent remained unchanged.

When, on the other hand, hexamine is present, its first hydrolysis product (the $CH_2{=}NH$ fragment) behaves as a hydrogen acceptor, being reduced by both benzylamine and formaldehyde:

$$C_6H_5.CH_2.NH_2 + CH_2{=}NH + H_2O = C_6H_5.CHO + NH_3 + CH_3.NH_2. \quad (2a)$$

$$CH_2{=}NH + HCHO + H_2O = CH_3.NH_2 + HCOOH. \quad (3a)$$

Thus, in presence of hexamine, reactions (2) and (2a) are competitive. It is obvious that for high yields of benzaldehyde, the ratio of hexamine to benzylamine should be kept high. By adding benzyl-chloride drop by drop to a hexamine solution, or by using a large excess of the latter, yields of benzaldehyde equal to 85 per cent are readily obtainable.

The Sommelet reaction is thus essentially the reverse of the Leuckart reaction[4]; fatty-aromatic ketones such as acetophenone, and the corresponding amines are interconvertible by these two reactions[2,5]:

$$C_6H_5.CH(NH_2)CH_3 \xrightleftharpoons[\text{HCOOH}]{\text{hexamine}} C_6H_5.COCH_3 + NH_3.$$

In the case of aldehydes, however, the Leuckart reaction does not stop with the primary amine, but gives the tertiary compound.

Details of our work will be given in a forthcoming publication.

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[1] Sommelet, M., *C.R. Acad. Sci., Paris*, 157, 852 (1913).

[2] Graymore, J., and Davies, D. R., *J. Chem. Soc.*, 293 (1945).

[3] Plöchl, J., *Ber.*, 21, 2117 (1888). Werner, E. A., *J. Chem. Soc.*, 111, 844 (1917).

[4] Leuckart, R., *Ber.*, 18, 2341 (1885). Wallach, O., *Ann.*, 343, 60 (1905).

[5] Ingersoll, A. W., "Org. Synth. Coll.", 2, 503.

Chemistry of Visual Processes

IN a recent article under the above title in *Nature*, Ball, Collins, Morton and Stubbs[1] discuss the relation between 'action spectra' and 'absorption spectra' of photosensitive pigments in the retina. They show that the 'action spectra' must—purely on account of the physical laws of light absorption—be broader when the optical density of the layer of the photosensitive substance is greater[2].

I may perhaps point out that this effect has been used by Hecht, Shlaer and myself[3] in order to obtain an estimate of the absolute value of the percentage of light absorbed by the rhodopsin in the rods of the dark-adapted human eye. In this investigation, the shape of the rod spectral luminosity curve of the retina (plotted in terms of numbers of quanta) was compared to the shapes of calculated curves giving the percentage of light absorbed by layers of rhodopsin having various maximum optical densities. (The latter curves were called 'percentage absorption spectra': they correspond to the 'action spectra' α of Ball *et al.*[1].) An upper value of 20 per cent was thus arrived at for the maximum absorption of the rhodopsin in the living retina. The hypothesis on which such determinations rest is that equal numbers of quanta absorbed produce equal physiological effects in the retina, whatever the wave-length of the light.

In the sensitivity curves obtained by Granit[4] for single fibres of, say, the frog retina, the complications due to selective absorption of light by the eye media are avoided, and it appears that the above comparison method would thus be likely to yield interesting results. In fact, Granit has found, for example, that "the curve for the frog was slightly broader than the visual purple [rhodopsin] absorption curve"[5]. Now the visual purple curve referred to here is a curve obtained *in vitro*, for a layer of solution having, of course, a particular optical density. It is then possible that a curve calculated for a higher density would give an accurate fit with the sensitivity curve of the frog. The particular density value giving such a fit could then be taken as an estimate of the optical density of the rhodopsin layer in this retina. Knowledge of the absolute value of this density is of intrinsic interest, since it makes it possible to calculate the number of quanta absorbed, that is, the number of rhodopsin molecules acted upon in the primary photochemical process, under known conditions of stimulation of the retina.

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April 10.

[1] Ball, S., Collins, F. D., Morton, R. A., and Stubbs, A. L., *Nature*, 161, 424 (1948).

[2] It is of historical interest to note that Newton dealt with this effect in his "Opticks", Bk. 1, Pt. 2, Prop. x, 4th edit. (London, 1730; reprinted by G. Bell and Sons, London, in 1931).

[3] Hecht, S., Shlaer, S., and Pirenne, M. H., *J. Gen. Physiol.*, 25, 819 (1942).

[4] Granit, R., "Sensory Mechanisms of the Retina" (Oxford, 1947).

[5] Granit, R., *ibid.*, p. 270.

Variation of the Force Constant with the Ionization Potential and the Polarizability for some Halogen Compounds

VARIOUS attempts have been made to systematize the force constants of chemical linkages. In the formulæ of Badger[1] and of Clark[2] relating the constant k_{A-B} with the interatomic distance r_{A-B}, there occur arbitrary constants the magnitudes of which depend on the positions of the atoms A and B in the Periodic Table, and in the later formula of Gordy[3] the electro-negativities of A and B are involved. None of these relations holds very generally.

I have recently investigated systematics in the force constants of halogen compounds, and evidence has been obtained for the existence of a linear relation between the force constant k_{A-X} and the ionization potential V_i of the variable halogen atom X. The results for the series HX, CX_4, SiX_4, BX_3, PX_3 and CH_3X are shown in Fig. 1. For all except the first of these series the constants are ambiguous, there being several frequencies involving the halogen atoms. In CX_4 and SiX_4, k is obtained from the single totally symmetric Class A_1 mode, for BX_3 from the single totally symmetric Class A_1' mode, and in PX_3 from both $P—X$ stretching modes, using a general potential function[4]; k_{C-X} in the methyl halides is obtained from ν_{C-X} on the assumption that the methyl group remains rigid in this mode.

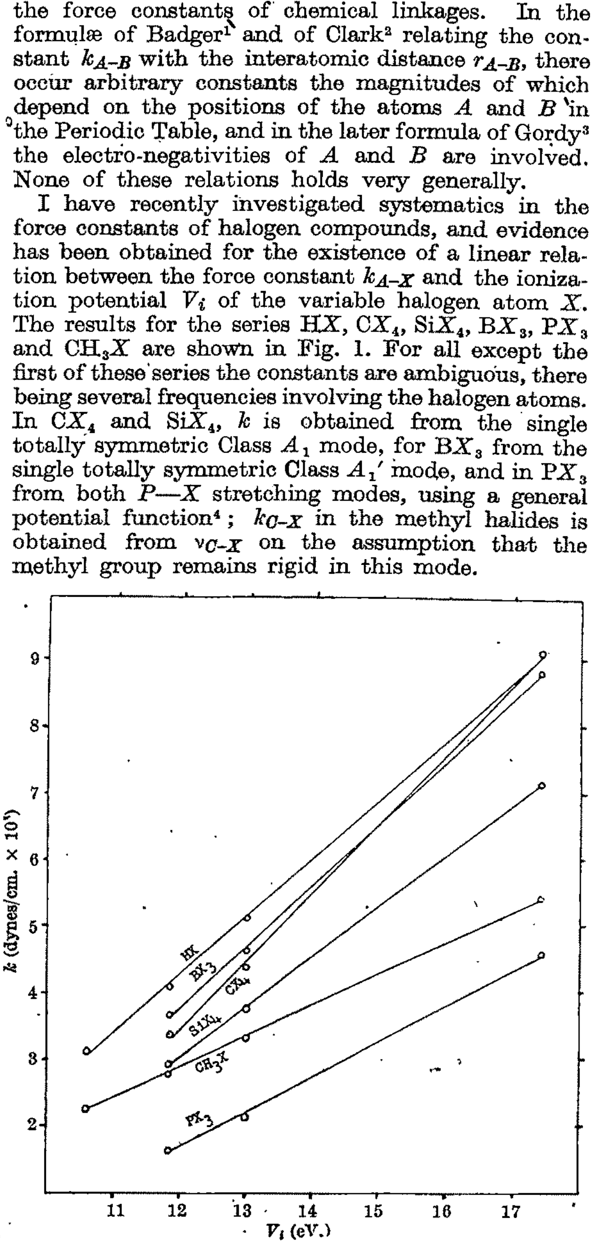

Fig. 1

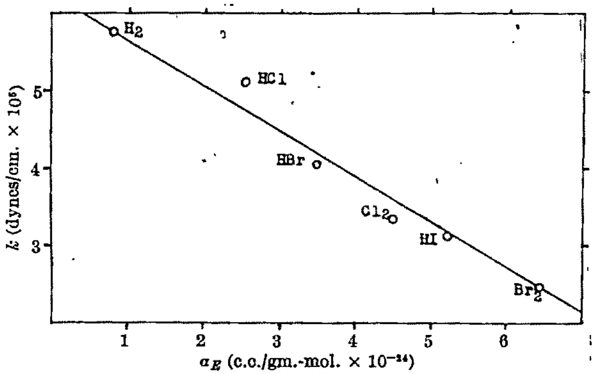

Fig. 2

Even allowing for ambiguities in the force constants, the linear relation between k and V_i is remarkable. The ionization potential is a measure of the tightness of binding of the outer valence electron; the above relation implies that, in a given series, the valence bond is the stronger the greater the force required to transfer the outer electron into the valence orbital. There is also evidence that the slope $(\partial k/\partial V_i)$ is related to the position of the atom A in the Periodic Table; thus it is less for SiX_4 than for CX_4, and, though the data are incomplete, this decrease appears to continue through GeX_4 and SnX_4.

A further relationship which appears worthy of note is that between the force constants of diatomic molecules HX and X_2 and the corresponding electron polarizabilities obtained from dispersion data[5]. This is shown in Fig. 2. The electron polarizability α_E is a measure of the ease of deformation of the outer electron shell of the molecule; as expected, the relation between k and α_E is an inverse one. The linearity may or may not be real.

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Jan. 12.

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[1] Badger, *J. Chem. Phys.*, **2**, 128 (1934).

[2] Clark, *Phil. Mag.*, **18**, 459 (1934).

[3] Gordy, *J. Chem. Phys.*, **15**, 305 (1947).

[4] Herzberg, G., "Infrared and Raman Spectra of Polyatomic Molecules" (D. van Nostrand Co., Inc., New York; London: Macmillan and Co., Ltd., 1945).

[5] Cuthbertson, C., and Cuthbertson, M., *Phil. Trans. Roy. Soc.*, **213**, 1 (1914).

The Melanin Problem: a Synthesis of 5 : 6-Dihydroxy-indole and its Derivatives

A COMMUNICATION by Robertson *et al.*[1] under this title makes it necessary for us to record that we have been working on almost identical lines.

When piperonal is condensed with nitromethane, and the resulting 2′-nitro-3 : 4-methylenedioxystyrene nitrated in acetic acid, 6 : 2′-dinitro-3 : 4-methylenedioxystyrene is obtained in good yield. The same dinitro-compound can also be obtained directly from 6-nitropiperonal and nitromethane. Reduction of the dinitro-compound then affords 5 : 6-methylenedioxyindole (blue-red colour with cold Ehrlich's reagent). Similarly, 2′-nitro-2′-methyl-3 : 4-methylenedioxystyrene (from piperonal and nitroethane) is nitrated to 6 : 2′-dinitro-2′-methyl-3 : 4-methylenedioxystyrene (also obtained from 6-nitropiperonal and nitroethane), which is reduced to 5 : 6-methylenedioxy-2-methylindole (bright red colour with cold Ehrlich's reagent). Demethyleneation of the above indoles to the corresponding dihydroxy-derivatives can be effected, but in poor yield, with pyridine hydrochloride.

Details of some of this work are complete and are being submitted to the Chemical Society. It was intended to apply the reaction to the synthesis of the 3-methyl- and 2 : 3-dimethyl-derivatives of 5 : 6-dihydroxyindole, starting from 3 : 4-methylenedioxyacetophenone, by an analogous series of reactions. In addition, we were investigating the synthesis of 5 : 6-dihydroxyindole and its derivatives by the method described by Robertson *et al.*, and also by ring closure of suitable acyl derivatives of 6-aminohomocatechol.

In collaboration with Dr. J. L. Stoves, we are also investigating the Fischer synthesis, starting with 3 : 4-di(benzyloxy)phenylhydrazine.

We have found that 5 : 6-dihydroxy-2-methylindole, as well as 5 : 6-dihydroxyindole, gives a melanin by oxidation (air) in an alkaline medium. The significance of this is referred to in an article which will appear shortly in *Chemistry and Industry*.

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[1] *Nature*, **161**, 525 (1948).

Bond-Strength of C—Cd in Cadmium Methyl and of C—I in Methyl Iodide

Heat of Hydrolysis of Cadmium Methyl and the C—Cd Bond-Strength. As part of a programme designed to establish the strength of metal-carbon bonds, we have measured the heats of the reactions:

(1) $CdMe_2(liq.) + 2H_2O(liq.) \rightarrow Cd(OH)_2(ppt.) + 2CH_4(g.) + Q_1$.

(2) $CdMe_2(liq.) + H_2SO_4(aq.) \rightarrow CdSO_4(aq.) + 2CH_4(g.) + Q_2$.

The reactions were carried out *in vacuo* in a sealed metal vessel, and the heats of reaction measured in an adiabatic calorimetric system. Analysis of the products of reaction revealed that the reactions proceed as written, with little or no side-reactions.

The mean of several experimental determinations of the hydrolysis heat gave

$$Q_1(-\Delta H) = 48{\cdot}5 \pm 0{\cdot}4 \text{ kcal. mole}^{-1},$$

corresponding to a heat of formation[3] (at 20° C.)

$$Q_f(CdMe_2, \text{liq.}) = -16{\cdot}0_5 \pm 0{\cdot}4 \text{ kcal.}$$

From the heat of reaction with sulphuric acid, we have obtained

$$Q_f = -16{\cdot}3 \pm 0{\cdot}2 \text{ kcal.}$$

This latter value is regarded as the more accurate of the two estimations.

Bamford, Levi and Newitt[1] obtain for the heat of vaporization of cadmium methyl 8·5 kcal., from which we obtain

$Q_f(CdMe_2, g.) = -24{\cdot}8 \pm 0{\cdot}2$ kcal., leading to

$Q_a(CdMe_2, g.) = 314{\cdot}0 + 2L$ kcal., for the heat of formation from normal atoms (L is the heat of sublimation of carbon).

Using $D(CH_3—H) = 102$ kcal. for the dissociation energy of the first C—H bond in CH_4 [2], the above Q_a value gives 66·2 kcal. for the sum of the dissociation energies of the two Cd—C bonds in cadmium methyl. The latter figure is independent of the value assumed for L. The *mean* bond dissociation energy is accordingly 33·1 kcal. We would point out, however, that it cannot be assumed that the bond dissociation energies of the first and second Cd—CH$_3$ bonds are equal to one another.

Heat of Formation of Methyl Iodide, and the C—I Bond-Strength. We have observed that the reaction between cadmium dimethyl and iodine, in dry ether, proceeds almost exclusively according to the equation (1):

$$(1)\quad \mathrm{CdMe_2(liq.)} + 2\mathrm{I_2(ether)} \rightarrow \mathrm{CdI_2(ppt.)} + 2\mathrm{CH_3I\ (ether)}$$

when the dimethyl is added, with stirring, to a solution of excess iodine in ether. The side-reaction (2):

$$(2)\quad \mathrm{CdMe_2} + \mathrm{I_2} \rightarrow \mathrm{CdI_2} + \mathrm{C_2H_6}$$

occurs to an extent of 1–3 per cent under the conditions we have used.

The heat of reaction (1) has been found in an adiabatic vacuum calorimeter to be 75·6 ± 0·5 kcal. Combining this heat value with our value for the heat of formation of CdMe$_2$(liq.), and with published values for the heat of formation of CdI$_2$(ppt.)[4], and the heat of solution of iodine in ether[4], we obtain

$$Q_f(\mathrm{CH_3I,\ liq.}) = 3{\cdot}8_5 \pm 0{\cdot}4\ \mathrm{kcal.},$$

for the heat of formation of liquid methyl iodide at 20° C.

Assuming $D(\mathrm{CH_3—H}) = 102$ kcal.[3], our value for $Q_f(\mathrm{CH_3I})$ leads to

$$D(\mathrm{CH_3—I}) = 55{\cdot}0_5 \pm 0{\cdot}4\ \mathrm{kcal.},$$

for the dissociation-energy of the C—I bond in methyl iodide. This may be compared with the value 54–55 kcal., given by Butler and Polanyi[5], from kinetic studies, and 54·75 ± 1·4 kcal., recently reported by Ubbelohde and Mackle[6], from thermochemical measurements.

A full description of this work will be published elsewhere.

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[1] Bamford, Levi and Newitt, *J. Chem. Soc.*, 468 (1946).

[2] Kistiakowsky and v. Artsdalen, *J. Chem. Phys.*, **12**, 469 (1944).

[3] Rossini, "Tables of Selected Values of Chemical Thermodynamic Properties", Nat. Bur. of Standards, U.S.A., 1947.

[4] Rossini and Bichowsky, "Thermochemistry of Chemical Substances" (1936).

[5] Butler and Polanyi, *Trans. Farad. Soc.*, **39**, 27 (1943).

[6] Ubbelohde and Mackle, *Nature*, **160**, 303 (1947).

Atomic Oxygen and Dissociation in Flame Gases

IT has been shown that an abnormal dissociation obtains in flame gases resulting from the combustion of carbon monoxide–air mixtures[1,2]. (Such an abnormal dissociation also obtains in hydrocarbon flame gases[3].) If, as we believe, the dissociation products of metastable carbon dioxide molecules are carbon monoxide and atomic oxygen, there must be a considerable concentration of atomic oxygen in the flame gases unless there is a large excess of carbon monoxide present, in which case atomic oxygen recombines almost as soon as it is formed.

Experiments utilizing the Gaydon nitric oxide test for atomic oxygen[4] confirm this. Perfectly mixed mixtures of 30 per cent carbon monoxide + 70 per cent oxygen and 87 per cent carbon monoxide + 13 per cent oxygen contained in a tank were burnt in a Smithells separator and nitric oxide injected (through a fine quartz tube) into the flame gases at various points *above* the combustion zone. In the case of the excess oxygen flame gases there was a marked yellow-green coloration indicating atomic oxygen; but in the case of the excess carbon monoxide gases there was only a very faint brown coloration.

With the exceptionally fine plain and quartz-covered wires we use, there is no detectable difference between the temperatures measured by these wires when they are immersed in flame gases resulting from the combustion of very over-rich mixtures. But in the case of excess oxygen flame gases the temperatures measured by the wires differ by as much as 300° C. or 400° C.[1,2]. The concentration of carbon monoxide and atomic oxygen would thus appear to be very considerable in the latter flame gases.

The nitric oxide experiments have been repeated with the mixtures 10 per cent methane + 90 per cent oxygen and 80 per cent methane + 20 per cent oxygen. The results were similar to those with the carbon monoxide mixtures. Experiments with fine plain and quartz-covered platinum wires in methane and propane flame gases yield results which are also similar to those for carbon monoxide flame gases. The difference between the wire temperatures for the excess oxygen flame gases is, however, rather less; it varies between 200° C. and 300° C.[3].

In the experiments referred to above the mixtures were burnt at atmospheric pressure, and what for all practical purposes may be regarded as a state of equilibrium is very rapidly attained after the initiation of combustion; in other words, the reaction zone is very narrow. When inflammable mixtures are burnt at low pressures the reaction zone becomes greatly extended, and the flame gases in this zone possess a great apparent potency. For example, when a perfectly mixed mixture consisting of 90 per cent carbon monoxide + 10 per cent oxygen is burnt under certain conditions at a pressure of 0·15 atmosphere, a fine platinum–rhodium wire (melting point 1,850° C.) is rapidly melted in the zone, although the theoretical flame gas temperature calculated by means of thermochemical data is only 1,690° C.

It would seem that these extensive reaction zones offer good opportunities for investigating intermediate products; but we would especially stress that it is essential to arrange for the perfect mixing of the inflammable gases before combustion.

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[1] *Nature*, **145**, 896 (1940).

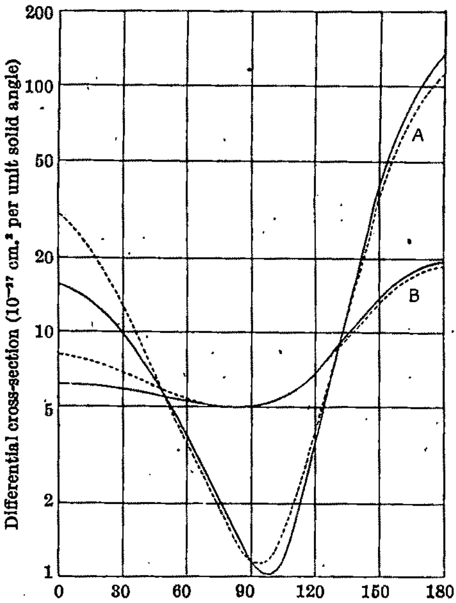
[2] *Proc. Inst. Mech. Eng.*, **151**, 236 (1944).

[3] Unpublished experiments.

[4] *Trans. Farad. Soc.*, **42**, 292 (1946).

Scattering of 100-MeV. Neutrons by Protons

CALCULATIONS of the differential cross-section for the scattering of 100-MeV. neutrons by protons have been made, using an exponential-well potential $V_0\, e^{-r/a}$ with two values of the range a. The depths of the triplet and singlet interactions, determined from the deuteron binding energy and the cross-section for the scattering of slow neutrons by protons, were respectively 313·5, 191·2 MeV. for $a = 0{\cdot}5 \times 10^{-13}$ cm., and 98·4, 60·0 MeV. for $a = 1{\cdot}0 \times 10^{-13}$ cm. The two cases of exchange forces and of symmetric forces were assumed.



A : $a = 1 \cdot 0 \times 10^{-13}$ cm. B : $a = 0 \cdot 5 \times 10^{-13}$ cm. Full lines, exchange forces ; broken lines, symmetric forces

ANGULAR DISTRIBUTION OF SCATTERING OF 100 MEV. NEUTRONS BY PROTONS

A new method[1] for determining the phase shifts of the partial waves enabled the contribution to the phase of the potential within a distance of $4a$ from the origin to be rapidly obtained, the correction for the remainder of the potential coming from a perturbation calculation. For the two ranges, phases beyond $l = 4$, 8 respectively could be neglected.

The differential cross-sections for the two cases are shown on a logarithmic scale in the accompanying diagram. It is seen that even for the energy considered, the type of force has little effect on the shape of the differential cross-section, or on the total cross-section, which is of the order $0 \cdot 09$, $0 \cdot 13 \times 10^{-24}$ cm.^{2} for the two ranges respectively. These results are similar to those published recently[2] for a lower range of energies and a square-well potential.

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[1] Ferretti and Krook, *Proc. Phys. Soc.* (in the press).

[2] Camac and Bethe, *Phys. Rev.*, **73**, 191 (1948).

Comparison of Cross-sections for the Capture of 220 and 900 keV. Neutrons

WE have compared the capture cross-sections of a number of nuclei, for neutrons of 220 and 900 keV. The neutrons were produced by placing 400 mc. of radiothorium (contained in a platinum cylinder 5·5 mm. high and 5·5 mm. in diameter) inside either a beryllium cylinder (height 2·3 cm., wall thickness 9 mm.) or a cylindrical brass vessel containing heavy water (height 15 mm., wall thickness of D_2O 5·75 mm.). The photo-neutrons obtained thus are fairly monokinetic; but owing to the conservation of momentum they are spread out over an energy interval of 57 keV. in the case of heavy hydrogen and 25 keV. in the case of beryllium. (G. D. Latyshev[1] published new measurements of the thorium (C C″) gamma-rays which show that besides the main line at 2·62 MeV. there exists a line at 2·2 MeV. the relative intensity of which is 5 per cent as compared to the main line. This line gives rise in the case of heavy hydrogen to neutrons of only 10 or 20 kV.; but an estimate of the cross-section of the photo-effect on that region shows that the total number of these slow photo-neutrons will not be more than 1·5 per cent of those of 220 kV. energy.)

Considerable care has to be taken to avoid slowing down of the photo-neutrons due to the moderating influence of the surrounding materials. The samples were irradiated inside an asbestos hut on the laboratory roof. It was found that irradiation inside the hut produced the same amount of artificial radioactivity as irradiation outside. Under these conditions, slowing down can still occur in the heavy water or beryllium itself. It was found, however, by reducing the amount of heavy water to one quarter of the quantity used in the main series of measurements, that this effect is negligible under our conditions, except in the case of indium, where a correction of 12 per cent had to be applied.

The samples for irradiation were, so far as possible, used in the form of foils bent to a cylinder 2·8 cm. high and 2·8 cm. in diameter, in the middle of which the source of photo-neutrons was placed for irradiation. Powders were filled into a double-walled cylinder of brass placed around the neutron sources.

The ratios of cross-sections were obtained by irradiating the same sample of each element in turn with each of the two photo-neutron sources. The relative number of neutrons produced by the two sources was determined separately[2]. The ratio of the intensity of artificial radioactivity obtained in the two irradiations, with a small correction, leads thus to the ratio of the cross-sections. The correction of 6·5 per cent was applied to allow for the anisotropy of neutron emission from the heavy water; it was obtained empirically.

Active isotope	^{28}Al	^{56}Mn	^{64}Cu	^{66}Cu
Ratio of cross-sections	1·7±0·5	2·3±0·6	1·0±0·2	1·3±0·5
Active isotope	^{76}As	^{80}Br. 18 min.	^{80}Br. 4·4 hr.	^{82}Br.
Ratio of cross-sections	3·7±0·4	2·0±0·4	1·8±0·3	2·2±0·4
Active isotope	^{104}Rh 94 sec.	^{104}Rh 4·2 min.	^{104,109}Pd	^{111}Pd
Ratio of cross-sections	3·1±0·8	2·2±0·8	2·0±0·3	1·1±0·3
Active isotope	^{108}Ag	^{110}Ag	^{116}In 54 min.	^{122}Sb
Ratio of cross-sections	2·0±0·3	1·00±0·2	0·8±0·1	1·2±0·1
Active isotope	^{128}I	^{139}Ba	^{131}Te	^{165}Dy
Ratio of cross-sections	1·7±0·3	1·9±0·7	1·3±0·4	1·0±0·15
Active isotope	^{187}W	^{199}Pt	^{198}Au	
Ratio of cross-sections	1·3±0·3	2·5±0·6	1·0±0·1	

The ratios of cross-sections are given in the accompanying table, from which it is seen that σ 220/σ 900 varies only between 1 and 4.

These results can be compared with the theory of Fishbach, Peaslee and Weisskopf[3]; the values for σ 220/σ 900 predicted by these authors vary still less than our results. In particular, their theory does not predict ratios of the order of 1 as we observe them in several cases.

We wish to thank Dr. Placzek and Prof. Peierls and Weisskopf for valuable discussions.

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P. DEMERS
H. HALBAN

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Université de Montreal.
March 23.

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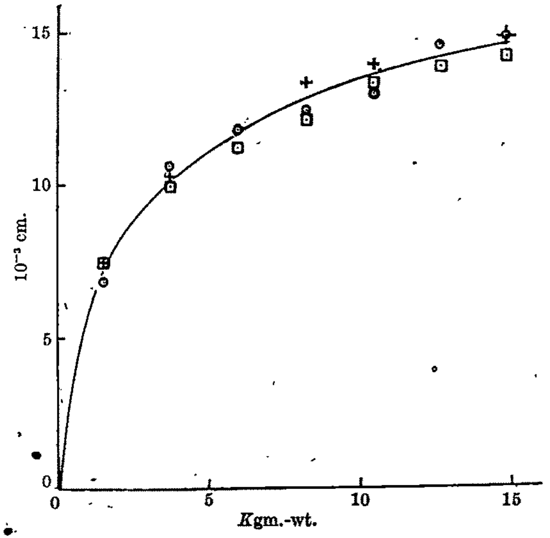
[1] *Rev. Mod. Phys.*, **19**, 132 (April 1947).

[2] Amaldi, Hafsted and Tuve, *Phys. Rev.*, **51**, 896 (1937).

[3] *Phys. Rev.*, **71**, 156 (1947).

Rate of Wear in the Region of the Validity of Amontons' Law

AMONTONS' law[1] of the direct proportion between the frictional force and the applied normal load has been shown to be valid when the actual area of contact is a small proportion of the nominal area of contact. Recently[2], experimental results obtained under conditions of 'extreme pressure' (in lubrication literature bearing-pressures of at least 15,000 kgm.-wt./cm.^{2} are termed 'extreme pressures') were presented to indicate that, within the region of the validity of Amontons' law, lubricants which reduced the thermo-electromotive forces[3] generated at the area of actual contact also reduced the final wear diameter produced by a revolving steel ball loaded against a metal plate.



RADIUS r (IN 10^{-3} CM.) OF THE FINAL WEAR PRINTS PLOTTED AS A FUNCTION OF THE NORMAL LOAD (IN KGM.-WT.) FOR ONE-MINUTE RUNS WITH LUBRICANTS $A(+)$, $B(\boxdot)$ AND $C(\odot)$, IN THE REGION OF THE VALIDITY OF AMONTONS' LAW

With a four-ball apparatus[4], measurements were made on one hand of the temperature rise of the oil cup (containing the three rigidly clamped steel balls), and on the other hand of the frictional torque, both as a function of the normal load. Depending upon the quality of the lubricant, Amontons' law may remain valid over an appreciable region of normal loads (see table). Within this region, the accompanying diagram represents the dependence of the radius of the final wear print of one-minute runs upon the normal load.

From the geometry of the friction elements, the abraded volume V is

$$\frac{2\pi}{3}a^3\left(1-\sqrt{1-\left(\frac{r}{a}\right)^2}\right)-\frac{a\pi r^2}{3}\sqrt{1-\left(\frac{r}{a}\right)^2},$$

where a is radius of steel balls and r is radius of wear print. To a first approximation $V = \pi r^4/6a$, with a rate of wear for the one-minute run of $3{\cdot}4 \times 10^{-9}$ cm.^{3} per kgm.-wt.

FRICTIONAL TORQUE MEASUREMENTS

Normal load L in kgm.-wt.	Frictional torque F in kgm.-wt. Lubricant A	Lubricant B	$\mu = F/L$ A	B
1·428	0·4496	0·325	0·31	$0{\cdot}2_8$
3·652	1·013	1·174	$0{\cdot}2_8$	0·32
5·878	1·380	1·432	0·23	0·24
5·878	1·837	—	0·31	—
8·10	2·132	2·267	0·26	0·28
10·33	2·978	2·96	$0{\cdot}2_9$	$0{\cdot}2_9$
12·55	3·341	3·437	$0{\cdot}2_7$	0·27
		Mean :	0·28±0·04	0·27±0·04

For a thrust of 80 lb.-wt. (normal load 14,830 gm.-wt.) the temperature rise of the metal cup was about 2° C. as the result of a one-minute run with a straight mineral oil, indicating, on account of the water equivalent of the cup, frictional work of $3{\cdot}57 \times 10^9$ ergs. On the other hand, from the observed frictional torque of about 4,000 gm.-wt., one would calculate for the total work done in one minute 10^{10} ergs. From the observed final wear diameters, $18{\cdot}9 \times 10^{-7}$ gm. of material was calculated to have been abraded from the three clamped steel balls in the one-minute run. Since the latent heat of vaporization of steel (89,025 cal./gm.[5] at 1,000° C.) is the upper limit of the energy required for its abrasion, one can estimate that about 9×10^6 ergs (allowing 2×10^6 ergs for abrasion of the revolving steel ball) have been expended on abrading metal. The 'bearing pressure' at the end of this run was about 21,000 kgm.-wt./cm.^{2}.

In agreement with Whittaker's[6] observation, in the region of the validity of Amontons' law, the work done on abrading matter from the clamped steel balls was in the present case a small proportion (about 10^{-3}) of the total frictional work, the main portion apparently being used for shearing the boundary layer.

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Jan. 19.

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[1] Schnurmann, R., *J. Appl. Phys.*, 13, 235 (1942).

[2] Schnurmann, R., Paper presented in Section III of the 6th Inter. Conf. of Appl. Mech., Paris, Sept. 25, 1946.

[3] Schnurmann, R., *Nature*, 151, 420 (1943).

[4] This was a home-made instrument of the Boerlage type (*Engineering*, 136, 46 ; 1933) using $\frac{3}{8}$-in. steel balls. Experimental details will be given in the M.Sc. Thesis of H. J. Bezer.

[5] Jones, H. A., Langmuir, I., and Mackay, G. M. J., *Phys. Rev.*, 30, 201 (1927).

[6] Whittaker, E. J. W., *Nature*, 159, 541 (1947).

Optical Transmission of a Colloidal Solution in a Magnetic Field

THE change in optical transmission of a colloidal solution as a function of the applied magnetic field strength has been investigated both theoretically and experimentally.

In the colloid which has been considered theoretically, the particles are of uniform size and of laminar shape, diamagnetic and magnetically anisotropic. Such particles tend to orientate themselves with the axis of greatest diamagnetic susceptibility normal to the direction of the applied field; the Brownian movement tends to orientate them at random, so that the alignment becomes more complete as the magnetic field strength is increased.

If the dispersion medium is transparent, the particles opaque and the concentration small, classical absorption may be regarded as the predominating factor ; that is, the light absorbed may be assumed proportional to the projected area of the particle. It is then found that the change in optical transmission for light parallel or normal to the magnetic field is a function of H^2/T, H being the magnetic field strength and T the absolute temperature.

Stuart[1] tried to find a suitable method of detecting and measuring small quantities of graphite in oil. He observed that a solution of colloidal graphite shows a change in transmission of visible light when a magnetic field is applied, and that this change varies with the concentration.

Experiments have now been carried out to determine quantitatively the dependence of this effect on field strength ($H \leqslant 4{,}000$ oersteds) and concentration, and the results have been compared with those derived from the theory outlined above; they agree well when the particle size is assumed to be approximately 1 μ. This is nearly the same as the known value of the mean size of the particles in 'Aquadag S' which was used here (information kindly supplied by Acheson Colloids, Ltd.).

The mean particle size has since been found by another method: from Einstein's theory[2] of the Brownian movement, an expression can be derived for the relaxation time, that is, the time required to re-establish random orientation when the field is removed. The relaxation time has been measured with a cathode ray oscillograph and is of order 1 sec., from which again an average particle size of 1 μ follows.

It has already been observed by Stuart[1] that the increase in transmission with a magnetic field parallel to the beam also occurs when an alternating field is applied; this is because the change in transmission is a function of H^2. It seems as if this may have some application in the measurement of rapidly alternating fields.

A full account of this investigation will be published by one of us (F. D. S.) in the near future.

F. D. Stott
A. von Engel

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Jan. 26.

[1] Stuart, A. H., *Eng.*, **145**, 17 (1938).

[2] Einstein, A., *Ann. d. Phys.*, **19**, 289, 371 (1906).

Dielectric Constant of Diamond

The dielectric constant of diamond has been the subject of investigation by a number of workers, among whom particular mention may be made of Robertson, Fox and Martin[1], Whitehead and Hackett[2] and Groves and Martin[3]. The exact value of this constant and whether there is any difference between the values exhibited by the two types, namely, ultra-violet opaque and ultra-violet transparent, appear to be the two main issues involved. The most accurate determination of Whitehead and Hackett gave 5·66 at 800 c./sec. and 27·8° C., whereas Martin and Groves obtained 5·26 by one method and 5·35 by another. Probable reasons for the lower values obtained by Martin and Groves were suggested by them. A significant statement of Robertson and co-workers is that they found no measurable differences for the two types of diamonds.

A special liquid-mixture method useful for the determination of dielectric constants of crystal plates has been developed in this laboratory[4]. In view of the importance of this subject, a determination of the dielectric constant of both types of diamond was undertaken. A type I diamond of oval shape, about 2 sq. cm. in area and 1·42 mm. thick, and a type II diamond of rectangular shape, about 1 sq. cm. in area and 1·27 mm. thick, both kindly lent to us by Sir C. V. Raman, were employed in the investigation. The dielectric constants found were 5·70 and 5·65 respectively for these two plates at a frequency of 1·6 mc./sec. and 26° C. In agreement with Robertson and co-workers, we conclude that there is no measurable difference between the dielectric constants of the two types of diamonds, but the exact value obtained by us is definitely higher than that reported by these authors. The mean of our results, namely, 5·68, is quite close to that obtained by Whitehead and Hackett, and is nearly identical with the extrapolated value of the square of the refractive index, which is found to be 5·67.

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Jan. 20.

[1] *Phil. Trans.*, A, **232**, 463 (1934).

[2] *Proc. Phys. Soc.*, **51**, 173 (1939).

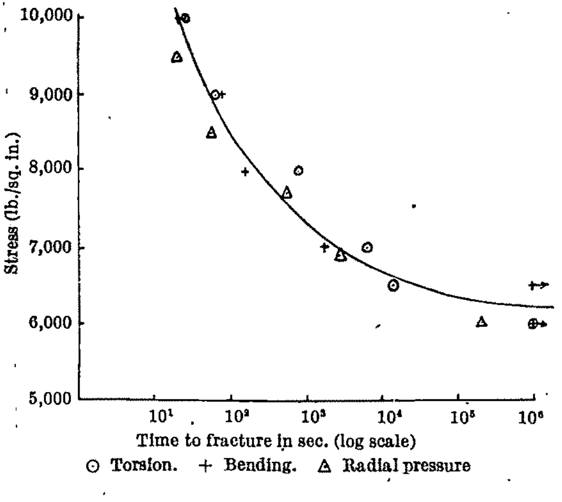
[3] *Trans. Farad. Soc.*, **36**, 575 (1940).

[4] *Proc. Ind. Acad. Sci.*, A, **25**, 408 (1946).

Delayed Fracture of Glass under Tension, Torsion and Radial Pressure

A plausible explanation[1] of delayed fracture of glass is that cracks initially present in the unstressed material gradually extend when glass is loaded. As the cracks extend, the stress at the ends of the cracks increases, until it becomes equal to the maximum stress which the glass can even momentarily withstand; catastrophic fracture then occurs. Other factors being constant, the rate of crack spreading would be expected to depend on the stress at the end of the largest and most unfavourably orientated crack. Delayed fracture in tension and torsion would therefore be expected to occur in equal times, when the glass is subjected to equal principal tensile stresses.

A simple deduction from the crack hypothesis leads to the conclusion that tensile stresses occur at the ends of cracks in rods subjected to radial fluid pressure (no axial force). The magnitude of these



stresses is effectively equal to that occurring in rods subjected to nominally uniform axial tension numerically equal to the fluid pressure. Experiments[2] on glasses with three different compositions broken at constant rate of loading support this deduction.

Briefly, the argument is as follows. A state of radial pressure on a cylindrical rod may be regarded as a state of hydrostatic pressure, on which is superimposed an axial tensile stress numerically equal to the pressure. Under a state of hydrostatic pressure, there is no concentration of stress at the ends of surface cracks; while under an axial tensile stress there is a stress concentration of the order of one hundred. The stress at the ends of cracks in rods subjected to radial fluid pressure is therefore sensibly equal to that at the ends of cracks in rods subjected to an axial tensile stress, numerically equal to the fluid pressure.

Delayed fracture under radial pressure and under axial tension would therefore be expected to occur in equal time when the pressure was equal to the nominal tension stress.

To test these conclusions, delayed fracture experiments in bending, torsion and radial pressure have been made on ¼-in. diameter annealed soda glass rods. The experimental work was done by Mr. S. Pearson. In the accompanying figure, the ordinates represent the nominal principal tensile stresses to which the rods were subjected in bending and torsion, and the radial pressures to which the rods were subjected. The abscissæ represent the logarithm of the corresponding times to fracture. Each point plotted is the median point for twelve nominally identical experiments. It will be seen that the points are all scattered about the same curve. The results are therefore in agreement with deductions from the crack theory.

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Jan. 26.

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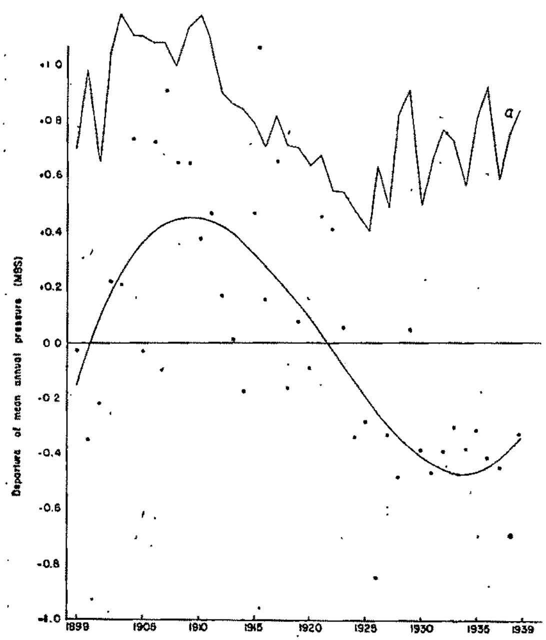
[1] Gurney, C., *Proc. Phys. Soc.*, **59**, 169 (1947).

[2] Gurney, C., and Rowe, P. W., A.R.C. Rep. Mem. No. 2284 (1945) (in the press).

Northern Hemisphere Surface Pressure and Climatic Fluctuations and Vegetation Growth in Northern Finland

THE recent article by Dr. I. Hustich[1] and the accompanying note of Dr. E. W. Jones presenting data on vegetation growth and temperature trends in Europe are of considerable interest when viewed in relation to trends in the surface pressure of the northern hemisphere during the period 1899–1939. I have pointed out recently[2] that there has been a considerable decrease in the total mass of air over the northern hemisphere between 1899 and 1939. The accompanying graph, which is reproduced from that paper[2], shows the departures of mean annual hemisphere pressure from normal for the 41-year period. These values were obtained from the series of Daily Historical Maps[3] prepared in the United States in 1943–44. The smooth curve shown is the cubic regression line fitted to the annual departures by the method of orthogonal polynomials[4].

This curve is practically the reversal of the Curve *a* of the article by Dr. Hustich[1], which has been reproduced at the top of the diagram with the ordinate inverted. In fact, the correlation coefficient between the data shown in Fig. 1 and the series of figures read from Curve *a* given by Hustich is −0·55, a value beyond the 1 per cent significance level. This indicates, therefore, that during the period 1899–1939 there was a tendency for maximum tree-growth in the north of Finland to take place during years of low average pressure over the northern hemisphere.



An explanation that immediately suggests itself is that years with high mean pressure tend to be years with lower mean temperature in northern latitudes, since high pressure in the northern latitudes is usually associated with cold polar anticyclones. Furthermore, it has been pointed out[2] that the cyclical variations in pressure above lat. 60° N. are similar to that shown in the accompanying graph but much more pronounced in amplitude. This hypothesis appears to be reasonable since the correlation coefficient between the mean annual hemisphere pressure and the mean annual temperature of stations above lat. 60° N. was found to be negative for each of six stations that were examined. The largest coefficient numerically was −0·55 for Bodo, Norway, and the smallest coefficient was −0·17 for Vardo, Norway.

Hustich points out the fact that summer temperatures in northern Finland increased during the period 1890–1939, and the influence of precipitation on growth in the far north is of minor significance. The correlation between the tree-growth data shown by Hustich and the mean summer temperature determined by taking the average of Karasjok, Karesaundo and Vardo, Norway, is found to be 0·47, slightly less than the correlation between tree-growth and mean annual hemisphere pressure. The multiple correlation coefficient between tree-growth and these two factors is 0·68, which indicates that nearly half the variation in annual tree-growth is accounted for by the regression on local summer temperature and the mean annual pressure for the hemisphere. Since the mean annual pressure for the hemisphere is only one crude index of the general circulation of the atmosphere that prevailed during the year, it seems quite remarkable for it to account for such a large proportion of the variation in tree-growth. No doubt there are other indices or parameters characterizing the general circulation pattern that should do as well or better.

In conclusion, it seems appropriate to endorse the closing remarks of Jones[1] to the effect that the investigation of trends of growth shown by trees over long periods offers a promising field of work for the climatologist studying long-period fluctuations in the world's climate.

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[1] Hustich, I., *Nature*, 160, 479 (1947).

[2] Brier, G. W., *Bull. Amer. Meteorol. Soc.*, 28, 237 (1947).

[3] U.S. Weather Bureau and Army Air Forces, "Historical Weather Maps, Northern Hemisphere, Sea Level" (1943–44).

[4] Fisher, R. A., and Yates, F., "Statistical Tables for Biological, Agricultural, and Medical Research" (London: Oliver and Boyd, Ltd., 1938).

Dissociation Energies

In my recent book[1] there are a few errors and misprints. As it may be a year or two before a second edition is in print and use of the data might lead to errors in other people's work, it seems desirable to record them. I am indebted to Dr. L. Brewer for pointing out these errors. Those for HBr and HI also occur in Herzberg's book[2].

	Dissociation energy			
	Value given		Correct value	
Molecule	e.v.	k.cal./mole	e.v.	k.cal./mole
F_2	2·2 ± 0·6	72	2·2 ± 0·6	50
HBr	3·60	83·0	3·78	87·4
HBr^+	3·3	76	3·5	80
HI	2·75	63·4	3·1	71·6
HI^+	3·24	75	3·6	83

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[1] "Dissociation Energies and Spectra of Diatomic Molecules" (London, Chapman and Hall, 1947).

[2] "Molecular Spectra and Molecular Structure; I. Diatomic Molecules" (New York, Prentice-Hall, 1939).

The Swimming of Dolphins

In reply to Mr. A. H. Woodcock's[1] inquiry whether other observers have seen the 'motionless' swimming of dolphins and what explanations may have been given, I can state that I have seen this phenomenon on several occasions.

One particular instance about which I have notes available occurred on January 6, 1926, in approximately lat. 55° 15′ S., long. 39° 05′ W. At midday seven dolphins, almost certainly of the species *Lagenorhynchus cruciger*, played for some time round the bows of the whaler *Don Ernesto*, making between 9 and 10 knots, course S.W. 1/2 S., weather clear, several tabular bergs in sight. I photographed the dolphins from the bow rollers directly above the animals as they swam immediately ahead of the forefoot, slipping through the water with no apparent swimming motion. The beauty of this seemingly effortless speed impressed me greatly.

Mr. Woodcock's explanation that 'motionless' dolphins may be riding the bow wave and falling down the inclined surface did not occur to me. I have always assumed that the forward movement of 'motionless' dolphins must be due to rapid up and down strokes of very small amplitude by the tail flukes, strokes which escape notice because the disturbed surface of the water hinders exact observation. This assumption now appears to be incorrect in view of Mr. Woodcock's observation of a 'motionless' dolphin swimming on its side for a distance of 304 metres with no visible oscillation of the tail.

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[1] Woodcock, A. H., *Nature*, 161, 602 (1948).

References in Scientific Literature

There is now increasing use, in scientific literature, of a system in which all references to literature are inserted in the text in the same type. I quote two recent ones: (*a*) from British literature and (*b*) from the United States.

(*a*) "The first step in the breakdown of glycogen is the formation of glucose-1-phosphate and, as shown by Cori and his coworkers (Cori, Cori & Hegnauer, 1937; Cori, Colowick & Cori, 1937; Cori, Cori & Schmidt 1939; Cori, Schmidt & Cori, 1939; Cori & Cori, 1939; Cori, Green & Cori, 1942), this reaction is reversible." . . . "Glycogen has been produced *in vitro* with minced tissues (Kiessling, 1936, 1937; Ostern, Herbert & Holmes, 1939; Ostern & Holmes, 1939), tissue extracts (Cori, Cori & Schmidt, 1939; Cori & Cori, 1939; Mirski & Wertheimer, 1942) and with purified or even crystalline enzymes (Cori *et al.*, 1937; Cori, Colowick & Cori, 1938; Cori *et al.*, 1942; Kiessling, 1939 a, 1939 b; Colowick & Sutherland, 1942; Schäffner & Specht, 1938, 1939)."

(*b*) "Impairment of the ability of the thyroid to collect or retain radioactive iodine has been reported with thiourea (Keston, Goldsmith *et al.*, 1944; Buciero and Vieira, 1944; Chagas, De Robertis, and Couceiro, 1945), thiouracil (Rawson, Tannheimer and Peacock, 1944; Rawson, Cortell *et al.*, 1944; Rawson, Evans *et al.*, 1944; Couceiro, Vicira and de Moraes, 1944; Salter, Cortell, and McKay, 1945) and promizole (Higgins and Ingle, 1946)."

Surely we are losing sight of the object of the printed paper, namely, that it should be readable. Nowadays it may be somewhat of an athletic feat to pick out the text. It is time that the whole question of references was reconsidered and that the convenience of the printer was not made the main consideration. Even smaller type for the references would be an improvement, or some system which made introductory words stand out.

In this respect contrast the readability of (*c*) from another British journal.

(*c*) "the earlier statement that all known heteronuclear mononitronaphthylamines were orange-red required modification in that the 5- and 6-nitro-2-naphthylamines should be styled orange-yellow and golden-yellow respectively[2,5–8]. (Since this work was completed, Hertel[9] reports that . . .)"

(2, 5–8 and 9 are placed in a convenient footnote.)

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BRITISH SCIENTIFIC INSTRUMENTS

THE 1948 Exhibition of Scientific Instruments, the thirty-second of the series, held by the Physical Society at the Imperial College of Science and Technology, London, was worthy of its predecessors. As in 1947, the Exhibition was open for four days, April 6–9 inclusive, during the University Easter vacation. In order to limit the attendance to reasonable proportions, it was necessary again to issue tickets for admission on all the days. There was therefore no 'public' or 'open' days as in pre-war Exhibitions. Nevertheless, the number of visitors (including fellows of the Physical Society) attending the Exhibition this year reached a total of approximately 13,000. Certain sessions were rather overcrowded; but on the whole the restriction on the issue of tickets had the desired effect and visitors could view the exhibits in reasonable comfort.

It had been arranged that the Right Hon. J. H. Wilson, President of the Board of Trade, should open the Exhibition on April 6; this coincided with the presentation of the Budget in the House of Commons, and the planned opening had to be cancelled. Prof. G. I. Finch, president of the Physical Society, however, acted as deputy to the President of the Board of Trade in opening the Exhibition. It will be recalled that the opening function was performed in 1946 by Sir Stafford Cripps. The national importance of this Exhibition is demonstrated not only by the high standing of the Cabinet Ministers invited to open it, but also by the high quality and export value of the scientific instruments which are exhibited. As a display of such instruments the Exhibition is pre-eminent in Great Britain.

In its youth, the Exhibition was primarily concerned with 'research' items, but at a later stage in its development a certain number of trade exhibits of a novel character were also included. Now the Exhibition is primarily 'trade', while the 'research' section is relatively small in size but large in interest. This year, the number of firms represented in the trade section was 124, while in the Research and Educational Section there were 38 exhibitors. It should be pointed out, of course, that a number of firms and organisations represented in the Trade Section exhibit also in the Research Section. Special mention should be made on this occasion of the exhibition of the film "Atomic Physics" once during each session of the Exhibition. The film displays very vividly and with good historical accuracy the growth of atomic physics since the time of Dalton's atomic theory; and is a noteworthy scientific achievement for which much credit is due to those who conceived and produced it (see also *Nature*, Dec. 13, 1947, p. 822).

On each of the first three evenings of the Exhibition a discourse was given dealing with recent developments in a particular branch of physics and its applications.

The discourse by Dr. K. Mendelssohn of the Clarendon Laboratory, Oxford, dealt with the subject of "Low-Temperature Physics". In the course of his talk Dr. Mendelssohn explained that the fundamental relation between temperature and disorder provides a basis for an understanding of both the technique and the aims of low-temperature research. In order to lower the temperature we must have at our disposal a system the entropy of which changes appreciably with a variable other than the temperature. Such a system is a gas or a paramagnetic salt, the variables being the pressure and the magnetic field respectively. The techniques of gas liquefaction and adiabatic demagnetization were described. The increase of order with decreasing temperature provides two striking phenomena, superconductivity and the superfluidity of liquid helium. Experiments show that the electrons in a persistent current as well as the helium engaged in superflow have zero entropy.

In his discourse on "The Reflecting Microscope", Dr. C. R. Burch, of the University of Bristol, surveyed some of the fields in which the instrument seemed likely to play a prominent part; for example, in micro-dissection and ultra-violet absorption studies made possible by the long working distance and focal achromatism. He showed slides illustrating the new ground being broken in ultra-violet cytological spectromicrography by Dr. R. Barer (of the Department of Human Anatomy, Oxford). In his discourse Dr. Burch was assisted by Mr. K. W. Keohane and Mr. W. J. Bates, both of the University of Bristol. The former showed photomicrographs of red-hot metals, and the latter described the use of the reflecting microscope in the study of cosmic ray phenomena in nuclear photographic emulsions, using phase-contrast illumination.

Mr. H. L. Kirke, director of research in the British Broadcasting Corporation, selected for the title of his discourse "Studio Acoustics". He described room acoustics as 'the scenery of sound' and then discussed briefly the history of the subject from the time of Sabine's early work. The effect of reverberation time and its relationship to the size of the room and number of performers was considered. He showed slides of the reverberation frequency characteristic of a number of halls and studios, pointing out the defects of certain studios. The old method of measurement of reverberation time using a warble tone was described, together with the effect of eigentone modes and other resonances. He referred also to the methods of measuring absorption in the various frequency ranges, with particular reference to absorption in the low-frequency range of vibrating panels and resonators. Demonstrations were given by recordings and lantern slides of some of the peculiar effects of resonances, concluding with references to the effect of shape of wall surfaces on reflected sound, particularly with polycylindrical surfaces.

An interesting film, "Physics of the Film", was shown at intervals by the British Kinematograph Society, illustrating the faults in picture and sound due to neglect of fundamental physical and mechanical principles. The application of photographic theory to the colour film was especially illustrated.

It is not possible in a review such as this to make even a brief reference to more than a few of the multitude of interesting exhibits. The reader is recommended to consult the Exhibition catalogue, a well-illustrated volume of about 370 pages, for further particulars. This catalogue, available on application to the Secretary of the Physical Society, is a valuable book of reference, renewed annually, to the scientific instrument industry in Great Britain.

A centre of attraction to visitors in the Research Section was the demonstration of the production and properties of 8 mm. electromagnetic waves. The advent of power sources of this wave-length makes possible the demonstration of many optical phenomena such as interference, diffraction, polarization, lenses, 'blooming', etc. A novel feature of this exhibit was the use of a neon tube containing a large-diameter plane metal plate containing a large number of 'slit' dipoles. This surface served as the optical screen to make 8 mm. waves 'visible'. In another research exhibit a cathode ray tube was used to display three-dimensional data. The Post Office Engineering Department demonstrated the use of radar technique in the location of line faults. When the radar pulse arrives at a fault or other discontinuity, it is reflected back—just as a radar pulse is reflected from an aeroplane—and the echo arrives at the sending end after a time interval which is a measure of the distance of the fault, the time interval being indicated in the usual manner on a cathode ray screen.

An exhibit which will no doubt be of interest to smokers in these days of expensive tobacco provided an indicator of the moisture content of a small sample of tobacco. The sample exhibited contained 40 per cent moisture!

In a study of underwater noise produced by ships' propellers, a method was demonstrated of measuring the distribution of pressure across the face of a propeller blade while it is revolving in water. In another application of acoustics; supersonic vibrations were used as a depth gauge. This gauge is a development of the supersonic flaw detector, using echo technique with cathode ray tube indication.

On the optical side may be mentioned a fine array of microscopes, demonstration of phase-contrast methods and electron microscopes. Developments in phosphors were illustrated in a demountable cathode ray tube. Some unusual tungstate phosphors activated by uranium or bismuth showed the interesting characteristic of giving different colours when excited by different wave-lengths of ultra-violet light. New glasses have been developed for the special purpose of acting as a 'solder' and enabling, for example, glass, metal and mica to be soldered to glass. Various examples of the use of the new glasses were shown. In another exhibit a surface layer had been applied to glass by a special technique which results in a low electrical resistance together with a high light transmission and low reflexion losses. The conducting layer is extremely resistant to attack by strong chemicals, including hot hydrofluoric acid. Very high frequency (megacycle) sound waves are being increasingly used in a number of industrial purposes; for example, for mixing and emulsifying in chemical and biological processes. Quartz crystal transducers controlled by powerful high-frequency generator units were used in demonstrations.

Progress in atomic physics was demonstrated in a number of exhibits illustrating, for example, new forms of electronic counters, photographic methods of recording nuclear particle tracks, a synchrotron vacuum annulus for acceleration of electrons to energies of 30 MeV., and so on.

The general impression created by the Exhibition is that the scientific instrument industry of Britain is in a very flourishing and healthy condition. The Physical Society, the Exhibition Committee, and the secretarial staff involved in organising the Exhibition are to be heartily congratulated on its success.

A. B. WOOD

CRITICAL BRITISH GROUPS OF FLOWERING PLANTS

THE study of the taxonomy of the British flora has suffered a long period of neglect at the universities, and until very recently its progress has been mainly in the hands of amateur botanists, the British Museum (Natural History) and the Royal Botanic Gardens, Kew. Cytology and ecology have provided the taxonomist with important new tools, and their application has led to a revival of interest in the seats of learning on a scale which would have seemed impossible only a decade ago. The conference on "The Study of Critical British Groups", arranged by the Botanical Society of the British Isles under the chairmanship of its president, Mr. J. S. L. Gilmour, on April 9 and 10, marked a new epoch in the combined application of the new and old tools.

The object of the Conference was to bring together field botanists, herbarium botanists, cytologists, geneticists and ecologists in a demonstration of the new synthetic approach to taxonomy. This was attained by a series of papers covering recent work on the elucidation of 'critical groups', that is, groups of flowering plants in which difficulty is found in defining closely allied species. By the end of the second day it was evident that a very wide variety of methods could be employed and that each group considered provided problems which differed from those of others.

A short introductory talk by the president was followed by three papers covering general aspects of the subject. Dr. E. F. Warburg (Bedford College, London) dealt with "Cytology in Relation to Critical Groups". He showed that plants might be considered according to the number of chromosomes under the following three classes: (1) where the chromosome number is the same throughout a relatively large taxonomic unit as in *Ribes* and *Pinus*; (2) where the chromosome numbers are all multiples of a basic number throughout the group as in *Salix* and *Sorbus*; and (3) where the numbers within a group bear no obvious relation to each other as in *Erophila verna* ($2n = 14, 24, 64$, etc.), *Viola* (pansies with 26, 34 and 48), and the annual *Gerania* (18, 22, 26). The second class is the most common and the most useful to taxonomists. As instances of the value of cytological work in the differentiation of species, Dr. Warburg mentioned Hagerup's separation of the diploid *Empetrum nigrum* from the tetraploid *E. hermaphroditum*, and Howard and Manton's separation of the diploid *Nasturtium officinale* from *N. uniseriatim* with double the number of chromosomes. He also directed attention to the fact that *Oxycoccus microcarpus*, which had been regarded as a mountain variety of *O. quadripetalus* by British botanists, had only half the chromosome complement of the lowland plant, and that Hagerup's work indicated that it should be given specific rank. After stating that imperfect pairing led to imperfect pollen and eggs and often partial sterility in hybrids, and pointing out that suspected hybridity could often be confirmed by examination of meiosis, he directed attention to the important part played by hybridization in the origin of new species and particularly of polyploids. Dr. Warburg instanced *Galeopsis Tetrahit* as a species which had been made artificially by a geneticist. He reminded botanists that in cases like *Spartina Townsendii*, which behaves as a species although of known hybrid origin, the hybrid sign

('×') should be omitted before the name. Finally, he dealt with apomixis, where seed is produced from a diploid cell of the female parent without reduction division or fertilization. In some of our most critical genera, such as *Rubus*, *Hieracium*, *Alchemilla* and *Sorbus*, the polyploid species are usually apomictic, but occasional sexual reproduction occurs and produces new forms.

Dr. W. B. Turrill (Kew) gave an account of "Experimental Studies on British Species of Plants", which was particularly valuable on account of the many suggestions for lines of research which could be profitably followed up. He summarized the transplant experiments carried out under the ægis of the British Ecological Society, and his genetic researches on *Silene Cucubalus* and *S. maritima*, *Centaurea*, *Anthyllis*, *Geum*, *Saxifraga* and *Anagallis*, which had revealed an unsuspected range of variation in British species. He regarded taxonomy as the focus of all branches of botany and stressed that experimental methods must be used as an addition to the old taxonomic methods—they do not supersede them.

The third introductory lecture was given by Prof. A. R. Clapham (University of Sheffield) on "Ecology in Relation to Critical Groups". He pointed out that distinctions of a kind which taxonomists regard as specific cannot be made without barriers to prevent interbreeding. In addition to the cytological barriers already mentioned, interbreeding might be prevented by geographical isolation from climatic and historical causes or by ecological isolation from habitat differences within the same climatic area. Thus *Orchis fuchsii* and *O. ericetorum*, *Galium palustre* and *G. uliginosum*, *Glyceria declinata* and *G. fluitans*, *Empetrum nigrum* and *E. hermaphroditum*, *Oxycoccus quadripetalus* and *O. microcarpus*, and *Viola Riviniana* and *V. Reichenbachiana*, are pairs of species more or less subject to ecological isolation. Recent work has shown that the two British hawthorns are similarly differentiated—*C. oxyacanthoides* being more definitely a woodland species than *C. monogyna* of hedgerows.

The Conference then turned to the consideration of the problems of particular groups. Following the afternoon session when some of the exhibitors gave short talks on the material displayed (see below), Mr. W. C. R. Watson read a paper on "An Introduction to *Rubus*". He discussed the evolutionary trends in the genus as based on morphology and distribution. During the discussion which followed, Mr. A. J. Wilmott (British Museum (Natural History)) directed attention to the prevalence of critical species of such apomictic genera as *Rubus*, *Rosa* and *Hieracium* in areas which had been glaciated.

Dr. D. H. Valentine (University of Durham) lectured on "Vegetative and Cytological Variation in *Viola Riviviana*" with special reference to the production of adventitious shoots from the roots in certain plants. The chromosome number for the species is $2n = 40$, but he had also counted 42, 45 and 46 in material from Cambridgeshire and Durham. There was some evidence that the supernumeraries were associated with the production of adventitious shoots.

The proceedings for the second day opened with a paper on "Intraspecific Categories of Variation" by Mr. A. J. Wilmott. In analysing the collection of such units made for the Systematics Association, he developed important original theories which were received with very great interest. He emphasized that many of the difficulties which arose in discussing the term 'species' came from the use of that word in two discrepant ways, nomenclatural and philosophic. Hence many botanists refuse to recognize as different kinds of species all groups of specific nature—that is, possessing correlated characters and distinct distribution—because if they did so they would have to treat them as nomenclatural species also and give them biverbal names. He therefore proposed the term *biverbum*—a thing with two words—for the latter, and *triverbum* for the lesser unit variously called microspecies, subspecies, or races. The various kinds of intraspecific groups were then discussed, and distinguished from these intraspecific variations which did not produce groups. He emphasized that only discrete natural groups should be given epithetal designations, and suggested methods for designating other units should this be necessary in systematic or other studies.

Dr. K. B. Blackburn (King's College, Newcastle) dealt with "Chromosomes and Classification in the Genus *Rosa*". After outlining the purely taxonomic classifications of De Candolle, Lindley, Crépin, Christ, and others, she gave examples of the use of cytology as a straight taxonomic character. Certain of the Caninæ with $2n = 35$ behave in an irregular manner at reduction division. The odd chromosome gets on to the plate in meiosis and divides—the progeny are fertile. In *R. Richardsoniana* Harrison the eggs have 35 minus 7, and the pollen grains have 7 chromosomes, so that the group can go on with the odd number of chromosomes. Although Gustafsson had denied the occurrence of apomixis, it was reported by earlier workers, and efforts should be made to confirm it.

The paper read by Dr. T. A. Sprague (Kew, retired) on "Forms of *Valeriana officinalis*" described cytological variants which are not certainly distinguishable by morphological characters. He stated that the diploid of the aggregate species with $2n = 14$ was known in Europe, but only the tetraploid and octoploid had been detected in Britain. The two latter showed ecological differentiation, the tetraploid being restricted to oolitic limestone, chalk and carboniferous limestone in the south of England on slopes and dry valleys in hilly regions, while the octoploid inhabited low ground on swampy and more acid soils and had a wider distribution. Certain morphological differences existed but there was much overlapping of characters, and even after considerable experience Dr. Sprague was able to distinguish the octoploid from the tetraploid with only about 90 per cent accuracy. The cytological work was done by Dr. Skalinska, who found that the size of the pollen grains enabled the two to be separated in herbarium material. Reproduction from seed was estimated to produce only about 95 per cent of the new plants, the remainder coming from soboles or occasionally from bulbils.

"Some Taxonomic Problems in *Galium* and *Juncus*" was the title of an extremely lucid paper by Prof. A. R. Clapham. He showed that in *Galium palustre* there was an octoploid with $2n = 96$ and a diploid with $2n = 24$, which differed in morphological characters, ecological requirements, and time of flowering, and approximated to varieties which had been described by taxonomists. The length of the guard-cells of the stomata provided an unusual and almost absolute character. In *Juncus* the diploid chromosome number of *J. acutiflorus* was found to be 40, of *J. articulatus* 80, and of the hybrid 60, as might be expected. But in addition he had found in meadows near Oxford a variant which had vegetative characters nearly those of *J. acutiflorus* and reproductive characters, resembling those of *J. articulatus*, and which was quite fertile. This he had called "Large 80" on account of the chromosome complement, and no satisfactory suggestion had been made for dealing with it taxonomically.

In the last paper of the series Dr. R. W. Butcher (Ministry of Agriculture) considered "Some Problems of Water Buttercups". The aquatic Ranunculi provided an exceptionally good example of the effect of environment on morphology, and by growing them in tanks under controlled conditions he had been able to study the effect of depth of water, exposure to air, and the problem of the production of floating leaves. The study of the variants which occurred in rivers showed that there were probably three species, of which one was new.

Throughout the Conference, exhibits of herbarium material, photographs and diagrams were on view to illustrate features of various critical groups. Dr. Butcher, Prof. Clapham, Dr. Sprague and Mr. Watson displayed material referred to in their papers, and some of the other exhibitors gave short talks. Mr. G. M. Ash directed attention to the convenience of having leaves and dissections mounted separately on small cards for ease of comparison, as shown in his exhibit of *Epilobium*. Dr. K. B. Blackburn showed *Limosella aquatica* and *L. subulata* with the fertile colchicine-induced hybrid between them. She had worked on material from Wales supplied by Miss E. Vachell. Mr. C. E. Hubbard (Kew) spoke on his large series of grasses. His account of variation in *Agropyron* and *Poa pratensis* illustrated difficult problems. Dr. J. M. Lambert (Westfield College, London) described the ecology of *Glyceria* very clearly and directed attention to some remarkable variants she had found. Mr. J. E. Lousley outlined the cytogenetical work done on British species of *Rumex* abroad and indicated a number of problems in which he appealed for the assistance of a cytologist in his studies. His exhibits of wild and cultivated material of the tetraploid *R. tenuifolius* compared with the commoner hexaploid *R. Acetosella*, of the sterility of hybrids of the *Lapathum* subgenus, and of variation coupled with geographical distribution in the subspecies of *R. obtusifolius* and *R. pulcher*, and of variation proved to be due to habitat conditions in *R. maritimus*, illustrated various aspects of the subject. Prof. T. G. Tutin (University College, Leicester) showed material of *Bromus*. A plant which occurs at the Lizard is suspected of being *B. Ferronii* Mabille, which was described from western France. Mr. S. M. Walters (Cambridge) spoke on *Alchemilla*, of which he had recently carried out a revision.

The other exhibits included "Variation and Ecology in the British Watercresses" by Mr. H. K. A. Shaw (Kew), *Carex* by Mr. E. Nelmes (Kew), *Agrimonia* by Mr. N. H. Brittan (Newcastle), *Cardamine* by Miss F. Hussein (Newcastle), groups of British *Rubi* by Miss Y. Massey (Newcastle) and *Mentha* by Mr. R. Graham.

It was with certain misgivings that the organisers had arranged a 'brains trust' to conclude the proceedings of the Conference; but this feature proved an outstanding success. Acting as question master, Mr. J. S. L. Gilmour introduced the members of the trust: Miss M. S. Campbell, Profs. C. E. Raven and T. G. Tutin, Dr. E. F. Warburg and Messrs. J. E. Lousley and A. J. Wilmott—with pseudo-scientific names. The questions ranged from such subjects as the spelling of trivials with small initial letters, and estimates as to the relative greatness of field-botanists of the past, to the definition of an 'over-winter annual'. Although the 'brains trust' was arranged as a less serious item in the programme, there can be no doubt that the opinions provided on controversial subjects were of considerable value.

The outstanding feature of the Conference proved to be the revelation of the deeply interlocking nature of the studies of the very varied botanical interests represented. There was a spirit of eager collaboration among the 114 members and guests who attended. Cytologists were eager to help ecologists, amateur botanists to assist professionals, and *vice versa*. The Botanical Society of the British Isles proposes to foster this synthetic approach to taxonomy and, as the president stated in his concluding remarks, the note of collaboration engendered at the Conference will not be allowed to die.

The officers of the Society and in particular the secretary, Miss M. S. Campbell, and the assistant secretary, Mr. W. R. Price, are to be congratulated on the success of the first Conference arranged by the Society. The comfort of those who attended was ensured by the excellent accommodation provided by the Royal Horticultural Society. J. E. Lousley

EMISSION OF Li^8 IN THE EXPLOSIVE DISINTEGRATION OF NUCLEI

By C. FRANZINETTI and R. M. PAYNE

H. H. Wills Physical Laboratory, University of Bristol

IN a recent communication from this Laboratory[1], it was shown that unstable heavy nuclei are sometimes emitted during the explosive disintegrations produced in photographic plates by the passage of cosmic radiation. In some cases, these unstable particles, after being brought to rest in the emulsion, give rise to two particles of equal range, emitted in opposite directions. The characteristic tracks thus produced were referred to as 'hammer tracks'; and it was suggested that they are due to the emission of a nucleus of Li^8 during the disintegration, for this nucleus is known to suffer β-decay with a period of 0·88 sec.[2], and simultaneously to decompose into two α-particles. Twenty-eight examples of this process have now been observed in this Laboratory, and it has been possible to establish the correctness of the original interpretation of the phenomenon.

Figs. 1 and 2 show two examples of 'hammer' tracks which are of particular interest. In Fig. 1, the range of the heavy fragment is 60 μ, corresponding to an original energy of emission of the particle of approximately 15 MeV. Fig. 2 shows the tracks resulting from a disintegration, produced at the end of its range by a meson, σ. This transmutation results in the emission of two lightly ionizing particles, p_1 and p_2, which are probably fast protons, together with a fragment which decomposes into two α-particles at the end of its range. The photograph thus provides direct evidence for the ejection of Li^8 in the disintegrations produced by mesons.

In Fig. 3, we show the distribution in range of the α-particles observed in the twenty examples now available for measurement. The corresponding distribution, observed by Christy *et al.*[3], in experi-

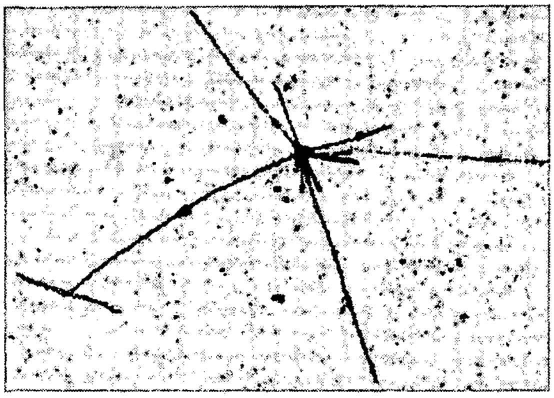

Fig. 1

ments on Li^8 generated in the laboratory in the reaction $Li^7 + H^2 \rightarrow Li^8 + H^1$, is shown by the dotted line in the figure. It will be seen that there is no significant difference in the two distributions. We can, therefore, conclude that the 'hammer' tracks are in fact due to Li^8 nuclei, in accord with the original explanation.

ANALYSIS OF THE 'HAMMER TRACKS'

Number	1	2	3	4	5	6	7	8	9	10	11
Energy of α-pair (MeV.)	4·2	3·8	3·9	5·5	4·3	7·2	5·0	6·7	3·6	2·7	5·8
Angle between α- and Li⁸-track	82°	44°	85°	58°	59°	73°	42°	90°	66°	22°	71°

Number	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Energy of α-pair (MeV.)	4·8	2·3	4·6	7·4	2·9	3·9	3·9	2·3	3·7	3·6	2·9	4·0	4·4	1·1	2·6	3·8	2·7
Angle between α- and Li⁸-track	—	58°	85°	77°	35°	47°	69°	50°	27°	70°	85°	65°	66°	72°	81°	88°	88°

RELATIVE FREQUENCY OF THE EMISSION OF Li^8 IN THE NUCLEAR DISINTEGRATIONS PRODUCED BY COSMIC RADIATION

Li^8/fission fragments . . .	= 2·28%
Li^8/fission fragments + α-particles .	= 0·37%
Li^8/fission fragments + α + protons .	= 0·185%

The accompanying table shows the details of the measurements made on the individual events. In accord with the explanation of the phenomena given above, the observations show that the directions of motion of the α-particles are orientated at random with respect to the lines of motion of the parent Li^8 nuclei at the end of their range. The table also shows the frequency with which Li^8 nuclei are emitted, as compared with heavy fragments, protons and α-particles, in the 'explosive' disintegrations produced by cosmic rays.

In the β-decay of Li^8, the momenta of the electron and the neutrino, commonly assumed to be ejected during the transformation, cause the resulting Be^8 nucleus to recoil. It follows that if the disintegration of this nucleus into two α-particles takes place in a time shorter than 10^{-22} sec., the two particles should not, in general, be projected in precisely opposite directions. The average difference between the lines of motion of the two particles in the emulsion will, however, only be of the order of one or two degrees. It would be difficult to establish such a difference in the conditions of our experiment, because of the small-angle scattering of the α-particles in the emulsion. As for the difference in energy between the two α-particles, this would be of the order of only a few per cent, and would not be measurable in our experimental conditions.

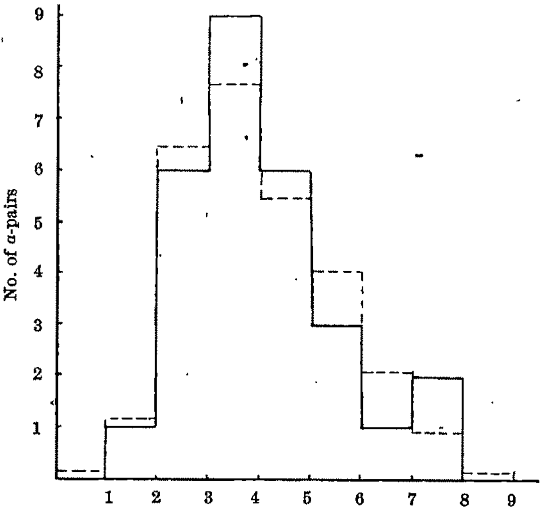

Fig. 3. PRESENT EXPERIMENTAL RESULTS, FULL LINES; DISTRIBUTION OBTAINED BY CHRISTY *et al.*, NORMALIZED TO CORRESPOND TO 28 EVENTS. THE DISTRIBUTION SHOWN IS OBTAINED BY SUMMING THE TWO RESULTS OF THESE WORKERS WITH LITHIUM DEPOSITED ON GOLD AND BERYLLIUM FOILS RESPECTIVELY

In most examples of disintegrations accompanied by the emission of Li^8, it is impossible to identify the original nucleus. Thirteen of the twenty-eight events, however, show that during disintegration, the Li^8 is accompanied by a strongly ionizing particle, probably an α-particle, and a proton. By estimating the energies of the Li^8 nucleus from the known range-energy relation of Lattes, Fowler and Cuer[4], and by applying the principles of the conservation of energy and momentum, it is found that the observations are consistent with the assumption that we are observing the disintegration of C^{12} by a fast neutron.

We are indebted to Dr. C. F. Powell, not only for suggesting this experiment, but also for his continued interest and encouragement; and we take this opportunity of thanking Dr. G. P. S. Occhialini for many helpful discussions and suggestions. One of us (C. F.) was enabled to take part in this investigation by a grant from the University of Bristol, and through the generosity of Mr. A. Giandolini of London.

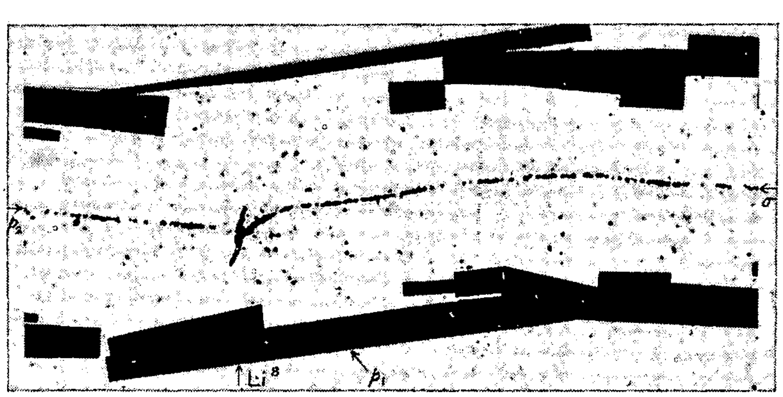

Fig. 2

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[1] Occhialini, G., and Powell, C. F., *Nature*, 159, 93 (1947).

[2] Lewis, W. B., Burcham, W. E., and Chang, W. Y., *Nature*, 139, 24 (1937).

[3] Christy, R. F., Cohen, E. R., Fowler, W. A., Lauritsen, C. C., and Lauritsen, T., *Phys. Rev.*, 72, 698 (1947).

[4] Lattes, Fowler and Cuer, *Proc. Phys. Soc.*, 59, 883 (1947).

RHEOLOGY IN THE TEXTILE INDUSTRIES

THE British Rheologists' Club in association with some provincial branches of the Chemical Society, the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Physics, together with the Textile Institute and the Society of Dyers and Colourists, recently organised a two-day discussion (March 19 and 20) on the rheological properties of textile materials. The meetings took place in the Department of Textile Industries of the University of Leeds under the chairmanship of Prof. J. B. Speakman, head of the Department and president of the Rheologists' Club. About a hundred and fifty scientific workers, including a number of overseas visitors, were present, and the problems discussed embraced such diverse phenomena as the flow of fibres over one another in the manufacture of yarns, and the state of orientation of long-chain molecules in viscose rayons.

The first day's proceedings commenced with a paper by D. R. Cox (Wool Industries Research Association) on "Fibre Movement in the Drafting Process". He derived the equations governing the velocity and distribution of the fibres in terms of general expressions for the frictional coefficient of the inter-fibre area of contact, which would depend on the pressure perpendicular to this surface. Only the relatively simple form of the equations was dealt with in the special case of short fibres. He then showed that the initial irregularity of the sliver, characterized by the values of its 'spectra', would be modified by the drafting process so that the spectrum of the issuing sliver could be derived from it by use of the fundamental equations. A single irregularity in the entering sliver was seen to give rise to an emerging wave of irregularities. R. Meredith (British Cotton Industry Research Association) read a paper on "Relaxation and Flow in Cellulose Fibres". The Tobolsky–Eyring–Halsey theory of viscous flow in high polymers was expounded and shown to provide a molecular picture of the delayed elasticity and creep properties of cotton and other such textile fibres. From these phenomena the theory enabled one to calculate the molecular dimensions of the 'flow unit' and the activation energy of the flow process.

Prof. W. E. Morton and F. Permanyer (Manchester College of Technology) then concluded the first session with a paper entitled "Torsional Relaxation in Textile Filaments". The behaviour of a wide range of textile materials had been studied and the data obtained were presented in graphical form. The logarithmic plots of the relaxation of stress with time illustrated the applicability of the Nutting–Scott Blair equations with only a few exceptions.

On the second day, H. J. Woods, R. R. Mukherjee and M. K. Sen (Textile Physics Department, University of Leeds) presented a short paper on "Some Tensile Properties of Jute". Results were given which emphasized the dependence of the values obtained for Young's modulus and tensile strength on the dimensions of the sample chosen. A significant negative correlation, for example, was shown to exist between the Young's modulus and the denier of the fibre (a measure of the thickness), which is in agreement with the 'weak spot' theory. Relaxation in jute fibres was negligible under the experimental conditions. The next paper, by L. Peters and Prof. J. B. Speakman (Textile Industries Department, University of Leeds), on "The Viscous-Elastic Properties of Wool Fibres", proposed a new theory of the elastic properties of wool or other keratin fibres. Unlike the kinetic theories of the elasticity of rubber and related high polymers, where extension is regarded as the transition from a disordered to a more ordered state, the new theory makes use of the X-ray data which indicate that keratin is transformed from one crystalline state to another by unfolding of the main peptide chains. Assuming that these two forms are in dynamic equilibrium with one another, it follows that there must be some of the extended form present even in unstretched fibres. The load-extension curve of wool in formic acid indicates that this is by no means a negligible proportion of the total. Quantitative analysis of the curve was attempted, and estimates of the change in heat content and entropy of stretching have been evaluated. The creep properties are considered to be due to the transference of stress from the 'crystalline' to the 'amorphous' phase.

This was followed by a paper on "Stress-Strain Characteristics of Viscose Rayon in Relation to Anisotropy" by L. Rose and J. D. Griffiths (Messrs. Courtaulds, Ltd.). The outstanding feature of the work is the discovery of a linear relation between the birefringence and the logarithm of the slope of the load-extension curve of the wet rayon. This enables the birefringence of a specimen to be calculated with an accuracy of 0·001 from a simple measurement of wet tenacity and elongation when the axial swelling is known. It was shown that normal 'unstretched' rayons are anisotropic because of the profound contraction which takes place during drying on the bobbin. Under conditions where free contraction takes place, the material is optically isotropic and the properties of the filaments are in satisfactory agreement with the above linear relation.

The final paper was given by F. S. Warburton (Wool Industries Research Association) on "The Mechanical Properties of Horn". He described optical methods of determining the elastic constants of strips of horn with high precision at different humidities.

The papers, and the highly interesting discussions which followed, are to be published in the *Journal of the Textile Institute*.

L. PETERS

RECENT RESEARCH IN MARINE BIOLOGY

THE first number of the twenty-seventh volume of the *Journal of the Marine Biological Association* contains eight papers on varied aspects of marine biology.

Mr. G. M. Spooner and Dr. Segerstråle describe, in independent papers, their investigations on species of *Gammarus*, as the result of which we now have a clear picture of the species and varieties of these important marine scavengers. Mr. Spooner's pre-war studies on the quantitative and qualitative distribution in estuaries of *G. locusta, zaddachi, duebeni, chevreuxi* and *pulex* have been expanded, and linked with the valuable systematic work of Mrs. Sexton. He also had access to the collections of eight zoologists working on different parts of the British and Danish coasts. He distinguishes between the typical forms of *G. zaddachi*, which he calls *G. zaddachi zaddachi*, and the saline or non-hairy forms, which he names *G. zaddachi salinus*. This separation of sub-species clears up difficulties met with by some observers on the range of the species.

Dr. Segerstråle writes on the distribution and morphology of *G. zaddachi* and its sub-species. Using material from the Baltic (Gulf of Finland to Denmark), the North Atlantic (Norway to Newfoundland) and the Arctic (Novaya Zemlya to Greenland), he distinguishes three sub-species of *G. zaddachi*, the oceanic, typical and saline forms. He regards the large arctic species *G. setosus* and *G. wilkitzkii* as allied to *G. zaddachi*.

Dr. R. Gurney contributes notes on parasitic Copepoda of the family Lernæopodidæ, summarizing those with free or with suppressed nauplius stages. He describes the copepodid stage of *Lernœenicus sprattœ*, probably, he thinks, the attacking stage.

There are two fishery papers. Mr. P. G. Corbin gives a comprehensive account of the spawning of mackerel in the Celtic sea, between Land's End and southern Eire. His investigations showed that spawning occurred between mid-March and the end of July, with the maximum in mid-April, spreading east and slightly north from the western edge of the Continental shelf towards Eire and the mouth of the English Channel. The young also moved eastwards.

The pilchard spawns at the mouth of the English Channel from March until December and spreads eastwards likewise. *Sagitta* spp. and *Muggiœa atlantica* were used as zooplankton indicators.

Mr. P. H. T. Hartley writes on the marking and recapture of flounders, with the object of discovering their migrations, distribution and growth-rates. Of the thousand specimens marked in the Tamar and Lynher estuaries in 1937–38, only 152 were recovered in the estuaries. Rewards were offered for their capture, and if brought in alive, they were measured and released. Seven were caught twice and one three times. Most of the fish do not travel far from the area in which they had been marked, but two showed more enterprise, moving up-channel to the east. One of these got as far as Brighton, two hundred miles away. The fish grew very little or not at all during the winter months. In the spring the young moved upstream, the mature fish down to the sea for spawning, but their movements subsequent to spawning vary considerably.

Prof. N. J. Berrill describes the interesting Ascidian *Pycnoclavella aurilucens*, peculiar to the Plymouth area, and recorded by Garstang in 1891. Its colonies are found in shallow water, growing on gorgonians, large hydroids and calcareous algæ. In structure it closely resembles *Clavelina*.

Mr. R. G. Evans, in a continuation of his ecological studies in Cardigan Bay, discusses the influence of wave action on the fauna and flora of twelve selected localities in the Plymouth area. He investigated wave effects on horizontal distribution and vertical zonation, on the size of individuals of certain common species, and on their toleration of exposure to the air. Although many factors make broad generalizations difficult, he establishes the existence of critical levels in the upper zone (between M.H.W.S. and E.H.W.N.) and the lower zone (between M.L.W.S. and M.L.W.N.). In the former many species attain their highest limit, in the latter some littoral species achieve their lowermost limit and sublittoral species their upper limit. The least critical level lies between E.H.W.N. and E.L.W.N., because here all conditions are more regular than in any other level on the shore.

Lastly, there is Mr. D. P. Wilson's paper on *Physalia physalis*, with an account of its occurrence in the British and adjacent seas during the past hundred years, and of its feeding habits. Swarms of this floating siphonophore appeared off our south-west coasts in the summer of 1945, and off La Rochelle in 1946. Mr. Wilson concluded that *Physalia* is wind-borne, not current-driven; that it was blown north from its normal limit of 40° N. latitude. Associated with it were other southern species, from stalked barnacles to loggerhead turtles. From a single specimen sent from the Scillies by Major A. A. Dorrien Smith, Mr. Wilson was able to observe the rolling action of the pale blue pneumatophore, causing wetting of the pink crest in the water, the elongation of the dark blue dactylozooids, and the attachment of the purple gastrozooids to an unfortunate wrasse provided as food for the *Physalia*. This interesting account is illustrated by three of Mr. Wilson's superb photographs of the living animal.

Abstracts of papers published elsewhere, but written from Plymouth, and the report of the Council of the Marine Biological Association complete the volume.

N. B. Eales

NAPLES ZOOLOGICAL STATION

The director of the Stazione Zoologica di Napoli writes to say that the institute is now in full working order again. In 1947 there were fifty-seven visiting scientific workers, of whom nearly half came from countries outside Italy. There were visitors from America, Belgium, France, Great Britain, Greece, Holland, Hungary, Spain, Sweden, Switzerland and Turkey. This variety of guests and the very varied research work being carried on revives the characteristic feature of the institute as a 'permanent international biological congress' in which valuable new contacts are made, both personally and in the symposia which are held from time to time. Advantage of these new contacts has been taken by the staff in obtaining advice for refitting the various departments of the institute. Laboratory facilities have been not only restored but also improved; in this work help has been given by official bodies and learned societies, both in Italy and abroad, and also by the Rockefeller Foundation, the United Nations Educational, Scientific and Cultural Organisation and the International Union for Biological Sciences.

The research work done in 1947, as in the past, stretches the title 'zoological station' to the utmost, for it embraces the whole field of biology. The more familiar fields of ecological, histological and cytological investigations have been extended to the ultra-structure of cell components, and to experimental embryological investigations along new lines. Many workers were engaged on the analysis of behaviour in fish, *Octopus* and Crustacea. Biochemical investigations included studies on molluscan muscles, the metabolism of the electric organ of *Torpedo*, the chemical nature of respiratory pigments in ascidians and annelids and the active principles concerned in the fertilization of echinoderm eggs. These widely different researches were made possible by the variety of apparatus now at hand. In this connexion thanks are due to the Swedish Research Council and the Wenner-Grens Institut for help in obtaining freeze-drying apparatus (Flossdorf and Mudd) for the rapid fixation and dehydration of tissues at low temperatures *in vacuo*, and refrigerating units. These are very useful additions to the constant-temperature rooms recently installed for dealing with problems demanding special temperatures.

The library has been successful in filling the gaps caused by the War. It now contains some 45,000 volumes, including two hundred and fifty periodicals.

The boats used for collecting have been repaired and the regular supply of living material is assured.

The names of the following visitors show that the institute has regained its position as an international centre: J. and A. Runnström, with G. Lundblad as assistant (Wenner-Grens Institut, Stockholm); A. Bohus Jensen (Carlsberg Laboratory, Copenhagen); L. J. Mullins (Berkeley, California), all working upon the physiology and biochemistry of fertilization, partly with radioactive isotopes; S. Hörstadius (Uppsala), physiology of development in sea-urchin eggs; J. Z. Young and B. B. Boycott (University College, London), the behaviour of *Octopus* and effect of operation on the central nervous system; Miss E. M. Brown (Plymouth), parasitic Protozoa; Miss Helen Brown (Cambridge), protein skeletons in invertebrates; H. Nüesch (Basel), Echinodermata.

Intending visitors are asked to write to the Director setting out their requirements, since many of these are now likely to be met from apparatus in possession of the laboratory. Visitors should also communicate with him concerning apparatus of their own which they wish to bring, as the Director can arrange for exemption from duty at the local Customs. He can also give full information concerning arrangements for lodging; and of that characteristic feature of the institute, the 'mensa', which offers the two main meals of the day to visitors at reasonable prices.

ELECTRICAL STIMULATION OF THE NEUROHYPOPHYSIS IN THE CONSCIOUS ANIMAL

G. W. HARRIS (*Phil. Trans. Roy. Soc. Lond.*, B, **232**, 385; 1947) has devised an ingenious and successful method for electrical stimulation of the hypothalamus or neurohypophysis in the fully conscious rabbit.

A small secondary coil connected to two electrodes was placed between the scalp and the dorsal surface of the skull. The stimulating electrode, a fine insulated platinum wire, was passed through a plug accurately fitting a trephine hole of the skull down through the brain in the middle line until its bared tip lay in the hypothalamus or in the neurohypophysis itself. The indifferent electrode lay between the scalp and skull. The coil and electrodes were fixed in the animal at a preliminary operation, and after recovery the animal showed no ill-effects from the presence of the stimulating unit, indeed it appeared to be quite unconscious of it. Animals have lived up to three years with the unit in place.

A primary coil fed from the A.C. mains, when brought near the animal, energized the embedded secondary coil and so electrical stimulation of any desired intensity could be applied by remote control. Positive results, indicating activity of the neurohypophysis, were obtained when the electrode was in the supraoptico-hypophyseal tract or in the neurohypophysis itself. No results were obtained when the electrode tip was more than half a millimetre away from these structures. Stimulation for a period of 5–10 min. was shown to cause inhibition of a water diuresis and an increase of urinary chloride. In female rabbits, during natural or artificially induced œstrus, stimulation brought about a marked increase of uterine contraction, but little or no effect was observed in the anœstrous or pseudopregnant uterus. This is in conformity with the ordinary results of injecting posterior-pituitary extracts.

These results demonstrate clearly that the neurohypophysis in the normal animal can liberate a hormone or hormones which have antidiuretic and oxytocic activity. Particular interest attaches to the oxytocic effect; for, although the oxytocic action of posterior-pituitary extract has long been known as a pharmacological phenomenon, the demonstration that a natural hormone having oxytocic action is ever secreted by the neurohypophysis during life has hitherto been lacking.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Tuesday, May 11

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. C. B. Symes: "Control of Insect-borne Diseases in the Colonies—some Recent Progress and Future Prospects".

Royal Anthropological Institute (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Raymond Firth: "Religious Belief and Personal Adjustment" (Henry Myers Lecture).

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Institution of Civil Engineers (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. T. H. Seaton: "Coast Erosion and Sea Defence, with Special Reference to Problems on the East Coast of England associated with the London and North Eastern Railway"; Mr. C. R. Irving: "The Effect of Winds and Tides on Sea Coast Defence Works in North Wales".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. Ruddlesden, Mr. E. Forster and Mr. Z. Jelonek: "Carrier Frequency Shift Telegraphy"; Mr. J. A. Smale: "Some Developments in Communication Point-to-Point Radiotelegraphy".

Society of Public Analysts and other Analytical Chemists, Biological Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. A. A. Miles: "Biological Standards".

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.15 p.m.—Annual General Meeting; Mr. C. F. Budenberg: "Pressure Gauges with Special Reference to their Selection, Installation and Maintenance".

Wednesday, May 12

Geological Society (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Frederick Murray Trotter: "Devolatilization of Coal Seams in South Wales".

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Films illustrating various phases of the Petroleum Industry.

Institution of Electrical Engineers, Transmission Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. B. Calvert: "Transformer Economic Efficiency".

Wednesday, May 12—Thursday, May 13

British Ceramic Society, Refractory Materials Section (at the Institute of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-upon-Tyne)—Spring Meeting.

Thursday, May 13

Chadwick Public Lecture (at University College, Nottingham), at 4 p.m.—Sir Arthur MacNalty: "Advances in Preventive Medicine during the War of 1939–1945".*

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion on "The Orientation of Birds on Migratory and Homing Flights" (to be opened by Dr. D. H. Wilkinson and Dr. W. H. Thorpe).

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Annual General Meeting.

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Mr. I. A. Harris: "The Calculation of Electrode Temperatures in the Radio Valve".

British Institution of Radio Engineers, North-Western Section (in the Reynolds Hall, College of Technology, Sackville Street, Manchester), at 6.45 p.m.—Dr. W. E. Boyd: "The Wave Analysis of the Low Frequency Potentials of the Human Body".

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Symposium on "Reversal Development".

Friday, May 14

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. E. M. Gray: "Labour in the Cotton Industry".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

British Association of Chemists, Birmingham Section (at the University, Edmund Street, Birmingham), at 6.30 p.m.—Mr. J. F. J. Dippey: "Observations on the Strength of Organic Acids".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Ian Heilbron, F.R.S.: "The Role of Chemistry in Combating Tropical Diseases".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Head of the Horticultural Department, and a Horticultural Adviser and Lecturer (one Senior and one Junior post)—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (May 14).

Lecturer in Surveying in the Mining Department—The Registrar, The University, Leeds 2 (May 14).

Assistant Analyst—The City Analyst, 152 Great Charles Street, Birmingham 3 (May 15).

Research Awards in the Departments of Botany, Geography, Mathematics and Zoology—The Registrar, University College, Hull (May 15).

Assistant Lecturers (2) in Geology, with special qualifications in either mineralogy and petrology or stratigraphy—The Registrar, The University, Manchester 13 (May 15).

Lecturer in Psychology in the United College—The Secretary, The University, St. Andrews (May 15).

Leverhulme Studentships in Chemical Engineering—The Secretary, University College, Gower Street, London, W.C.1 (May 15).

Lecturer in Geography—The Secretary, University College, Gower Street, London, W.C.1 (May 19).

Lecturer in Physics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (May 19).

Assistant Lecturer (Grade III) in Geography—The Secretary and Registrar, The University, Bristol (May 22).

Lecturer or Assistant Lecturer in the Department of Geology—The Registrar, The University, Sheffield (May 22).

Assistant Experimental Officers in Scientific Establishments in various Government Departments—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2162 (May 27).

Lecturer in the Department of Fuel Technology, and a Research Assistant to the Professor of Fuel Technology—The Registrar, The University, Sheffield (May 29).

Superintendent of the Light Division of the National Physical Laboratory—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2154 (May 29).

Senior Lecturer in Theoretical Physics in the United College—The Secretary, The University, St. Andrews (May 31).

Principal Scientific Officer (at Waltham Abbey, Essex) with sound knowledge of chemical engineering and experience of plant design problems in organic chemical technology, and a Principal Scientific Officer (at Sutton Oak, Lancs.) with practical experience of chemical plant design, in the Ministry of Supply Research and Development Establishments—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2160 (May 31).

Principal Scientific Officer in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2159 (May 31).

Senior and Junior Fellowships—The Director, Atomic Energy Research Establishment, Harwell, Didcot, Berks (May 31).

Chemical Engineers as Experimental Officers in Ministry of Supply Establishments—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2161 (June 1).

Chair of Social Geography at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 3).

Lecturer in Agricultural Zoology, and Demonstrators in Agriculture, Agricultural Engineering, Botany, Zoology, Applied Chemistry, Poultry Husbandry, at the School of Agriculture, Sutton Bonington, Loughborough—The Registrar, University College, Nottingham.

Physicist to investigate, in collaboration with senior rheologist, physical properties of bovine secretions—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

Laboratory Steward in the Department of Applied Chemistry—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Lecturer to teach Zoology to B.Sc. generalstandard and to assist in teaching of Biology to first M.B. standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Technician (Grade B) in the Pathological Laboratory—The Area Pathologist, Musgrove Park Hospital, Taunton.

Lecturers in (*a*) Physics, (*b*) Botany (a senior appointment with some administrative responsibility), and (*c*) Zoology; Assistant Lecturers in (*a*) Physical Chemistry, (*b*) Physics, and (*c*) Zoology; Demonstrators in (*a*) Physics, (*b*) Botany, (*c*) Chemistry, (*d*) Geography, (*e*) Geology, and (*f*) Zoology—The Registrar, University College, Nottingham.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Other Countries

Sugar Research Foundation, Inc. Scientific Report Series. No. 1: Sugar and Sugar By-Products in the Plastics Industry. By Dr. Louis Long, Jr. Pp. 61. No. 2: Intravenous Sucrose Administration in Clinical Practice. By Dr. C. Jelleff Carr. Pp. 31. No. 3: The Utilization of Sugar Cane Bagasse for Paper, Board, Plastics and Chemicals; an Annotated Bibliography. Edited by Dr. Clarence J. West. Pp. 146. No. 4: Invertase; a Monograph. By Prof. Carl Neuberg and Dr. Irene S. Roberts. Pp. 62. No. 5: Sugars and Sugar Derivatives in Pharmacy. By Dr. Paul S. Pittenger. Pp. 53. No. 6: Bacterial Polysaccharides. By Dr. Taylor H. Evans and Dr. Harold Hibbert. Pp. 37. No. 7: Chemical Compounds formed from Sugars by Molds. By Dr. Bernard S. Gould. Pp. ix + 17. No. 8: Levulinic Acid as a Source of Heterocyclic Compounds. By Prof. Avery A. Morton. Pp. 28. (New York: Sugar Research Foundation, Inc., 1945–1947.) [2210

Sugar Research Foundation, Inc. Technological Report Series. No. 1: Patents on the Reactions of Sugars; a Digest. By Alvin Guttag. Pp. v + 108. No. 2: The Color Problem in Sucrose Manufacture. By Dr. F. W. Zerban. Pp. vii + 31. (New York: Sugar Research Foundation, Inc., 1947.) [2210

Sugar Research Foundation, Inc. Technological Report Series, No. 3: Wax and Fatty Byproducts from Sugarcane. By Robert T. Belch. Pp. vii + 62. (New York: Sugar Research Foundation, Inc., 1947.) [2810

Jamaica Medical Review. (Published annually). Vol. 1, No. 1, August. Pp. 81. (Kingston: Jamaica Medical Review, 95 Church Street, 1947.) 5*s*. [2810

The Eastern Anthropologist: a Quarterly Record of Ethnography and Folk Culture. (Published by the Ethnographic and Folk Culture Society, U.P.) Vol. 1, No. 1, September. Pp. ii + 48. (Lucknow: Universal Publishers, Ltd., 1947.) 3 rupees; annual subscription, 10 rupees, 20*s*. [511

Biological Antioxidants. Transactions of the First Conference, October 10–11, 1946, New York. Edited by Cosmo G. Mackenzie. Pp. vi + 82. (New York: Josiah Macy Jr. Foundation, 1947.) 2 dollars. [1011

Conference on Metabolic Aspects of Convalescence. Transactions of the Thirteenth Meeting, Naushon Island, Woods Hole, Mass., June 10–11, 1946. Edited by Dr. Edward C. Reifenstein, Jr. Pp. ii + 232. 2 dollars. Transactions of the Fourteenth Meeting, New York, November 12–13, 1946. Edited by Dr. Edward C. Reifenstein, Jr. Pp. ii + 190. 2.25 dollars. (New York: Josiah Macy Jr. Foundation, 1947.) [1011

Indian Association for the Cultivation of Science. Special Publication No. 11: Petroleum Resources of India. By D. N. Wadia. (Based on the Lectures delivered on the occasion of the Award of the Joykissen Mookerjee Medal, 1945.) Pp. v + 34. (Calcutta: Indian Association for the Cultivation of Science, 1945.) [2011

The Theory of Valency and the Structure of Chemical Compounds. By Sir P. Ray. (Cooch-Behar Professorship Lectures for 1941.) Pp. vii + 82. (Calcutta: Indian Association for the Cultivation of Science, 1946.) [2011

Journal of the Science Club, Calcutta. Vol. 1, No. 1, August. Pp. ii + 38. (Calcutta: Science Club, 1947.) 2 rupees; annual subscription, 7.8 rupees. [2011

All Necessary Water can be Synthesized within the Plants. By Nandlal Sharma. Pp. 16. (Khamgaon P.O.: The Author, 1947.) [112

The Hypothesis of the Gene-Symbiosis and its Importance in the Explanation of the Origin of the Gamic Reproduction. By Nils Aall Barricelli. Pp. 10. (Oslo: Cammermeyer's Boghandel, 1947.) [112

Carnegie Institution of Washington. Publication 572: Endocrines and Constitution in Doves and Pigeons. By Oscar Riddle. Pp. xi + 306. (Washington, D.C.: Carnegie Institution, 1947.) 3 dollars. [412

Catalogues

From Alchemy to Chemistry and Pharmacology; History of Photography. (Catalogue 10). Pp. 46. (London: E. Weil, c/o Nationa Provincial Bank, 9 Market Place, N.W.11, 1947.)

A Catalogue of Books and Periodicals relating to Mathematics, Physics and Allied Sciences. (No. 644). Pp. 36. 6*d*. A Catalogue o Books and Periodicals on all branches of Zoology, Geology, Palaeontology and Botany. (No. 650). Pp. 104. 6*d*. (London: Bernard Quaritch, Ltd., 1947.)

A Catalogue on Books on the Arts, with a selection of examples o Modern Fine Printing. (Catalogue No. 686). Pp. 90. (London: Francis Edwards, Ltd., 1947.)

New Designs of 'Gallenkamp' Laboratory Furnaces. (Publicatio No. 510.) Pp. 2. (London: A. Gallenkamp and Co., Ltd., 1947.)

Standard Specifications and Typical Analyses: Metals, Metalli Alloys and Carbides. (Booklet PM. 2.) New edition. Pp. 16. (Rainham Murex, Ltd., 1947.)

Rhodium: Engineering Properties and Uses. (Publication 2053. Pp. 8. (London: Johnson, Matthey and Co., Ltd., 1947.)

Sunvic Hotwire Vacuum Switches. (Publication VS. 10a.) Pp. 16 (London: Sunvic Controls, Ltd., 1947.)

A Selection of Books illustrating the Spirit of the Renaissance (Catalogue 8.) Pp. 60. (New York: Herbert Reichner, 34 East 62n Street, 1947.)

The Phantomyser Clears the Air. Pp. 20. (London: Aerosols, Ltd. 1947.)

Fibreglass and Electrical Insulation. Pp. 28. (Glasgow: Fibreglas Ltd., 1947.)

Selenium SenTerCel Rectifiers. (Bulletin SRG. 1.) Pp. 56. (London Standard Telephones and Cables, Ltd., 1947.)

Metal Powders for Welding Electrode Manufacture. Pp. 4. (Rainham: Murex, Ltd., 1947.)

A Catalogue of Books, Autograph Letters, Atlases and Map (Catalogue No. 687.) Pp. 114. (London: Francis Edwards, Ltd. 1947.)

Marmite Yeast Extract in Medicine and Dietetics. New edition Pp. 16. (London: Marmite Food Extract Co., Ltd., 1948.)

NATURE

No. 4099 SATURDAY, MAY 22, 1948 Vol. 161

CONTENTS

Page

National Parks in Britain . . . 783
Cosmic Rays. By Prof. T. G. Cowling, F.R.S. . . . 785
The Story of Jade . . . 786
Physical Planning in the South-West of England. By Prof. L. Dudley Stamp . . . 786
Algebraic Geometry. By Prof. H. T. H. Piaggio . . . 787
Private Lives of the Alchemists. By T. I. W. . . . 787
Contact Laminated Plastics. By J. M. J. Estevez . . . 788
Dermatology. By Dr. James Marshall . . . 788
Human Factors in Industry : Conference at Leamington . . . 791
Scientific Radio. By Dr. R. L. Smith-Rose . . . 793
Problems of Tidal Biology. By Prof. C. M. Yonge, F.R.S. . . . 796

Obituaries :

Prof. G. H. Hardy, F.R.S. . . . 797
Dr. Thomas Stephenson. By V. S. Summerhayes . . . 799
News and Views . . . 799

Letters to the Editors :

Branched-Chain High Polymers.—Prof. H. W. Melville, F.R.S., and G. W. Youngson . . . 803
Catalytic Poisons and Magnetic Susceptibility.—M. H. Dilke, Dr. D. D. Eley and Dr. E. B. Maxted . . . 804
Synthetic Pentapeptides Related to Gramicidin-S.—J. I. Harris and T. S. Work . . . 804
Reversion : a New Procedure in Absorptiometry.—Dr. H. Irving, G. Andrew and E. J. Risdon . . . 805
Gases Liberated from Explosions Initiated by Impact.—Dr. A. J. B. Robertson and A. Yoffe . . . 806
'Semaphore' Numerals.—Prof. W. G. Bickley . . . 807
Angular Distribution of Radioactive Disintegration Products.—J. A. Spiers . . . 807
Capture of Negative Mesons by Nuclei.—A. S. Lodge . . . 809
Cloud Chamber Investigation of Straggling of Short-Range Particles Produced by Slow Neutron Reactions.—Dr. J. K. Bøggild . . . 810
A Doubly Charged Cosmic Ray Particle.—A. B. Sahiar . . . 811
Interpretation of Data from Electrical Resistivity Geophysical Surveys.—J. M. Hough . . . 812
Annealing of Glass.—Dr. G. O. Jones ; S. M. Cox . . . 813
Failure of Adrenal Cortical Extracts to Cause Lysis of Living Lymphocytes *in vitro*.—J. S. Robertson . . . 814
Formation of Oxime-Nitrogen in *Torula*-Yeast Fed with Potassium Nitrate.—Prof. Artturi I. Virtanen and Tihamér Z. Csáky . . . 814
Bacterial Hydrolysis and Utilization of Polysaccharide-like Substances ('Mucin') in Saliva.—Dr. H. J. Rogers . . . 815
A Possible Relation Between the Action of Clover Juice on Isolated Muscle and 'Bloat' in Cattle.—W. S. Ferguson . . . 816
Pharmacological Activities in Different Rodent Species of *d*-Tubocurarine Chloride and the Dimethyl Ether of *d*-Tubocurarine Iodide. By Dr. H. O. J. Collier, Sheila K. Paris and Dr. L. I. Woolf 817
The Flow of Glaciers. By J. F. Nye . . . 819
Progress in Artificial Illumination . . . 821
Planktonic Copepods and Hydrocorals of the John Murray Expedition 822
The Electricity Grid in Great Britain. By R. W. Haywood . . . 822
Mosses as Soil Indicators . . . 823

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NATIONAL PARKS IN BRITAIN

THE intimation by the Lord President of the Council in the House of Commons on April 29 that the Government has at long last agreed in principle to establish a Nature Conservation Board and a Biological Service under the auspices of the Agricultural Research Council is both welcome and reassuring. It is not merely that the scientific community has the satisfaction of seeing the principal scientific recommendations of the Conservation of Nature reports accepted. By implication, some effective action must be contemplated in regard to Nature reserves, and possibly national parks also, if the proposed Biological Service is to have an adequate field of work. The statement was the more welcome because earlier replies, given in the House of Commons on April 8 and during a debate on the same day in the House of Lords, gave the impression that the Government was hesitating to take a decision.

Following its recommendation that the prime charge of national parks should be given to a specific central authority, in the form of a National Parks Commission, under the parliamentary responsibility of the Minister of Town and Country Planning, the National Parks Committee recommended that the committee set up for each national park should be designated the local planning authority for that area. The park committee would thus replace the county council or councils in whose area the park lay for the purposes of planning and controlling development, although any important conflict between local and national interests which the park committee could not resolve would be referred to the Minister for his decision. The Hobhouse Report further recommended that the chairman and half the other members of each park committee should be appointed by the National Parks Commission and the other half by the county council or county borough councils whose administrative areas fell wholly or partly within the national park.

Uneasiness, not to say dissatisfaction, has already been manifested in the frequent disputes concerning the land requirements of the Services over the Government's failure either to appoint a National Parks Commission or to take any decision concerning the areas to be designated as national parks. It now appears that the Government has decided on the appointment of a National Parks Commission; but the position with regard to the Hobhouse proposals on local organisation and planning still awaits clarification. Lord Henderson's statement in the House of Lords was not altogether clear; on the ground of the general planning system of the country being in a state of evolution and of the much higher standard of planning anticipated, especially in rural areas, under the new planning authorities set up under the Town and Country Planning Act, 1947, he seemed to commit the Government to accepting the county councils as planning authorities responsible for the national parks, to the exclusion of any National Parks Commission which may be established.

It will be recognized, as was emphasized in the debate, that under the Hobhouse proposals some counties would lose a third or more of their area—one of them more than three-quarters; indeed, some ten per cent of the total area of England and Wales would be affected. It will never be easy to strike the right balance between the different interests—even different national interests—concerned; but the whole trend of the debate in the House of Lords indicated the immense amount of goodwill and the general desire to reconcile interests which might sometimes clash. But no one who has followed, however superficially, the discussions in recent years on local government reform will be satisfied that, if a National Parks Commission has no hand in the planning of these areas, there is no danger that some county councils will allow particular local interests, whether farming, mining or building, to destroy altogether the scenic and amenity interest which is the mainspring of the whole idea of national parks.

Lord Henderson's inability to forecast either the date or the extent of future legislation on this matter was very disappointing in spite of his reference to the hope expressed by the Minister of Town and Country Planning that it would be possible to introduce such legislation during the life-time of the present Parliament. His statement would have been more convincing had he shown some appreciation of the fact that, in making its proposals, the Hobhouse Committee very clearly recognized that it is essential to preserve and to extend the means for the expression of local views and for maintaining local interest. The conception on which its policy and proposals for national parks are based is dynamic and not static, as Lord Henderson implied. The Hobhouse Committee, while emphasizing the importance of national control and a national policy, and that the central management and development of national parks and Nature reserves must be planned from the start in adjustment with other essential interests in the land, such as agriculture, forestry, water supply, communications and building, was equally insistent on the importance of enlisting local knowledge and experience, and encouraging and maintaining local interest and co-operation.

In the absence of any indication that the Government intends to give a National Parks Commission real authority as distinct from merely advisory functions, there is every reason to believe that the county councils will be so firmly entrenched in the proposed national park areas that it will be difficult, if not impossible, to secure for any such Commission a preponderant voice in the planning of the parks. Harm may already have been done to areas of exceptional beauty that will be beyond the power of the wisest and ablest management to repair. Furthermore, if the Minister of Town and Country Planning deals with the whole matter under the Planning Act, as Lord Henderson more or less implied he proposes to do, there will not be unity of control even within such important areas as those proposed for the Lake District and the Peak, which are themselves within the boundaries of several planning authorities.

It is clear from this debate that a coherent system of national parks in Britain is by no means assured, and that little effective may remain of the recommendations which last year received such a friendly welcome from public opinion. No Government could have had at its disposal a greater volume of expert advice and of objective study in these matters. In spite, however, of something approaching its intense activity in the nationalization of industry, the Government is singularly indifferent to the dangers of drift and of unco-ordinated action in matters affecting the utilization of the land, and seems reluctant to insist on the national control that is imperative and has been urged by such impartial authority. Even in the matter of Service land requirements, the Government has consistently ignored the need for providing some means for overall review and for avoiding piecemeal encroachment on other national interests. Both in the White Paper on the "Needs of the Armed Forces for Land for Training and Other Purposes", and in debates in the House of Commons on specific proposals, Government spokesmen have studiously avoided giving any positive reply to direct questions regarding national parks and National Trust property.

The case for a National Parks Commission with full statutory powers, and the importance of the time factor in this connexion, was ably put by Lord Merthyr in opening the debate. Quite apart from the question of Service lands, mineral developments, afforestation and hydro-electric power or water-supply developments, it may well be too late, as Lord Merthyr observed, if we wait until the building restrictions are lifted before establishing national parks. Lord Merthyr was ably supported by Lord Samuel and others, and while Lord Rochdale and Lord Roborough in particular advocated use of the planning organisation laid down in the Town and Country Planning Act, 1947, it was generally recognized that means must be found for securing the co-operation of local communities and authorities in order to achieve the national purpose, whatever degree of authority is given to a National Parks Commission.

Some of the criticism of the Hobhouse Reports as well as of the Huxley Report on the conservation of Nature in England and Wales and the reports of the Scottish National Parks and Wild Life Preservation Committees suggested that the speakers have not studied these reports with sufficient care. Despite some differences in several recommendations, they all agree as to the necessity for a national policy and control, and that a national parks policy must be considered in relation to other national interests affecting the use of the land and the exploitation of natural resources. Nor could the importance of securing local understanding and support be better urged than throughout the reports. Lord Robinson, and with him Lord Hylton, may have been right to suggest in the debate that further consideration should be given to the use of the land for agriculture and other purposes in our present economic position; but the suggestion that the Hobhouse Committee had overlooked such considerations, and had taken a static view of the question likely to lead to sterilization of the areas to be allotted as national parks, is surely inaccurate.

What is clear from the debate, as from the reports, is that the balance between national needs in respect of land for agriculture, water supply, afforestation, minerals and the like must be struck at the national level, and not piecemeal by either departmental, local or sectional interests. The proposed National Parks Commission can make a vital contribution in arriving at that balance, from the point of view of amenities, the preservation of wild life and scientific interests. Furthermore, the whole trend of Lord Roborough's remarks indicates, as Lord Methuen quickly noted, that even in such an extreme case as that of Devon and Dartmoor, there should be little difficulty in reaching an agreed solution under the Hobhouse Committee's proposal, and securing the efficient and whole-hearted co-operation of the county council in the planning and management of the national park.

Nothing in the debate, therefore, warrants further delay on the part of the Government in the creation of a National Parks Commission or in determining the areas of the parks themselves. On the contrary, the debate gave clear warning to the Government of the dangers of delay, and of the shock that public confidence in its good faith in this matter has already received. The Government has taken care in many matters to provide itself with expert and impartial advice. Failure to act on such advice, above all in matters which are not the subject of party controversy, and where, as in the matter of the Huxley Report and those of the Hobhouse Committee, inaction itself prejudices the issue, must react adversely on the understanding and good relations which the Government has often been at pains to foster with the scientific community.

COSMIC RAYS

Cosmic Rays

By L. Jánossy. (International Series of Monographs on Physics.) Pp. xiii+424. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 35*s*. net.

THE study of cosmic rays is one to which scientific men in very many countries have contributed materially. It is therefore fitting that the book under review should have something of an international character: its author, Prof. L. Jánossy, came to Britain from the Continent, and spent several years at Manchester before taking his present post at the Dublin Institute for Advanced Studies.

Most of the book was written during the last years of the War, when, because of the slowing down of cosmic-ray research, a comprehensive view of the whole subject was more readily attainable than in more normal times. The author has given a reasonably complete picture of the state of the subject as it then was. All the material to be found in reports and books published before the War is here also: experimental work on transition effects, showers, cosmic rays at great heights or depths, and the influence of the geomagnetic field. In addition, more ecent work is also reported, such as that on the properties and life of the meson, and on extensive and penetrating air showers. The recent work at Bristol, using photographic methods to investigate meson behaviour, is briefly reported in an appendix.

The book is an experimenter's book; experimental physicists would, however, have grounds for grievance if the impression were given that it was simply an experimenter's book. While much time is spent on the observations, and an important chapter is devoted to experimental technique, a large part of the book is devoted to the theory needed in interpreting the observations. A relativistic theory of collisions is given, for, without going into relativity, even a qualitative interpretation of cosmic rays is impossible. In discussing radiation, semi-classical methods are used: where quantal results are needed, they are quoted without proof, with an indication of their relation to the corresponding classical results. A few hints on meson theory are given, but only enough to whet the appetite. The theory of cascades is discussed in detail: in this, the author plunges fearlessly into Laplace transforms, and the evaluation of complex integrals by residue and saddle-point methods. In the chapter on geomagnetic effects, Störmer's theory of the forbidden cone is set out; and statistical ideas necessary in interpreting the experiments are explained in another appendix.

But theory to Jánossy means a useful adjunct to experiment, not speculation. He comes closest to speculation in introducing the sun's magnetic field. In so far as the book has a guiding thread running through it, it is that the primaries giving rise to observed cosmic rays have a momentum spectrum given by an inverse power law, cut off at the low-energy end by an agency supposed to be the sun's magnetic field. But the inverse power spectrum cannot, in any event, extend to low energies, since it would give an infinite number of low-energy particles, and one wonders whether the energy cut-off need be so sharp as Jánossy suggests; and the properties and precise magnitude of the sun's field are still open to some doubt.

A book discussing so wide a range of subjects as the present cannot fail to be difficult. Unfortunately, the author has made it harder than need be. The style is very variable: while fluent in some places, in others it is disjointed and crabbed, and there is little to suggest the excitement which first attended the discovery of the positive electron and the meson. Needless repetitions abound: the first (historical) chapter is the worst in this respect. The author seems not always clear how much prior knowledge to assume; the first chapter is scarcely intelligible unless one already understands something about transition effects, coincidences, Geiger counters, positive electrons and mesons, all discussed in detail later; while in the middle of Chapter 6, after already giving long chapters on the general properties of cosmic rays and on meson decay, the author suddenly says, in a Micawber-like burst of confidence, "Photographs . . . show clearly that the cosmic rays consist of two groups of particles: (1) penetrating particles, (2) electrons". Altogether, one feels that the book could have been improved considerably by due care in arrangement.

Nevertheless, the author has taken great pains to ensure that the book is as comprehensive as possible, and has succeeded in bringing together and correlating a large mass of useful information. There is little doubt that it will be indispensable to research workers, and will serve to stimulate further the growing interest in the subject. T. G. COWLING

THE STORY OF JADE

Adventure in Jade

By James Lewis Kraft. Pp. ix+81. (New York: Henry Holt and Co., 1947.) 3.50 dollars.

JADE was used for ornaments and tools by the native peoples of Mexico, Central America and Peru, by the Indians of British Columbia, and by the Eskimos. The source of the jade was something of a mystery. In the absence of any known sources—either of nephrite or jadeite—on the American continent, it was supposed, up to ten or twenty years ago, that the jade used by the Eskimos and also that of the Maya and other Central and South American peoples had been brought in from Asia. Of late years, however, some localities for jade have been found in the United States, and Mr. J. Lewis Kraft tells the story of these discoveries.

The subject of the book is of particular interest to Americans not only because of this problem of the origin of the ancient worked articles of jade, but also because there has grown up in the United States a widespread and very active interest in all kinds of semi-precious stones. All over the country there are now local societies and clubs the common interest of which is the search for semi-precious stones and the fashioning of these stones into cabochons and faceted stones for collection specimens or jewellery. Many amateur lapidaries have acquired great skill at this work, and Mr. Kraft is one of these.

His book is not deeply scientific. It is the story, simply told, of how a very busy man found an absorbing interest in jade and the fashioning of it with his own hands into pieces for his collection, presents for his friends, and jade rings as awards for merit to his "fellow workers at the Company". There is much of legend and folk-lore in the book and tales of miners and prospectors and their finds. The author has encouraged or persuaded several prospectors to search for jade, giving them fresh clues to follow or urging them to penetrate to such remote regions as Jade Mountain in Alaska, discovered by George M. Stoney so far back as 1886 but scarcely ever visited since. In Wyoming, nephrite was found near Lander in 1931, and two other occurrences in that State are recorded in this book. An immense boulder weighing 2,490 lb. from Crooks Mountain, fifty miles south-west of Lander, was removed under the author's supervision, transported to Chicago and presented to the Natural History Museum there in 1944.

Ten years ago Pabst's "Minerals of California" contained no record of jade; now the author describes four localities in California from which he has obtained good nephrite. The story of one of these finds reads like the discovery of the first diamond in South Africa. In 1880 a hunter after sea lion entered a cave on the coast of Monterey County. Finding the cave-floor covered with shining green pebbles, he took some home. Fifty or sixty years later a visitor to the hunter's home noticed the children, grandchildren of the hunter, playing with the pebbles. Being interested, he took some back to Stanford University. They were identified as nephrite, and afterwards an enterprising search resulted in the rediscovery of the cave and the recovery of some of the nephrite pebbles and boulders which strew its floor.

It seems that at all these Californian localities the jade is nephrite, so the source of the jade used by the Mexicans, which is largely jadeite, is still to be found. One feels sure that Mr. Kraft will leave no stone unturned until he solves this problem too.

Special care has been taken in the design and type for this book, and the result is a fine example of modern printing. All the royalties will go into a charitable trust.

PHYSICAL PLANNING IN THE SOUTH-WEST OF ENGLAND

Devon and Cornwall

A Preliminary Survey. A Report issued by the Survey Committee of the University College of the South-West, Exeter. Pp. iv+318. (Exeter: A. Wheaton and Co., Ltd., 1947.) 31*s*. 6*d*. net.

IN the provisions of the Town and Country Planning Act, 1947, Britain is committed to the planning of the use of every acre of its land surface, and the county authorities become the primary planning authorities. They are required to put forward their proposals for the approval of the Minister within a brief space of time, and there is a very real danger that far-reaching decisions on policy will be taken with a totally inadequate foundation of factual knowledge. It is therefore of the utmost importance that surveys such as this volume on Devon and Cornwall should be undertaken and made available at the earliest possible opportunity. There is an obvious advantage in such work being undertaken by independent groups with no preconceived points of view and with no axe of their own to grind.

Like the survey of Herefordshire previously issued by the West Midland Group, this survey of the south-west has been undertaken by a representative survey committee, headed by the principal of the University College of the South-West, Exeter, and including both members of the College and experts from outside. The result is a comprehensive account, well documented, adequately provided with statistical information and with a number of excellent maps and diagrams covering the two counties. Published or other documentary material has been supplemented from the results of field surveys, notably one carried out by groups from the College in 1944. Particularly instructive are the attempts to show on a cartographical basis the spheres of influence of the urban centres in these two rural counties. In places the point of view is that of the townsman visiting the country rather than that of the dweller in the village, and it would be possible to criticize in detail some of the maps, as well as some of the information, particularly regarding that rather remote area of north-east Cornwall and adjoining parts of Devon, where the text and maps suggest a stagnation of social life rather far from the experience of those who know the area intimately from within.

There is no indication as to the authorship of the individual sections, and one wonders whether the general conclusions of the excellent first section on population are those of the whole group or of the individual responsible, especially when one reads "The whole emphasis should be on providing the country with the amenities of the town". Further the separate contributions tend to be distinct essays rather than a connected whole. Whereas some summarize published information, others contain much original material. The section on climate is inadequate; that which deals with fisheries is excellent in its scope and treatment, though it is difficult to understand why there should be no recorded landings of fish at Bideford, which in pre-war years was a favourite resort on market days of those who bought their fish fresh from the fishermen on the quayside.

Apart, however, from such minor criticisms, there can be nothing but praise for a volume which embraces such a wide field and which presents in small compass a collection of facts absolutely invaluable and essential for all planning work.

L. Dudley Stamp

ALGEBRAIC GEOMETRY

Foundations of Algebraic Geometry

By Prof. André Weil. (American Mathematical Society: Colloquium Publications, Vol. 29.) Pp. xix+288. (New York: American Mathematical Society, 1946.) 5.50 dollars.

ALGEBRAIC geometry, in spite of its beauty and importance, has long been reproached for lacking proper foundations. Great discoveries have been made, especially in Italy, by the intuition of a number of gifted workers, whose insight had been cultivated by a careful study of special cases. But the time for placing the subject on a firm foundation is long overdue, and the delay is seriously hampering progress. For the last twenty years a few geometers, such as Severi, van der Waerden and Zariski, have made important contributions towards this end. Now Prof. Weil has given a connected and comprehensive account of his own and other researches, sufficient to justify the use of intersection-multiplicities, which play such a large part in recent geometry, especially in Italian work. The book is not easy reading, especially for those to whom geometry is synonymous with space-intuition. At a first glance the reader might imagine that it is a treatise on something like abstract algebra. Indeed, the author warns the reader that it is necessary to have a good elementary knowledge of abstract fields and of other topics that will be found in van der Waerden's "Moderne Algebra". Apart from this the book is self-contained, and its subject is not abstract algebra, but what might be called abstract geometry.

The first three chapters are preliminary; they state and prove all the purely algebraic results required. In particular, Chapter 3 gives the crucial theorem on the multiplicity of a proper specialization. Geometric language is introduced in Chapter 4, which deals with algebraic varieties in affine spaces. Chapters 5 and 6 contain a careful and detailed treatment of intersection-multiplicities.

Chapter 7 extends the definitions and results of previous chapters to 'abstract varieties'. It also translates the main results of intersection theory into a new language, the 'calculus of cycles', which is particularly well adapted to applications. The author points out the confusion that has arisen by the use of ambiguous terms, and endeavours to do away with this by introducing new terms such as 'bunches of varieties' and 'cycles' instead of the single term 'reducible variety' used in two different senses. The term 'variety' is reserved for 'absolutely irreducible algebraic varieties'. An algebraic calculus of cycles can then be developed, closely analogous to the algebra of homology-classes as used in modern topology.

Chapter 8 gives a detailed treatment of the theory of divisors on a variety. Chapter 9 contains general comments on the preceding work, formulates problems, some of considerable importance, and in some cases makes suggestions which may lead to their solution.

H. T. H. Piaggio

PRIVATE LIVES OF THE ALCHEMISTS

The Alchemist in Life, Literature and Art

By Prof. John Read. Pp. xii+100+30 plates. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1947.) 10s. 6d. net.

THE practical operations of the alchemists and their main theoretical beliefs are familiar, in outline at least, to every student of chemistry. The chemical historian may be as familiar with alchemical technique and ideas as the average chemist is with the modern technique of his science. Few, however, have any clear picture of the alchemist as a human being, an individual with a private as well as a professional life. This picture has been skilfully and entertainingly drawn by Prof. John Read in the book under notice, and there are not many, either men of science or laymen, who will not derive both pleasure and profit from reading this scholarly little work.

As the title indicates, Prof. Read draws his material from three main sources. First, there are alchemical biographies, unfortunately all too few, such as Thomas Norton's "Ordinall of Alchimy" and Simon Forman's personal diary. Second, there are the artists who sought inspiration in alchemical themes and have left us invaluable records of the appearance of alchemical laboratories and those who worked in them. Outstanding among these was David Teniers the Younger, to whom the author appropriately dedicates his book. Finally, there are the writers who introduce alchemists and their assistants as characters in their works. Few modern chemists would regard Chaucer's "Canon's Yeoman's Tale" as an important piece of alchemical literature without Prof. Read's skilful analysis and apt quotation. He shows that, in fact, this tale contains a vivid picture of both the charlatan alchemist—the mere puffer or bellows-blower—who will stoop to selling a fake formula to a credulous priest, and also of the genuine alchemist who, even if his ideas are coloured by the hope of discovering the Philosopher's Stone, is, in fact, a serious seeker after knowledge.

As we may expect, the alchemist in his private life conformed to no particular type in mind or body. We have the libertine Forman, for ever guiding his amorous ventures by reading special mystical meanings into the events of his daily life; the cheating Subtle, in whom Jonson holds up to shame and ridicule the alchemical charlatans of his time; the melancholy and frustrated beings portrayed by Dürer and Teniers; the fanatic in threadbare clothes with complexion of "wan and leden hewe" after long hours at the furnace, ignoring the pleas of his starving family; and that fantastic international adventurer Seton, the "martyr of alchemy".

Publisher and author are to be congratulated. After several years of austerity productions, it is a pleasure to take up a book which is so attractively printed and so well illustrated (with the exception of the frontispiece in colour). This attention to detail extends even to the dust-cover, which is of a very pleasing design. T. I. W.

CONTACT LAMINATED PLASTICS

Low-Pressure Laminating of Plastics

By J. S. Hicks, assisted by R. J. Francis. (Reinhold Plastics Series.) Pp. ix+162. (New York: Reinhold Publishing Corporation, 1947.) 4.50 dollars.

THIS small book is to be welcomed as it is the first devoted entirely to the new techniques for moulding by laminating under comparatively low pressure. Starting with the almost inevitable definition of plastics, and disposing of all but the polyesters and related resins in little more than half a page, the author proceeds to describe the moulds used, the resins available, the procedures followed, the finishing of the objects made and the commercial aspects of these new methods. One excellent feature of the book is the large number of photographs illustrating both the stages in production of mouldings and the types of objects that result from them. Since manufacturers are frequently in doubt as to the type of goods for which low-pressure methods are suited, and it is presumably to manufacturers that the book is addressed, the book will serve a useful purpose in bringing home to industry the considerable scope offered by these new methods.

It is, therefore, all the more to be regretted that the book has been written so uncritically and in such a turgid manner. In almost every case where a number of alternative procedures are possible, they are enumerated without the outstanding merits or limitations of any one being considered. Plaster moulds have their advantages, but one could forgive a reader of Chapter 2, new to the subject, wondering why metal moulds are ever considered when plaster is available. Again, the lists of references are formidable and appear to contain all the important papers up to mid-1946, but they are so cluttered up with the titles of papers which were never worth the publishing that much of their value is dissipated.

Many subjects are treated in unexpected places, and the text abounds in irrelevant matter that makes reading difficult.

It is not surprising that the author, coming from Owens Corning Fiberglass Corporation, should devote most of his space to glass fibre cloth laminates, since this company has played a very important part in developing these techniques and is completely responsible for launching several of them; but the title suggests a wider field. Other materials are mentioned but are not given the importance they deserve. To-day more than half the supply of contact resins in the United States goes with paper to the making of continuous laminated sheet. This was not so in 1946, yet even at that time the process deserved a better fate than that of being treated under the heading of 'post forming' and being illustrated by such an inadequate and inaccurate diagram.

The book can be recommended to the people for whom it was written because it is the only one in the field and because there is a need for such a book. To these it will prove well worth its purchase price.

J. M. J. ESTEVEZ

DERMATOLOGY

Modern Trends in Dermatology

Edited by Dr. R. M. B. MacKenna. Pp. xiv+432. (London: Butterworth and Co. (Publishers), Ltd., 1948.) 42s. net.

THIS book might serve as an obituary notice to descriptive dermatology. The only chapter in which description of lesions is a feature is that by Dr. F. Parkes Weber on "Necrobioses, atrophies, scleroses, infiltrations and accumulations in the skin and subcutaneous tissue". It is not implied that the descriptive studies of the past, brought to perfection by Brocq and his followers, can in future be ignored. Without the ability properly to classify skin diseases from a knowledge of surface and cellular anatomy of lesions the practice of dermatology is impossible.

Classification of skin diseases is now becoming clearer and the general trend in dermatology is, as demonstrated in this book, towards biochemical, pathological and bacteriological investigation on a scale never before contemplated. Descriptive dermatology is not yet complete, however, and there might profitably have been included descriptions of such items, apparently unknown or unrecognized in Britain, as Gougerot's syndrome and Koenen's tumours (found in some cases of epiloia). It is a pity that British dermatologists are not provided with any survey of world literature comparable with that available to the French in the admirable abstracts in *Les Annales de Dermatologie et de Syphiligraphie*.

Dr. MacKenna refers in his introduction to the fact that rare diseases receive much more study than do the common ones. His point is confirmed in the book, where the only common conditions fully discussed are the 'seborrhœic' eruptions (by Dr. H. W. Barber).

The widening scope of dermatological research and practice is indicated by chapters on "The Prevention of Cutaneous Diseases, excluding Industrial Maladies", by Prof. F. A. E. Crew; "The Rehabilitation of Patients Suffering from Cutaneous Disease", by Dr. F. F. Hellier; and "Psychological Aspects of Dermatology", by Dr. E. Wittkower. This last chapter is the best short account of the problem of neurodermatosis that I have read. Another outstanding chapter is that by Dr. L. Schwartz on "Occupational Dermatoses".

Dr. MacKenna is to be congratulated on his choice of collaborators, British and American, who have produced an excellent review of the modern trends and advances in dermatology. It is to be hoped that its success will merit further editions on the same lines as the need arises.

My only criticism is that there is no mention of that common skin disease, syphilis, which, in Britain, has become almost divorced from dermatology. Dermatology could be learnt from a study of syphilis and its differential diagnosis, and the dermatologist who does not know all about syphilis—and this is not rare—cannot be a master of his art.

JAMES MARSHALL

Electrons (+ and −), Protons, Photons, Neutrons, Mesotrons and Cosmic Rays

By Robert Andrews Millikan. Revised edition. Pp. x+642. (Chicago: University of Chicago Press; London: Cambridge University Press, 1947.) 30*s.* net.

THIS book is a revised and enlarged edition of Prof. Millikan's book "Electrons" which appeared in 1935, and was itself based on his celebrated work "The Electron" (1917), which in its day occupied a unique position in the literature of atomic physics. It is pleasing to note that the early chapters of the new edition still conform closely to the text of "The Electron", for they contain one of the few accurate accounts in English of the early history of the measurement of the atomic charge. The first fifteen chapters are essentially the same in the new edition as in the 1936 edition, except for emendations to the text, the most important of which is to the value of the atomic charge as obtained from observations of falling drops. This now appears as $e=4{\cdot}807\times10^{-10}$ E.S.U. It is also stated that the value $e=4{\cdot}803\times10^{-10}$ E.S.U. obtained from a comparison of X-ray diffraction from a ruled grating and a crystal lattice is the more precise.

The book is essentially a text on modern atomic physics with special emphasis on the discoveries of the various fundamental particles, and of cosmic rays. The new edition differs from its predecessors in giving more recent information in five additional and valuable chapters, which include a brief discussion of the utilization of nuclear energy and its international control.

The material is everywhere clearly and vividly presented with many illustrations, but the use of the first person singular throughout has rendered it difficult for the author always to give the impression of that scientific detachment which is desirable in an introductory text. L. G. H. Huxley

British Sources of Reference and Information

A Guide to Societies, Works of Reference and Libraries. Compiled under the direction of a Committee of ASLIB and edited by Theodore Besterman. (Published for the British Council.) Pp. vii+56. (London: Association of Special Libraries and Information Bureaux, 1947.) 6*s.*; to ASLIB members, 5*s.*

THIS useful desk tool could have been much more useful had its scope been limited and the defined objectives kept closely in mind. The accounts of the National Central Library, the copyright libraries and library organisations are admirable and adequate, though the references to the Association of Special Libraries and Information Bureaux itself and to the British Society for International Bibliography are already out of date. The sections covering the university libraries and the public libraries of Britain are also adequate although some expansion would have been welcome, particularly as Colonel Newcome's book and the "Yearbook of Learned Societies" are out of print. It is the 'select' list of special libraries that is most open to criticism. No attempt is made to indicate the basis of selection, but while it may be pardonable to omit St. Deiniol's Gladstone Memorial Library at Hawarden, it is difficult to know what to make of a list which omits, for example, the John Ryland's Library in Manchester or the libraries of the Manchester and of the Newcastle-on-Tyne Literary and Philosophical Societies and includes a number of bodies without a library at all. If the compilers in future editions discard the list of general works of reference, leaving this field, for example, to L. McColvin's "How to Find Out", and give the space thus saved to the sections indicated, the value of a promising little guide will be considerably enhanced.

R. Brightman

Manual of Mathematics and Mechanics

By Prof. Guy Roger Clements and Prof. Levi Thomas Wilson. Second edition. Pp. ix+349. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 3.25 dollars.

THIS manual, first published in 1937, has an unusual title, but, as the authors point out in their preface, the book "contains facts and formulas that are useful in courses of mathematics and mechanics in colleges and engineering schools, arranged and presented in a form that makes them readily available for *rapid work with minimum eye strain*". Here we have the key to the title, for the book is not a text-book in the generally accepted meaning of the term. This is the second edition, and consists of many useful tables and formulæ for reference, covering algebra, trigonometry, calculus, statics, kinetics of a particle, and the dynamics of rigid bodies. In the new edition, the section on spherical trigonometry has been expanded to include the needs of courses in navigation. New matter has also been added to meet the demand of the applications of mathematics to electrical engineering, including radio circuits, while formulæ and tables have been appended to meet special demands of courses in physics. The book is therefore very comprehensive, and excellently printed in clear type so that essential data may be readily selected. This applies especially to the many tables provided.

There is room for a book of this nature, provided it is properly used and does not displace the legitimate text-book. Such a reference book is really most useful to the student who has completed courses in mathematics and mechanics and thus has an intelligent fundamental knowledge of the principles upon which the various results here quoted are based. It would be profoundly dangerous to use a book of tables and formulæ as a text-book. With this reservation, the volume may be confidently recommended as a comprehensive and useful adjunct for mature students.

An Analysis of Volitional Life

By C. Lambek. Translated from the Danish by Agnete Kortsen. Pp. 104. (Copenhagen: Einar Munksgaard; London: Williams and Norgate, Ltd., 1947.) 8 Danish Cr.

ONE of the great difficulties of pure introspective psychology has always been the function of the will. The processes of motivation in the human being are complex and elusive if only consciousness is to be considered. Indeed, the exponents of dynamic psychology have suggested that this is due to the strength of the unconscious, and have propounded the well-known analogy of conscious volition being regarded as comparable to a baby on an elephant, the baby (consciousness) believing that it controls the behaviour, but the elephant (unconscious) in reality going where it wishes.

In this book a Danish psychologist attempts to define and dissect the nature of will. He disregards the possibility of feeling-tones (emotions) being the cause of voluntary acts, and states that the intellectual, emotional and volitional processes are all interdependent and of equal importance. He believes that the spontaneous urgency of tendencies to develop is due to the presence of thought images and sense impressions, but that there are ancillary factors, stamps of attention and stamps of vitality, which result in variations of tension. Once motivation is started it is followed up by planning and execution, which indicate future changes and the order in which they are to take place.

This book unfortunately shows the superficial limits of introspective psychology and is not likely to interest the medical psychologist, but it may be of some interest to those studying pure classical psychology; although even those will find little new here. It is well produced, the paper and print are excellent, and the translation is well done.

CLIFFORD ALLEN

Sequential Analysis

By Prof. Abraham Wald. Pp. xii+212. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 24*s*. net.

SEQUENTIAL sampling methods were developed during the War and remained secret for some time. Accounts of the methods have since been published in statistical journals, and knowledge of them has been fairly widely diffused by lecture and discussion both in the United States and in Great Britain. Hitherto, however, there has been no systematic account in book form of the theory of the subject developed from first principles, and Prof. Wald's book is therefore a very welcome addition to statistical literature.

The book is in three sections. The first opens with the elements of the current theory of testing statistical hypotheses, and develops a general theory of sequential probability ratio tests. The second applies the general theory to special cases such as testing means and variances in sampling from normal variation. The third considers the problem of multivalued decisions and sequential estimation.

Prof. Wald writes as a mathematician, lucidly and carefully, with an obvious twinge when the necessities of a simple exposition force him to deviate from complete rigour. Practising statisticians will find it useful to study the book in combination with the bound set of reports (*SRG* 255) on applications of sequential analysis issued by the Columbia University Press (see *Nature*, **157**, 642; 1946).

M. G. KENDALL

Recent Advances in Sex and Reproductive Physiology

By Dr. J. M. Robson. Third edition. Pp. xii+336. (London: J. and A. Churchill, Ltd., 1947.) 21*s*.

IN the new edition of Dr. J. M. Robson's work, he has succeeded admirably in bringing the subject up to date, and the book has benefited by the inclusion of references to the more important papers which have appeared since the last edition. This is well seen in the account of the steroids, where it is shown that there is a relation between the chemical structure and the physiological action of all the hormones or hormone-like substances belonging to this class. The account of the probable factors in parturition is also especially interesting. Here the author points out that in various species the response of the uterus to oxytocin increases progressively during gestation and reaches a maximum at parturition, and the recent researches of Haterius and Ferguson are duly quoted. The factors concerned in ovulation are also discussed, and the evidence of a pathway from the hypothalamus in the brain to the anterior pituitary through the stalk is referred to. Chapter 10, on "Hormone Production and Excretion" under various conditions, and Chapter 13, dealing with "Clinical Applications", are particularly valuable.

F. H. A. MARSHALL

Severn Tide

By Brian Waters. Pp. vii + 183 + 16 plates. (London: J. M. Dent and Sons, Ltd., 1947.) 15*s*. net.

THE title of this book is perhaps slightly misleading. It is not a hydrographical treatise giving all the details of the propagation of the tide in the Severn, with ranges of tide, times of rising and falling, and so forth. Its main object is to relate the activities of the residents on the banks of the river to the flow and ebb of the tide. Nevertheless, the author gives many details regarding the famous Severn bore which are not to be found elsewhere; but these are scattered among many other things. It is as though the author takes the reader on a pilgrimage up and down the river, and in a leisurely way talks with all and sundry, exhibits interest in the details of their lives and occupations, their fishing and their farming, and so on, with intimate touches on how the tide in this river influences their lives.

It is a pleasant book, with much human interest, and it is one of those things which needed to be done, and has been well done. The age of craftsmanship is nearly gone, and the author has recorded many little details (for example, the particular shape of the bend in the handstaff of the lave net, and how such staffs are obtained) which are of interest to those interested in arts and crafts. This book will interest all who know the Severn, whether they be interested in the peculiar problems of navigating a boat with the bore, in fishing, in river lore, or in the intimate details of local life.

A. T. D.

Bibliography of the Technical Literature on Silk

By Dr. F. O. Howitt. Pp. xxiv+248. (London: Hutchinson's Scientific and Technical Publications, 1947.) 21*s*. net.

THE book is precisely described by its title. It is the result of a literature survey which Dr. Howitt undertook after his appointment as head of the Silk Section of the British Cotton Industry Research Association in 1936. At that time there was no systematic review of the widely scattered scientific and technological literature on silk, but Dr. Howitt has now made it possible to claim that the literature on silk is better documented than that relating to any other textile fibre. Starting with the cultivation of silk, he proceeds to discuss the properties of raw silk, sericin and fibroin. Then follow chapters on the preparation of nett silk yarns, degumming, weighting, dyeing, weaving, knitting and finishing. The book ends with a survey o testing methods and a brief reference to non-textile uses of silk. So thorough is Dr. Howitt's treatment of his subject—there are 528 references in the fifty-six pages devoted to the properties of fibroin—tha reading would have been difficult if the informatio had not been so well co-ordinated. The author ca be congratulated on his contribution to the newe scientific literature on textile materials and processes

J. B. SPEAKMAN

HUMAN FACTORS IN INDUSTRY

CONFERENCE AT LEAMINGTON

IN the Assembly Rooms at Leamington Spa, on May 8, the British Association's Division for Social and International Relations of Science held a conference on "Human Factors in Industry". At the first session, under the chairmanship of Sir Henry Tizard, president of the Association, Prof. R. E. Lane, Dr. C. L. Cope, Mr. H. C. Weston and Dr. T. Bedford spoke on the improvement of physical environmental conditions. At the second, under the chairmanship of Sir George Schuster, there were contributions by Dr. R. F. Tredgold, Mr. D. Chapman and Dr. A. T. M. Wilson on problems of human relations, and Mr. Alec Rodger summed up.

Prof. Lane, of Manchester, introduced by Sir Henry Tizard as the first holder of the first British chair of industrial medicine, dealt chiefly with the influence of environmental conditions on health, and in doing so stressed the value of the medical man's part in studying and improving them. He emphasized particularly the role of the industrial medical officer as an apostle of preventive medicine. In his view, a firm's occupational health should be the concern of a team led by the management, and representatives of various interests within the firm. The medical man could often help management to decide on the conflicting claims of experts inside the organisation. Prof. Lane indicated that training facilities, capable of producing men suitable for the educative and advisory work he had outlined, are now available. What was needed next was a guarantee from industry that there would be employment for the best type of medical officer. If that guarantee were given, the men would be provided.

Dr. Cope, director of research into human problems for the National Coal Board, confined his attention to the coal industry. As Dr. P. Hugh-Jones, a stimulating participant in the general discussion, put it, he spoke of darkness, danger and dust. Human wastage from accident and disease is greater among miners than among any other section of the industrial community. Deaths on the job average 550 a year, and accidents causing more than three days absence number 180,000 a year. Certifications of permanent incapacity from pneumokoniosis total 4,000 annually. The corresponding figures for nystagmus and dermatitis are 1,800 and 1,600. In addition, of course, the industry is afflicted with a multitude of wage disputes.

Vast changes are needed to remedy present bad conditions, and a start is being made. Ventilation is on the whole good, and lighting is improving. The number and efficiency of cap-lamps is rising steadily, and fluorescent lighting is being installed experimentally not only in haulage ways but also at the coal face. Attempts are being made to determine the effects of improved lighting on the incidence of nystagmus and accidents, and to facilitate the investigation of accidents a new system of accident recording, developed by Mr. J. W. Whitfield of the Cambridge Psychological Laboratory, has been largely adopted. In the effort to combat pneumokoniosis, dust suppression by spraying with water or foam is being tried extensively, and Dr. T. H. Jenkins is collecting data on the efficiency of these procedures. Dr. Cope indicated that improvements in working conditions at the coal face would probably come slowly, because the cost of making them has constantly to be balanced against the cost of coal to the consumer. He added that he did not wish it to be assumed that he regarded these improvements as more important than improvements in human relations.

Mr. Weston and Dr. Bedford, both of the Industrial Health Research Board, summarized the findings of the Board's investigations in the fields of lighting, heating and ventilation. In the course of his talk, which was delivered in Stygian conditions not conducive to satisfactory note-taking, Mr. Weston displayed a number of slides depicting good and bad lighting. Dr. Bedford gave the following six rules for the arrangement of pleasant and invigorating working conditions: (1) A room should be as cool as is compatible with comfort. (2) There should be adequate air movement but no local draughts. (3) The air movement should be variable rather than uniform and monotonous, for the body is stimulated by ceaseless change in the environment. (4) The relative humidity of the air should not be above 70 per cent and should preferably be much below that figure. (5) The average temperature of the walls and other solid surroundings should not be appreciably lower than that of the air and should preferably be higher. The combination of cold walls and warm air often causes feelings of stuffiness. (6) The air at head-level should not be distinctly warmer than that near the floor, and the heads of the occupants should not be exposed to excessive radiant heat.

In the discussion at the end of the first session of the conference, stress was laid on the need for operational research in the coal and cotton industries; and on the need for greater co-operation between medical scientists, engineers and others, not only for the improvement of environmental conditions but also for the improvement of the design and layout of machinery. Although all the main speakers had explicitly referred to the importance of psychological factors in the study of environmental conditions, it was evident that many members of their audience thought they had not made enough of this point.

Opening the second session, Sir George Schuster, chairman of the Industrial Productivity Committee's Panel on Human Factors, said that our aim must be to make industrial employment the basis of a satisfying life. The main problem is to discover how scientific workers can influence the conduct of industry at the present time and in its present mood. At what points should the man of science intervene? What methods should he use? In answering these questions, we must realize that conditions vary from one industry to another and from one place to another; the introduction of joint consultation to a coal-mine throws up difficulties different from those encountered in its introduction to a cotton-mill.

Dr. Tredgold, of the Roffey Park Rehabilitation Centre, maintained that 'human relations' is merely a new label for an old subject, but that, in fact, we know very little about human relations in industry. Particularly, we have not sufficiently recognized the need for social skill in those we call leaders: in selecting them, we have assumed that technical qualifications are enough, and we have given them very little training. To some extent, training is now being provided for junior leaders, but training for management is still inadequate. It is important for leaders to realize that very often people do not do what they should because they do not see *why* they should. If we want people to act in a certain way, we should take pains to see that they appreciate our reasons, and we should seek to understand their prejudices. In a passing comment on rehabilitation, Dr. Tredgold remarked that the aim at Roffey Park is not merely to encourage people to look after themselves, but also to encourage them to look after others.

Mr. Chapman, of the University of Liverpool, considered that the current tendency to exclude consideration of the pay-packet from discussions on incentives has gone too far. Financial incentives are undoubtedly important. At the present time, however, the proper use of them presents many difficulties; and we have yet to develop the social processes needed to secure the adoption, by management and workers, of modern payment systems. Suspicions based on their experience during periods of mass employment are still widespread among workers, many of whom doubt whether full employment will last. However, in the newer industries which make considerable use of semi-skilled and young workers, there is a more rational attitude than that commonly found in, for example, the cotton industry. Mr. Chapman remarked that in his view some of the unwillingness to produce additional effort was caused by the 'P.A.Y.E.' system of collection of income tax, which creates the impression that hard workers are penalized. He added that we must not overlook the fact that there is evidence that during the last thirty years national morale has declined considerably. Present culture patterns reflecting the decline include the popularity of football pools, self-medication, the building society movement and insurance-for-all.

Nation-wide exhortations have little or no effect; sometimes, Mr. Chapman said, they have a bad effect. The approach should be to the working group concerned, and the schemes proposed should not be elaborate. One firm has recently developed a simple piece-work scheme based on the advice of consultants who had said that output could be increased by a third. After persuading the local union organiser that the plan was not a capitalist plot, the firm tried it out in one small department. When the operatives in the department had accepted it, a team of people, including two workers, were asked to arrange for its extension to other departments. The scheme has so far been a great success. Elsewhere, a 'production drive' technique had been adopted. This was Saturnalian in character, for the trade unions had been persuaded to make substantial concessions for a fixed period. For example, young workers had been allowed to compete for prizes of up to 3 guineas. An increase in output of 75 per cent had been obtained by this method, and efficiency had become an important factor in prestige. A drawback of the scheme was its tendency to make mothers ask: "If Alice can get an extra pound this week, why not next?" Facile solutions, it must be recognized, have their dangers.

Dr. Wilson, of the Tavistock Institute of Human Relations, developed with emphasis Mr. Chapman's arguments about the importance of regarding the working group as a group. From birth onwards we are members of groups; our behaviour is greatly influenced by our membership of various groups; and our behaviour in one group is not the same as our behaviour in another group. The chief cause of low productivity often lies in bad group morale. We must therefore be ready to investigate factors affecting the morale of the group as a whole, and its constituent sub-groups, as well as factors affecting the morale of the individuals concerned. We cannot do this satisfactorily by conventional scientific procedures of observation and experiment. We must develop a close relationship with the group. This relationship must be more than a very friendly one; it must be therapeutic. In fact, only through a healing approach can diagnosis properly be effected.

If we pursue this aim by this method, what do we find? One of our discoveries will be that the workers in a group have spontaneous co-operative tendencies which are often denied expression. Another will be that there exists in industry (as outside it) an almost universal system of 'scapegoating'. This leads every group—management, line executives, technicians, office workers, supervisors, workers at the bench and on the shop floor—to find the causes of their own dissatisfactions in other groups. However, despite its tendency to blame other groups, every group has a 'need' for good relations with those others. For example, behind the envy which the shop worker feels for the clerk, there is often a real desire to work in a community in which hostility does not exist. Dr. Wilson concluded that, in fact, most groups have it in them to overcome their difficulties, and he pleaded for arrangements which would enable them to release their self-healing resources by free discussion and other means. This in turn led him to strong advocacy of the abandonment of autocratic practice and its replacement by honest co-operation.

In his summing-up, Mr. Alec Rodger, senior psychologist to the Admiralty, spoke critically of certain points made in the main contributions to the first session of the conference. He was in full agreement with most of Prof. Lane's remarks, but he disliked his suggestion that the industrial medical officer should become a kind of 'super'-adviser to management simply because he is a medical practitioner. If Prof. Lane could recruit doctors of the quality he wanted, he would, in fact, soon find them performing the duties he had planned for them; otherwise he would not, nor should he. Dr. Cope, Mr. Weston and Dr. Bedford had given convincing proof that in their particular fields much progress had been made, but it seemed to Mr. Rodger doubtful whether their findings are being utilized satisfactorily as the starting points for further researches. The American Hawthorne experiments had been used for this purpose: why could not ours? Mr. Rodger wanted to know whether, as a matter of routine, experiments on the influence of 'old' and 'new' environmental conditions were followed by investigations of the influence of what he called 'reinstated old' conditions. He thought they should be. In a comment on Dr. Wilson's address, with which he was in general sympathy, he challenged Dr. Wilson to explain why he and his colleagues are convinced that problems of human relations in industry cannot be studied by conventional scientific procedures.

Mr. Rodger urged, in conclusion, that we should recognize the present importance of short-term research in the industrial field; that we should readily participate in the co-ordination of our researches (by groups of recognized and accepted experts who would 'vet' research proposals and ask, about each, What problem is this meant to solve? How important is it that it *should* be solved? Is this the best way of solving it?); that with the aid of the statistician, who is indispensable in researches involving many variables, we should make more determined use of ordinary observational and experimental methods of inquiry; that we should learn to communicate our findings, in simple words and pictures, to everybody concerned (from politicians and senior Civil servants to workers on the shop-floor); that we should take pains to let people know what our functions are; that we should constantly strive to acquire more appreciation of the problems of the managers we advise; and that, above all, we should investigate thoroughly the causes of managerial and shop-floor resistance to techniques intended to increase production. He suggested that the British Association should later stage a conference with a broader sweep, at which a series of short progress reports might be read on 'fitting the man to the job' and 'fitting the job to the man'. Under the first heading might come work on the improvement of methods of vocational guidance, personnel selection, and occupational training. Under the second might come the improvement of methods of work, design and layout of working equipment, and working conditions (both physical and psychological).

SCIENTIFIC RADIO

A SPECIAL feature of the programme of the Radio Section of the Institution of Electrical Engineers this session was the holding of a Convention on Scientific Radio during April 7 and 8. This Convention, which was organised by the Institution in co-operation with the British National Committee for Scientific Radio, afforded an opportunity for a preliminary survey of the British contribution to be presented to the forthcoming meeting of the Union Radio Scientifique Internationale (U.R.S.I.), which has already been announced in *Nature* of May 1, p. 695. The proceedings of the Convention were divided into four sessions corresponding in scope to the four commissions of the Union Radio Scientifique Internationale; and in each session four or five short papers were presented surveying progress in the past few years in various parts of the field of fundamental radio science. Ample opportunity was provided for speakers who wished to discuss the individual contributions, and abstracts of the papers and of the discussions will in due course be published in the *Journal of the Institution.*

Standards and Measurements

The first session, on "Standards and Measurements", was held under the chairmanship of Mr. P. Good, president of the Institution of Electrical Engineers; and the four papers presented on this occasion emanated from the National Physical Laboratory (Department of Scientific and Industrial Research). The chairman explained that this was perhaps to be expected, since it is one of the duties of the Laboratory to set up and maintain tandards of reference for the electrical and radio measurements required by all users of the corresponding techniques. As was made quite clear by he individual speakers who followed, however, it was not intended to suggest that all progress made n recent years had been conducted within the Department of Scientific and Industrial Research; or it is well known that many substantial contributions during the war years were made by certain Government establishments and by industry.

Dr. L. Hartshorn, in a paper on "Radio Standards" resented jointly with Dr. L. Essen, first referred to the fact that, of the three standards recognized throughout the whole field of physical science, namely, length, mass and time, the last, if not already a radio standard, is very little short of it. For if once it is decided that the vibrations of the existing quartz-frequency standards are more regular than the rotation of the earth, then, for the period in question, the rotating earth is no longer to be regarded as the standard of either frequency or physical time. The paper pointed out the dependence of radio measurements on the existing electrical standards, and emphasized the need for distinguishing between definitive standards, derived standards, transfer standards and working standards. Reference was made to the changes which took place on January 1 last, when the ohm was defined by reference to the standards of length and time, with consequential changes in the numerical values of reactance and resistance of 0·05 per cent. Since inductance and capacitance standards can now be measured at radio frequencies with an accuracy of about 0·01 per cent, these changes are of decided significance in precision radio measurements. Frequency can be measured to a much higher order of accuracy, and an illustration was shown of relative measurements on three typical quartz standards, differing widely in design. These were found to agree with one another to within 2 or 3 parts in 10^8 over a period of several months.

In the following paper, Dr. T. I. Jones reviewed the techniques used in the measurement of current, voltage, impedance and attenuation at frequencies below about 300 Mc./s. Signal generators and receivers are calibrated in terms of voltage which, at a level of about 0·1 volt, can conveniently be measured by means of valve or crystal-detector voltmeters, and by a combination of a vacuum thermojunction and resistors in series or parallel. Suitable voltage-dividers are available to extend the range upwards and downwards. The methods available for measuring impedance fall into two classes: those which use resonance circuits and which are used for measuring components, cables and the properties of dielectrics; and bridge networks, which are available up to frequencies of the order of 50 Mc./s. but which deteriorate in performance for frequencies above 10 Mc./s.

Mr. F. M. Colebrook described the changes in technique which have taken place in recent years in conducting radio measurements at frequencies above about 300 Mc./s.; and some discussion ensued on the possibility of reaching agreement among workers interested on the value of this boundary frequency, above which current and voltage measurement should give place to the determination of power. The general position with regard to measuring technique at the very high frequencies now in common use remains substantially as has been described in various papers published in the *Journal of the Institution of Electrical Engineers* during the past two years.

The subject of radio field-strength measurement is of direct interest in connexion with all applications of radio-wave technique, and Dr. R. L. Smith-Rose presented a survey of the main lines of development of this subject over the past ten years or so. At the present time suitable field-strength measuring equipments have been developed on an experimental basis for all radio frequencies between about 0·1 and 600 Mc./s.; but there is a need for further development of these and for an inter-comparison of the different types available on both a national and an international basis.

Propagation

Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, presided at the next session, at which five papers were presented dealing with some topical aspects of the subject of radio wave propagation. Dr. A. C. B. Lovell gave an interesting account of his recent investigations on meteors, conducted by the aid of radar techniques at wave-lengths of a few metres and less. When a meteor enters the earth's atmosphere, it burns away at a height of about 100 km. and creates a dense concentration of electrons which scatter energy from incident radio waves. On a wave-length of about 4 m., the number of echoes which have been detected by available radio equipment is very closely related to visible meteoric phenomena. As the wave-length is increased, however, the rate at which echoes are detected undergoes a striking change, and at wave-lengths greater than 8 m. several hundred echoes per hour are received, a number which bears no close relation to the visible observations. The sporadic ionization in the *E*-layer of the ionosphere is now considered to be mainly caused by the effect of meteors, particularly in temperate latitudes.

In 1934 it was discovered that radio waves traversing the ionosphere could interact with each other in such a way that the modulation of one was transferred to the other. This effect was explained at the time by supposing that the absorption of energy from one of the waves increases the temperature of the electrons in the ionosphere, with a consequential increase in their collision frequency with neutral molecules. As a result, the absorption of the other wave is increased; and since this absorption varies with the modulation of the first wave, this modulation will be transferred to the second wave. Experimental work on this phenomenon has recently been resumed at the Cavendish Laboratory at Cambridge; and Mr. J. A. Ratcliffe described the manner in which he and his colleagues have been observing the phase of the transferred modulation, and comparing it with the phase of the modulation received direct, as a ground wave, from the interacting station. From the results of such measurements, it is possible to determine the collision frequency of the electrons at a known height; and the experiments have given values around 5×10^6/sec. for a height of about 85 km.

The third paper at this session was presented by Dr. W. J. G. Beynon, who gave an account of recent investigations on the reflexion of radio waves from the ionosphere at oblique incidence. He pointed out that it has long become established practice to calculate the maximum usable frequency for any desired transmission path from normal-incidence ionospheric data with an accuracy which is satisfactory for most practical purposes. Experiments on the absorption of radio waves carried out in Great Britain have shown that there is a marked disagreement between the apparent absorption at oblique incidence and that predicted on theoretical grounds from the values measured at normal incidence. In a similar manner, estimates of oblique-incidence ionospheric absorption obtained from observations of signal strength over trans-Atlantic radio circuits disagree with the values expected from long-term normal-incidence measurements. This subject of the absorption of radio waves in the different regions of the ionosphere is being actively pursued at the present time under the auspices of the Radio Research Board of the Department of Scientific and Industrial Research.

The need for increased knowledge on the propagation of very long radio waves has recently come into prominence due to the development during the War of some novel and very accurate methods of defining the position of a radio receiver, by measurements made on the arriving waves. Work on this subject was in progress at the Cavendish Laboratory before the War; and Mr. R. N. Bracewell gave an account of the experiments, which have now been resumed, on frequencies of 16 and between 30 and 40 kc./s., corresponding to wave-lengths of about 19,000 and 9,000 m. respectively. The height of reflexion of these very long waves is about 80 km., with regular diurnal variations, which are symmetrical about noon, of some 18 km. in summer and 12 km. in winter. Such measurements are made by determining the phase path of the sky wave received at distances of a few hundred kilometres, using the ground wave, which varies little with respect to the transmitter, as the source of reference.

Dr. H. G. Booker presented a new way of visualizing the Sommerfeld theory of propagation over a flat and imperfectly reflecting earth. This theory arose because the ray theory involves the assumption that the Fresnel reflexion coefficient of the earth does not vary rapidly with angle of incidence, and this assumption is not satisfied for vertically polarized medium waves as used for broadcasting, arriving at the earth's surface at glancing incidence. The main object of the new presentation is to facilitate the solution of problems involving propagation near the surface of the earth partly over land and partly over sea, a condition which applies frequently in practice to radio transmission for communication and other purposes.

Radio Noise

At the third session, on "Radio Noise", the chair was taken by Sir Robert Watson-Watt, who is chairman of the British National Committee for Scientific Radio. In a paper entitled "A Survey of Recent Progress in the Study of Fluctuation Noise", Dr. D. K. C. MacDonald referred to the report made by the Union Radio Scientifique Internationale on this subject in 1946, and to the subsequent publication of the associated work primarily directed to war requirements, which was concerned broadly with noise at frequencies of 60, 600 and from 3,000 to 10,000 Mc./s. The main problems have been in the development of methods and instruments for noise measurements, of valves, circuits and crystal detectors to improve the ratio of signal to noise. It is well established that certain elements show increased noise at relatively low frequencies; and a study of this phenomenon, which includes 'flicker effect' in valves and 'current noise' in semi-conductors, is of considerable significance, for example, in the design of amplifiers for the study of physiological effects.

During the past few years, there has been a marked resumption of interest in 'atmospherics', a subjec which had hitherto been rather neglected by radio physicists for some ten years. Two papers presented to the Convention served to direct attention to th investigations now in progress. In the first of these Dr. T. W. Wormell and Mr. E. T. Pierce described some recent studies made at the Solar Physic Observatory, Cambridge, on the structure of th disturbances in the vertical electric field at the earth's surface resulting from lightning discharges

In one type of investigation cathode-ray tube equipment and photographic recording technique are used to investigate the variation with time of the electric field produced by discharges not more than 50 km. distant. Concurrently, an investigation is being made of the detailed wave-form of the disturbance due to radiation from discharges at distances of many hundreds of kilometres. The results of such observations were discussed with the aid of photographic records and diagrams.

In the second paper, Dr. H. A. Thomas, of the National Physical Laboratory, described some of the results obtained from an analysis of observations of the strength of atmospherics as measured at some fourteen stations in various parts of the world. A large number of slides were shown to illustrate the general trend of these observations, which were made on five frequencies between 2·5 and 20 Mc./s., in which band the propagation of radio waves through the ionosphere is likely to play an important part in determining the general strength of atmospheric noise at any place. One of the important conclusions from this study, however, is that the characteristics of the atmospheric noise observed at any one location do not appear to be applicable over any large area; and this would tend to indicate that the sources of the noise being measured are local to the observer. Large differences between the ratio of day and night values are observed at different places; seasonal effects are marked, and also differ appreciably with location. Far more data on this subject are required, however, before any very definite conclusions can be drawn on such a complex subject.

The remaining two papers in this session dealt with recent investigations of the characteristics of galactic and solar radiation. Mr. J. S. Hey described how the emission of high-intensity radio waves from sunspot regions was first established by observations made with Army radar receivers in February 1942, during the transit of a large and active spot across the sun's disk. In the intervening years many workers have made observations of this phenomenon, particularly during the recent maximum of the sunspot cycle. The intensity of the radiations observed is particularly strong for a wave-length around 5 metres, and falls off very considerably as the wave-length is reduced below 1 m. Corresponding reception of this type of radio noise, as first noted by Jansky in 1932, has also been studied by recent workers; and in the discussion of this paper, Dr. J. L. Pawsey described some interesting observations, made in Australia, on galactic noise, from which it appears that some of the stars, or combinations thereof, radiate much more strongly than sunspots. This was followed up by Mr. M. Ryle's paper, describing experiments made on radiation emitted by the sun on wave-lengths of 1·7 and 3·8 m. The observations have been continued over a period of fifteen months, and it has been found that in the absence of sunspots the sun radiates with an intensity corresponding to a surface temperature of 10^6 °K. The radiation from sunspots is characterized by sudden increases of intensity which correspond to much higher temperatures.

Radio Physics

At the fourth session of the Convention, on "Radio Physics", the chair was taken by Prof. G. I. Finch, president of the Physical Society. The papers presented at this session demonstrated the manner in which some physicists are using the very high-frequency radio techniques, corresponding to wave-lengths of a few centimetres and less, to study various properties of solids, liquids and gases. Dr. B. Bleaney described the use of centimetre waves for studying absorption lines in the spectrum of gases due to heavy polar molecules. By making the radio frequency measurements to a high order of accuracy, the broadening of the lines due to collisions has been investigated at pressures up to six atmospheres. At low pressures (0·1–10 cm. mercury), the widths of the lines vary directly with the pressure; while at pressures above one atmosphere, the line breadth ceases to rise as rapidly as the pressure. Among the most interesting spectra studied in this manner are those of ammonia and water-vapour, the latter being of particular importance as a constituent of the atmosphere.

In their paper on "High-Frequency Absorption Phenomena in Liquids and Solids", Prof. Willis Jackson and Dr. J. A. Saxton directed attention to the significance of investigations on such materials as polythene, which is substantially non-polar, and liquid water, which exhibits purely polar characteristics. Such centimetre-wave measurements have served to illustrate more convincingly than previous work at longer wave-lengths the limitations of the original dipole theory of dielectric absorption formulated by Debye. With the reasonable prospects now in view of the extension of the range of these measurements to the millimetre wave-band and so towards the far infra-red portion of the spectrum, such investigations present interesting possibilities of leading to a fuller understanding of the properties of the liquid and solid states. In the meantime, the data already acquired on the absorption and scattering effects of water, ice and water vapour are of great value in connexion with the use of centimetre wave transmission through the atmosphere, and with the effect of fog, clouds, rain and snow on such transmission.

In the course of another paper in this session, Drs. R. Cooper and W. A. Prowse described experimental determinations of the minimum electric breakdown stress in air at frequencies corresponding to centimetre wave-lengths. It was found that radioactive irradiation of the spark gap improved the precision of the measurements without affecting the deductions drawn from the results. Spectrographic observations were made of the spark itself, and of the accompanying bright spot on the electrodes.

A paper entitled "Investigations of Magnetic Phenomena at Centimetre Wave-lengths" was presented by Dr. J. H. E. Griffiths, of the Clarendon Laboratory, Oxford, in which he stated that it is only recently that it has been possible to make measurements on the permeability of ferromagnetic materials in the centimetre wave region, and these have led to some interesting results. In addition to studying the permeability, which decreases rapidly with increase of frequency, the effect of a superimposed steady, transverse magnetic field has been investigated. It is then found that ferromagnetic metals exhibit a resonance phenomenon, in that the high-frequency loss in the metal becomes a maximum for a certain value of the steady magnetic field. A number of paramagnetic salts show a similar resonance absorption, and the interpretation of the results of such measurements is leading to a better understanding of the magnetic properties exhibited by various substances.

The last paper in the session, and also of the Convention, was presented by Mr. A. B. Pippard, who described experiments on the high-frequency conductivity of metals at low temperatures. It is well known that the classical theory, supported by measurements at moderately high frequencies, indicates that the resistivity of a conductor as determined by the skin effect should be inversely proportional to the square root of the bulk conductivity. Experiments made at a frequency of 1,200 Mc./s. have shown, however, that while this is true at room temperature, the great increase in conductivity due to cooling pure metals to very low temperatures is not accompanied by a corresponding decrease of surface resistivity. The explanation of this effect is that the free paths of the conduction electrons at low temperatures may exceed the classical value of the skin depth by as much as a factor of 100 under the conditions of the experiments. Thus it is no longer permissible to assume the validity of Ohm's law, since only a small proportion of the relevant electrons contribute to the surface conductivity. It is clear that we have here a quantitative radio technique for exploring the free paths of electrons, and investigations were referred to in which the method is being applied to the study of the surface characteristics of pure metals.

In the course of the discussion, Dr. R. A. Smith very aptly referred to the interesting fact that physicists, who had so ably assisted the radio investigators in the development and exploitation of radar and communications during the War, have now taken back into their own research laboratories some of the problems exposed by the radio engineers. The development of the higher frequency radio techniques in the past few years has clearly provided powerful research tools for studying the general physical constitution of matter. R. L. SMITH-ROSE

PROBLEMS OF TIDAL BIOLOGY

IN a letter published in *Nature* in 1944 (**154**, 300) it was pointed out by Prof. T. A. Stephenson, of University College, Aberystwyth (in continuation of an argument initiated by Prof. F. E. Fritsch, *Nature*, **154**, 144; 1944), that future investigation of intertidal biology in Great Britain demanded: (*a*) further work on the British coasts between tide-marks; (*b*) further work on the continental shelf of the British region below tide-marks; and (*c*) an attempt to make a preliminary world statement, based on a carefully selected series of surveys made by the same workers.

Since 1944 progress has been made towards the realization of all these objectives, but the present article is concerned particularly with the third one. Prof. Stephenson has now undertaken to write a monograph on plant- and animal-life between tide-marks throughout the world, and the expedition described below was a step in that direction. The monograph is intended to supplement the well-known works of Ekman ("Tiergeographie des Meeres", 1935) and of Sverdrup, Johnson and Fleming ("The Oceans", 1942). These volumes both provide world-wide pictures of certain aspects of marine life, but neither devotes particular attention to the intertidal region; nor is there any general work which attempts to do this. In the task which he has undertaken, Prof. Stephenson will have behind him thirty years experience of ecological work between tide-marks carried out in Australia, South and East Africa, Mauritius and Great Britain, much of which is embodied in a series of admirable papers. The shores of North America have now been added to the regions studied by him. In much of this work, of a type which could not be conducted unaided, Prof. Stephenson has been assisted by collaborators, and throughout Mrs. Stephenson has acted as his technical assistant.

Between December 1946 and January 1948, Prof. and Mrs. Stephenson made a thirteen months visit to the United States and Canada to collect new material for their monograph. It has been recognized throughout that, while nobody can expect to visit all the coasts of the world in this connexion, there is a certain amount of uniformity between one coast and another within the same temperature limits. There is thus reason to expect that a judiciously chosen series of samples will provide a basis for a general statement which, if only a first approximation, will form a foundation for later work. It so happens that most of the samples needed to complete Prof. and Mrs. Stephenson's earlier experience are to be found in North America. On this ground their visit was supported either financially or by the provision of facilities, or both, by a number of institutions in Great Britain and America.

While the intertidal ecology of the North American coasts is much better known than that of South America, it has been investigated less than might be supposed. There is an extensive literature dealing with the systematics of intertidal plants and animals, and a very considerable amount which describes the biology of particular species. Contributions reviewing the shore ecology as a whole are much fewer, and where they exist, may deal primarily with animals (for example, Hewatt[1]) or with plants (for example, Doty[2]) and rarely cover wide areas, except in occasional works such as that of Ricketts and Calvin[3], and the paper by Doty already mentioned. There are vast stretches of the coast which remain almost unknown from an ecological point of view. The places visited during the present work were chosen, so far as possible, in areas where the general shore ecology has not been described. The summary which follows is derived from a privately printed report prepared for submission to the institutions which supported the work.

The time spent in America extended from January 1, 1947, to January 25, 1948. During this period a distance of some 15,000 miles was covered, mainly by motor-car, and shore-work was carried out first on the Atlantic coast—among the Florida Keys, at Marineland in North Florida, at Charleston in South Carolina and at Beaufort in North Carolina. After crossing the continent it was continued on the Pacific coast at Nanaimo in British Columbia, and afterwards at Pacific Grove and La Jolla in California. This schedule permitted a stay of approximately two months at each of the main centres.

The amount of information collected was considerable, and it will be some time before it can be worked up for detailed publication. Meanwhile the following note will indicate the nature of the results. The work falls roughly under three headings: (*a*) broad geographical aspects; (*b*) questions of vertical and horizontal distribution within small areas; and (*c*) the causes of the facts observed under (*a*) and (*b*).

The Florida Keys represent a tropical region with an abnormally scanty intertidal population; scanty, that is to say, in total bulk of organic material regarded as a crop, not in number of species represented. The latter is considerable. The environmental features with which this poverty is connected appear to be produced by a peculiarly shallow, very heavily sedimented sea, with a low concentration of nutrient salts, operating in a tropical region with a rather small tidal range, on a clinker-like substratum formed from dead coral. This situation will be described for the first time, and it is hoped that a comparison of so unusual a tropical area with more ordinary ones will yield information about the underlying reasons for the differences.

The coasts of northern Florida, together with those of North and South Carolina, present an entirely different picture. It is hoped to show that between Cape Hatteras and Cape Canaveral there lies a region inhabited by a warm-temperate tidal biota with distinctive features of its own. The coast here consists primarily of sand, mud and gravel, outcrops of material harder than peat being exceptional; but the lack of hard substrata is made up for, to some extent, by the existence of rough rocky breakwaters essentially similar to reefs of natural rock. Information has been obtained relating to the reaction of a warm-temperate population of seaweeds and animals to the presence of small areas of hard bottom lost among vast tracts of sand, and it is expected that this will prove to be useful material for a general discussion of the problems of intertidal life.

On the Pacific coast, the areas visited provide the following special features. At Nanaimo in British Columbia there flourishes a superb example of a rich, fully marine fauna, in a region of quiet creeks with reduced wave-action, in a low range of salinity (23–28 $^{0}/_{00}$). It is remarkable in itself that so large a population of stenohaline animals such as starfish and anemones should flourish in water of such low salinity; but the district offers also, in the form of Brandon Island, a small island with a gradual, sunny, southward slope and a precipitous, shady, northern cliff, a perfect demonstration of the effect on plant and animal distribution of the contrast between these two combinations of conditions. Other reefs and islands in the district supplement what Brandon Island supplies, and also offer contrasts. Around the Monterey Peninsula and Point Lobos in California, on the other hand, there is found an example of a more southern version of a population not unlike that of Nanaimo, but exposed (on the more wave-beaten promontories) to maximal oceanic wave-action. In spite of the powerful wave-action, however, the very rugged and irregular nature of the coast provides so many degrees of exposure to, and shelter from, wave-action in small areas that the effect of these differences on a rich marine population in an area of normal salinity can be studied to advantage. Lastly, in the neighbourhood of La Jolla, near the boundary between Mexico and California, another very different picture is encountered. The wave action, while considerable and oceanic, is moderate compared with that of the Monterey region; and the shore biota is of a warm-temperate type, distinctly different ecologically from that of the more northern stations. The rock along the shore, moreover, provides a remarkable demonstration of the effect of different degrees of hardness on the species which can colonize it. The most prevalent rock is so soft that it has specific unusual effects on common organisms such as barnacles and encrusting Corallinaceæ; and these effects can be checked by comparison with local areas in which the rock is harder, in varying degrees, than the average, and which show clearly what happens on hard rock as compared with soft in the same district.

Throughout the work special attention has been paid to the zonation of plants and animals between tide-marks, and the relationship between zones and tide-levels will figure largely in the results. During their previous work in South Africa (see *Nature*, **143**, 503; 1939; and **156**, 27; 1945) Prof. and Mrs. Stephenson developed the idea that the shore zonation found there is based on a plan of universal application. They were able to test this idea later in Great Britain, Mauritius and East Africa, but during 1947–48 tested it much more widely on a variety of American shores. So far it has stood this examination very well, but there is much work to be done before the detailed application can be made.

The regional peculiarities of different parts of the world reveal themselves in many ways. This is shown particularly well by the distribution of limpets, which is one of the subjects covered in this work. While limpets of some kind are peculiarly characteristic of the intertidal regions of the world, the *genera to which they belong* show a markedly regional occurrence. Thus, in some areas the leading limpet genus is *Patella*; in others *Acmæa*; and on many of the warmer shores the pulmonate *Siphonaria*. An interesting point brought out by the present study is that the Carolina coasts visited are most exceptional in that, to all appearance, they have *no limpets at all* on open rock surfaces.

The prime object of the work here summarized was not the amassing of facts as such but their comparative study with the view of elucidating the underlying fundamental principles which are responsible for the surface appearances described. These principles cannot, however, be formulated until a full examination of the facts has been made. In the course of this expedition Prof. and Mrs. Stephenson have added greatly to their already unique experience in the study of shore ecology. It is most sincerely to be hoped that nothing will prevent, indeed that circumstances will conspire to further, the production of the monograph to the completion of which on the broadest possible basis their labours are directed.

C. M. YONGE

[1] Hewatt, W. G., *Amer. Midland Naturalist*, **18**, 161 (1937).

[2] Doty, M. S., *Ecology*, **27**, 315 (1946).

[3] Ricketts, E. F., and Calvin, J., "Between Pacific Tides" (Stanford Univ. Press and Oxford Univ. Press, 1939).

OBITUARIES

Prof. G. H. Hardy, F.R.S.

GODFREY HAROLD HARDY, who died at Cambridge on December 1, 1947, was the creator of the English school of mathematical analysis and had been for more than a quarter of a century the leader of pure mathematicians in Great Britain. He was born on February 7, 1877, the son of Isaac Hardy, who was bursar and art master at Cranleigh School. He went to Winchester and, in 1896, as a scholar to Trinity College, Cambridge. He was fourth wrangler in 1898 and was placed in the first division of the first class in Part II of the Mathematical Tripos in 1900. He was elected a fellow of Trinity in 1900 and (together with Jeans) gained a Smith's Prize in 1901.

At the turn of the century, pure mathematics in Britain was at a low ebb. Since the days of Newton, mathematics had been regarded as ancillary to physics, and the achievements and prestige of Maxwell, Kelvin and Stokes had prolonged this attitude throughout the nineteenth century. There had been great pure mathematicians (such as Cayley), but they had worked in isolation and had been untouched by the movements in France and Germany.

In "A Mathematician's Apology" (1941), Hardy recounts his introduction to analysis—"My eyes were first opened by Prof. Love, who taught me for a few terms and gave me my first serious conception of analysis. But the great debt which I owe to him—he was, after all, primarily an applied mathematician—was his advice to read Jordan's famous 'Cours d'Analyse'; and I shall never forget the astonishment with which I read that remarkable work, the first inspiration for so many mathematicians of my generation, and learnt for the first time as I read it what mathematics really meant."

From 1900 until 1911 Hardy wrote many papers on the convergence of series and integrals and allied topics. Important as these researches are—they led to his election to the Royal Society in 1910—they are not his great work, and perhaps the most significant product of the early period was "A Course of Pure Mathematics". In this book Hardy expounded the basic ideas of analysis—limit, continuity, convergence—to the schoolboy of scholarship standard and the undergraduate. These ideas were so little appreciated that Hardy could then write (1908): "I have indeed in an examination asked a dozen candidates, including several future Senior Wranglers, to sum the series $1 + x + x^2 + \ldots$, and not received a single answer that was not practically worthless—and this from men quite capable of solving difficult problems connected with the curvature and torsion of twisted curves".

In revising the book for the seventh edition (1938), he could reflect that, if he were to rewrite it, it would no longer be necessary to write like "a missionary talking to cannibals".

About 1911 came the real crisis of Hardy's career when he began his long collaboration with J. E. Littlewood, a partnership without parallel in the history of mathematics. One problem after another was reduced by the powerful methods which they developed, and on some topics in analysis there now seems nothing more to be said. The main headings of the joint work of Hardy and Littlewood are convergence and summability of series, trigonometrical series, inequalities and the analytic theory of numbers.

Their most spectacular work was in the theory of numbers; there are problems which need only elementary arithmetic for their statement (for example, "Is every even number the sum of two prime numbers?"), but all the resources of analysis are required to make any impression on them. Some questions (including the one quoted) are still unanswered, but they are not now—as they were in 1910—unapproachable.

In 1914 began another collaboration, this time with a man whose gifts were much less like Hardy's own than are Littlewood's. A poor, self-taught Indian, Ramanujan, wrote to Hardy stating a number of formulæ that he had discovered. He was brought to England and before his death at the age of thirty-two in 1920 had become a fellow of Trinity and a fellow of the Royal Society. Hardy's association with Ramanujan was in some measure that of teacher and pupil; he had to teach Ramanujan much of the routine analysis which every Tripos candidate now knows, and this without impairing the native genius of the man. Their joint papers are few, but one of them contains a theorem so astonishing that one cannot help indicating it.

Denote by $p(n)$ the number of ways of expressing the positive integer n as the sum of integers. For example, 5 can be expressed as $1 + 1 + 1 + 1 + 1$ or $1 + 1 + 1 + 2$ or $1 + 2 + 2$ or $1 + 1 + 3$ or $2 + 3$ or $1 + 4$ or 5, and so $p(5) = 7$. It is plain that $p(n)$ increases rapidly with n; and $p(200) = 3972999029388$ (as was shown by a computation which took more than a month). Hardy and Ramanujan's achievement was to establish an explicit formula for $p(n)$, of which the leading term is

$$\frac{1}{2\pi\sqrt{2}}\,\frac{d}{dn}\,\frac{\exp\left\{\dfrac{2\pi}{\sqrt{6}}\sqrt{\left(n-\dfrac{1}{24}\right)}\right\}}{\sqrt{\left(n-\dfrac{1}{24}\right)}}.$$

Five terms of the formula give the correct value of $p(200)$.

Hardy was a lecturer at Trinity until 1919, when he became Savilian professor of geometry at Oxford; there he founded a flourishing school of research. For the year 1928–29 he went to Princeton, changing places with O. Veblen. He returned to Cambridge in 1931, succeeding E. W. Hobson as Sadleirian professor of pure mathematics; he held this chair until his retirement in 1942.

Hardy received degrees and honours from many universities and societies. He valued highly his honorary fellowship of New College, Oxford. During the last few weeks of his life he had pleasure in the award of the Royal Society's highest honour, the Copley Medal; he had already received a Royal Medal in 1920 and the Sylvester Medal in 1940.

In the course of his life, Hardy collaborated with many mathematicians besides Littlewood and Ramanujan; among others, with Titchmarsh, Ingham, Pólya, Wright, Rogosinski and M. Riesz. He had an exceptional gift for working with others, as he had for leading young men in their early days of research.

Hardy had one ruling passion—mathematics. Apart from that his main interest was in ball-games, of which he was a skilled player and an expert critic. An illustration of some of his interests and antipathies is given by this list of "six New-Year wishes" which he sent on a postcard to a friend (in the 1920's): (1) prove the Riemann hypothesis; (2) make 211 not out in the fourth innings of the last Test Match at the Oval; (3) find an argument for the non-existence of God which shall convince the general public; (4) be the first man at the top of Mount Everest; (5) be proclaimed the first president of the U.S.S.R. of Great Britain and Germany; (6) murder Mussolini.

It is fairly expected of a writer of a notice that he will, within the limitations imposed by language, attempt to portray his subject. How far would it be possible to describe Hardy, say to a mathematician of a new generation? His writings would attest both his power as a mathematician and his mastery of English prose. A picture might show his finely cut features and his physical grace. But no words can convey his liveliness and charm, which made a lasting impression on men even after one chance meeting, and which will remain fresh in the memory of those, mathematicians and others, among whom he lived.

Dr. Thomas Stephenson

The death of the Rev. Dr. T. Stephenson, at Hindhead on April 15, removed yet another of that band of amateur botanists (others were Mr. H. W. Pugsley, Col. M. J. Godfery and Mr. P. M. Hall) who did so much during the past thirty years to advance our knowledge of British orchids. Born at Brackley in Northamptonshire in 1865, Dr. Stephenson was a minister of the Methodist Church for many years until his retirement in 1934. The continual change of residence involved in his calling brought him into many parts of Britain and enabled him to study his favourite group of plants in a great range of conditions and habitats. He concentrated especially on the marsh and spotted orchids (*Orchis*, section *Dactylorchis*) and on the helleborines (*Epipactis*), both extremely difficult and little-understood groups. In a series of more than twenty papers published during the period 1918–42, many of which were written in collaboration with his son, Prof. T. A. Stephenson, or with Col. M. J. Godfery, he contributed materially towards the elucidation and clarification of these two genera. His outstanding contribution was the recognition and description of *Orchis purpurella*, now known to be one of the most widespread marsh orchids of Britain.

Dr. Stephenson did not restrict his work on orchids to England but, with the assistance of grants from the Royal Society, made special trips to France, Spain and Algeria, where he was enabled to study not only the British species but also their western European allies.

In his later years, when resident in Torquay, he helped to edit the first part of the "Flora of Devon", which appeared in 1939, and to which he contributed the part on Orchidaceæ. His interest was, however, not confined to these plants, and he was preparing an account of the mosses for the second part of the "Flora" just prior to his death.

V. S. Summerhayes

We regret to announce the following deaths :

Dr. A. S. Corbet, of the Department of Entomology of the British Museum (Natural History), on May 16, aged fifty-one.

Sir Daniel Richmond, C.I.E., during 1927–32 chief conservator of forests, Madras, on May 1, aged sixty-nine.

Prof. Väinö Tanner, known for his geological studies of the Fennoscandian region, on April 26, aged sixty-seven.

NEWS and VIEWS

"Proposed Central Publication of Scientific Papers"

Prof. J. D. Bernal writes: "In their letter published in *Nature* of May 15, the President and Secretary of Society for Freedom in Science put forward a number of reasons for rejecting the proposals for central distribution of scientific papers as set forward in my paper for the Royal Society Scientific Information Conference. The paper referred to, however, has not been published as it was intended for discussion in the first place and it is therefore impossible for most readers to judge how far it is open to the criticisms here given to it.

"Many of these do not apply to the proposals at all; others only to an interpretation of them which was certainly not the author's. Nearly all could be met by useful though inessential modification of the scheme. Thus there has been no proposal to abolish either journals, editors, or to curtail in any way their admirable functions.

"Although it would be possible to deal with these points in detail I feel that it would be preferable to leave discussion of them until the Conference where new statistical and technical material bearing on methods of publication and distribution will be available and where scientific societies will be fully represented. The scheme in question is only one of those before the Conference and is susceptible to modification and improvement. In any case the Conference can only indicate the direction in which changes in publication might be effected. The actual changes might be effected in an orderly way preceding each step by observation through operational research and voluntary experiment in a limited field. Any alterations would have to be negotiated with Societies and there is therefore little danger that the freedom of science will be interfered with."

Copies of Prof. Bernal's memorandum have been circulated to official delegates. In his memorandum Prof. Bernal states that: "More detailed descriptions of the steps which have led to the formulation of such a scheme are to be found in *Nature*, vol. 160, p. 649, 8 November, 1947, and the Report of Proceedings of the Twentieth Conference, 1945—Association of Special Libraries and Information Bureaux".

Dr. John Hutchinson, F.R.S.

The retirement of Dr. John Hutchinson from the scientific staff of the Royal Botanic Gardens, Kew, on May 31, after forty-four years service, will be noted with interest by botanists in many parts of the world. Hutchinson's early life was spent in handling and working with living plants in various horticultural establishments, and he started his career at Kew on the Gardens' staff in 1904. He showed such marked capacity for systematic botanical work that after less than a year he was transferred to the Herbarium. Here he was engaged in systematic and taxonomic work under Dr. Otto Stapf, with whom he worked for many years in the closest harmony. He was 'Assistant' for India for six years, and 'Assistant' for tropical Africa for a similar period. It was then that his special interest in African botany developed, and he was placed in charge of the African section of the Herbarium in 1922. He was responsible for some of the difficult groups (Euphorbiaceæ, Moraceæ, etc.) in the "Flora of Tropical Africa", and later, in collaboration with the late Dr. J. M. Dalziel, for the whole of the "Flora of West Tropical Africa". Hutchinson's knowledge of African plants was enhanced by two extensive botanical expeditions in southern Africa between 1928 and 1930, and by a visit to West Africa in 1937. On the first of these expeditions he visited the greater part of the Union, including Namaqualand, and travelled with General Smuts in the Zoutpansberg. The second expedition was made at General Smuts' express invitation; on this occasion they explored widely through Southern and Northern Rhodesia, Nyasaland and Tanganyika. The results of these journeys were described by Hutchinson in his attractive book, "A Botanist in Southern Africa" (Gawthorn, 1946).

In 1936 Hutchinson was appointed keeper of museums at Kew. He received the honorary degree of LL.D. from the University of St. Andrews in 1934, and in 1947 was made a fellow of the Royal Society in recognition of his services to science in the field of plant classification. His "Families of Flowering Plants" (2 vols.) has become a standard work. In the horticultural field his special interest for many years was the genus *Rhododendron* and later the genus *Sorbus*. He has received various horticultural honours, including the Victoria Medal of Honour of the Royal Horticultural Society. In his retirement Dr. Hutchinson hopes to complete a revision of Bentham and Hooker's "Genera Plantarum" and also some botanical works of a more popular kind. The good wishes of all his friends go with him.

American Awards for Work on Penicillin

THE United States Medal for Merit, the highest award made by the President of the United States to a civilian, has been presented to Sir Alexander Fleming and also to Sir Howard Florey for their work on penicillin. The citations accompanying the awards are as follow:

Sir Alexander Fleming, for exceptionally meritorious conduct in the performance of outstanding services to the United Nations during 1939–45. Sir Alexander has distinguished himself and benefited mankind through his fundamental researches and exceptional scientific contributions on the therapeutic use of penicillin, which were of major importance to the successful completion of the mission of the medical services in World War II. His personal and enthusiastic assistance to medical officers in the European Theatre of Operations greatly advanced the earlier application of the penicillin programme than would otherwise have been possible in that theatre, thereby contributing materially to the care of the sick and wounded soldiers and to the conservation of man-power. Penicillin was a significant factor in halving the death-rate from wounds of United States troops in World War II as compared with those of World War I. Thousands of soldiers are alive to-day, and other thousands have been spared crippling disabilities, because of Sir Alexander's monumental contributions on penicillin.

Sir Howard Florey, for exceptionally meritorious conduct in the performance of outstanding services to the United Nations during 1939–45. Sir Howard distinguished himself during this period through important contributions and fundamental researches in the development of penicillin. His foresight in conferring with United States scientists of the National Research Council in June 1941 greatly furthered the knowledge of this antibiotic agent and its potentialities, and made possible the large-scale production of penicillin, for the incalculable benefit of the sick and wounded. His vigorous leadership in the researches and utilization of this agent stimulated medical scientists to greater effort and greatly extended the field of usefulness of penicillin. His enthusiastic personal assistance to medical officers in the European Theatre of Operations was of utmost importance in providing penicillin therapy for sick and wounded troops in that theatre at an earlier date than would otherwise have been possible. The significant role of penicillin as a major factor in reducing deaths from wounds is apparent, for the rate was halved over the death-rate of World War I. Thousands of soldiers are now alive and other thousands have been spared crippling injuries because of Sir Howard's leadership in the development and utilization of this antibiotic agent.

Guthrie Lecture of the Physical Society

THE Guthrie Lecture of the Physical Society will be given this year by Sir George Thomson, his subject being "The Growth of Crystals". The Lecture will be given on June 4 at the Science Museum, London, S.W.7, at 5 p.m. During the First World War, Prof. Thomson made notable contributions to aerodynamics; later his attention was directed to the demonstration of the wave nature of the electron and the proof of de Broglie's Law. These experiments, now classical, earned him the Nobel Prize in 1937. After his appointment to the chair of physics at the Imperial College of Science and Technology, the work on electron diffraction in particular was continued and led naturally to an interest in surface layers and to the general question of crystal structure. During the Second World War, Sir George Thomson held a number of important Government posts and more recently was the British delegate to the Atomic Energy Commission of the United Nations Organisation.

Inter-Departmental Committee on Overseas Scientific Relations

THE Lord President of the Council, on the advice of the Advisory Council on Scientific Policy, has approved the setting-up of an Inter-departmental Committee on Overseas Scientific Relations to consider and advise on questions of United Kingdom Government policy on matters of overseas scientific relations. Sir Edward Appleton is chairman, and in addition to representatives of Government departments, the membership will include the foreign secretary of the Royal Society, representatives of the British Council and of the Conference of Research Associations, and two university men of science. The secretary of the Committee is Mr. H. L. Verry, head of the Overseas Liaison Division, Department of Scientific and Industrial Research, 142 Piccadilly, London, W.1.

Scientific and Industrial Research in Palestine

THE Government of Palestine Board for Scientific and Industrial Research, which is the successor of the Scientific Advisory Committee of the Palestine War Supply Board formed in 1942, has issued a "Report of Activities, April 1945–March 1948" accompanied by summaries of research and a list of publications of the Board (Jerusalem: P.O. Box 607 and the Hebrew University. Pp. 56. 150 mils.; 3*s*.) A list of standing advisory committees and subcommittees and their personnel is included, as wel as of the projects carried out during 1946–48 and the institutions in which the research was located Most of the investigations are being published in scientific periodicals, but full reports of all of them are available on request at the Office of the Board The Sub-Committee for Citrus Products has compiled a card index of scientific literature on citrus product to serve as a reference work for further research The index covers the period 1927–46 and will be published in book form. The Sub-Committee for Water Research has dealt mainly with physico-chemical aspects of the problems, and a literature survey on the influence of ions on plants and soils has been published. Dr. M. Reiner, while studying methods of testing asphalt and bitumen used at the Road Research Laboratory in Britain, commenced investigations which led to the discovery of an important phenomenon in the deformation of asphalt, and visited England again in 1947 to follow up this discovery. A summary of his report on the rheological properties of bitumen and asphalt is included among the research summaries, as well as a joint note with A. Arnstein and M. Teinowitz on the loading test of reinforced concrete structures. Other research reports deal with bovine leptospirosis, the chemical composition of fodder plants in Palestine, chemical composition and nutritive value of foodstuffs produced in Palestine, citrus products, thermostable thromboplastin from human placenta, metabolic disturbance in diabetes, work hardening of polycrystalline metals, and several chemical investigations.

Royal Photographic Society's Annual Exhibition

THE Royal Photographic Society's ninety-third annual exhibition is to be held at the Society's House at 16 Princes Gate, London, S.W.7, during September and October this year. It will be in two parts, the first devoted to pictorial and colour photography and the second to scientific, technical, Nature and record photography. Lantern slides, colour transparencies and stereoscopic exhibits will be on view throughout the whole exhibition. The Scientific and Technical Group of the Society is very anxious to make the second part of the exhibition fully representative of the best work in all branches of modern applied photography. It may not be sufficiently widely known that the exhibition is open to all users of photography, and can assist them by giving them a standard against which to judge their own work. The Scientific Section of the exhibition is divided, for convenience, into seven classes: photomicrographs; radiographs (medical and industrial being judged separately); astronomical and meteorological; geological and metallurgical; survey (aerial and terrestrial); medical and surgical; other scientific photographs. Nature photography, record and technical photography (architectural, press, commercial and advertising) and kinematography are in separate sections. Scientific and technical films should be entered in the last section. Photographs produced in the course of scientific research are particularly welcomed.

Two awards are made annually by the Society in the Scientific Section, namely, the Hood Medal for meritorious performance in any branch of practical photography, and the Rodman Medal for outstanding work, preferably in photomicrography or radiography. The closing date for receiving entries is July 24.

American Section of the International Union of Crystallography

THE U.S. National Research Council has appointed a group of leading chemists, physicists and mineralogists to act as provisional executive committee of the American Section of the International Union of Crystallography, which will hold its first general assembly and congress at Harvard University during July 28–August 3. The Committee consists of Prof. L. O. Brockway, University of Michigan; Prof. M. J. Buerger, Massachusetts Institute of Technology; Prof. J. D. H. Donnay, Johns Hopkins University; Prof. I. Fankuchen, Polytechnic Institute of Brooklyn; Prof. C. Frondel, Harvard University; Dr. D. Harker, General Electric Co.; Dr. M. L. Huggins, Eastman Kodak Co.; Prof. A. L. Patterson (chairman), Bryn Mawr College; Prof. L. Pauling, California Institute of Technology; Prof. F. Seitz, Carnegie Institute of Technology; Prof. A. N. Winchell, American Cyanamid Co.; and Dr. R. W. G. Wyckoff, National Institute of Health. The Committee will recommend to the National Research Council a permanent constitution for the American Section of the Union, and will also advise the Council with regard to any matters which are of general concern to crystallographers in the United States. The British National Committee for Crystallography was announced in *Nature* of March 13, p. 390.

Education in Industry and Commerce

THE Minister of Education has recently announced that Lieutenant-General Sir Ronald Weeks has accepted the chairmanship of the newly established National Advisory Council for Education in Industry and Commerce. The Council has been set up to consider the national aspects of the policies of the ten regional councils and academic boards which have been constituted to develop and co-ordinate schemes for higher technological education in their respective regions. Sir Ronald was deputy chief of the Imperial General Staff from 1942 until 1945 and is now deputy chairman of Vickers, Ltd., and chairman of the English Steel Corporation, Ltd.

Conference on the Education of the Young Worker

A CONFERENCE on "The Education of the Young Worker" will be held at Manchester College, Oxford, during July 12–17, under the auspices of the Oxford University Department of Education, whose director is Mr. M. L. Jacks. The Conference aims at bringing together representatives of all the voluntary and statutory organisations, of central and local government departments, and others concerned in the education, employment and welfare of young people between the ages of fifteen and twenty, who are no longer receiving full-time education. It is hoped to produce a statement of policy applicable to the needs of these young people, setting out as clearly as possible the goals to be achieved in further education, whether in county college, industry or during leisure time. Suggestions will be made for practicable methods by which these goals can be achieved through the right co-ordination and administration of all available resources to form an integrated service, and some form of agreement will also be sought on the recruitment and training of all personnel who will be responsible for these young people. Well-known people, especially experienced in some aspect of this work, have been invited to speak at the Conference. The Conference itself will be divided into eight Commissions, namely: (1) county colleges; (2) leisure-time activities; (3) education in and through the job; (4) education for and in the Services; (5) recruitment and training of personnel; (6) differentiation in provision between the sexes; (7) differentiation between town and country; (8) administration and co-ordination. Further information can be obtained from the Director, University Department of Education, 15 Norham Gardens, Oxford.

Feeding Times of British Birds

The Rev. John Lees has recently made observations into the winter feeding hours of robins, blackbirds and blue-tits (*British Birds*, **41**, No. 3; March 1948). These were made during the periods October 1945–March 1946 and October 1946–March 1947, and showed that there was a rough similarity between the feeding frequency of all three species. Each shows almost equal maxima in the forenoon and afternoon and a midday slackening of activity. Beyond this the differences are strongly marked. The robin has its maxima well separated, these being associated with the hours after sunrise and before sunset; the less active period over midday extends to about five hours. The blackbird has maxima close together, one and a half hours on each side of midday, the noon break being short and not pronounced. With the blue-tit the maxima are between those of the other two species and there is a well-defined break at midday.

British Bryological Society

The members of the British Bryological Society assembled at Buxton during March 30–April 6 for the annual general meeting and week of field excursions. In spite of somewhat varied weather conditions, the members, under the leadership of Messrs. R. H. Hall and F. A. Sowter, visited Kinder Scout, Lathkill Dale, Dovedale and Monks Dale, and a considerable amount of field-work was accomplished. Two visits were made to Kinder Scout; on the first occasion the party proceeded to the edge of Kinder plateau via Grinds Brook, and on the second visit the ascent was made by Ashop Clough. The results of the field-work will be published later in the *Transactions* of the Society. The annual general meeting was held on April 2, with the president, Mr. A. Thompson, in the chair; the secretary, Mr. E. C. Wallace, reported a considerable increase in the number of new members. Dr. W. Watson (Taunton) and Mr. W. R. Sherrin (South London Botanical Institute) were unanimously elected honorary members in recognition of their long and valuable services to bryology and bryologists.

Matter-Radiation Cycle

Referring to his communication entitled "The Matter-Radiation Cycle in the Cosmos (and the Second 'Law'): the Sun's Equilibrium" in *Nature* of December 27, 1947, p. 906, Mr. Alfred Lauck Parson writes: "The expression used for the temperature which could be reached by inter-stellar matter in imagined finite groups of nebulæ should have been

$$T_2 = T_1 \times \sqrt[4]{\frac{A_1(1-F)}{A_2\left\{F + \frac{1}{A_2}(1-F)\right\}}}$$

and not $T_2 = T_1 \times \sqrt[4]{(1-F)}$, T_1, T_2 being the temperatures of the stars and of the interstellar matter, A_1, A_2 their superficial areas, and F the fraction of radiation escaping at the assumed radius of the group. The change does not affect the general conclusion."

Colonial Service Appointments

The following appointments have been made in the Colonial Service: H. W. Hamlin, assistant conservator of forests, Tanganyika; H. S. H. Watson, assistant conservator of forests, Northern Rhodesia; J. R. Fletcher, inspector of mines, Malaya; A. J. MacNair, temporary agricultural (cocoa survey) officer, Gold Coast; J. Phipps, entomological biologist, Tanganyika; T. C. Stibbs, mining inspector, Lands and Mines Department, British Guiana; G. W. Lock (senior agricultural officer, Tanganyika), senior research officer, Tanganyika; A. E. S. McIntosh (senior agricultural officer, Federation of Malaya), deputy director of agriculture, Federation of Malaya; F. J. Pound (senior agricultural officer, Trinidad), deputy director of agriculture (crop husbandry), Trinidad; G. M. Roddan (deputy agricultural adviser, Colonial Office), deputy director of agriculture, Kenya; O. S. Swainson (senior agricultural officer, Zanzibar), director of agriculture, Zanzibar; S. G. Willimott (chemist, Department of Chemistry, Federation of Malaya and Singapore), chemist (soils), Federation of Malaya; H. A. Hay-Barclay (senior veterinary officer, Nigeria), regional assistant director of veterinary services, Nigeria; A. Fulton (senior veterinary officer, Gold Coast), director of veterinary services, Sierra Leone/Gambia; L. R. Hutson (chief veterinary officer, Leeward Islands), veterinary officer, Department of Science and Agriculture, Barbados; J. W. Macaulay (veterinary research officer, Northern Rhodesia), senior veterinary research officer, Northern Rhodesia; J. Morton (veterinary officer, Nigeria), regional assistant director of veterinary services, Nigeria; H. G. Stewart (veterinary officer, Uganda), senior veterinary officer, Uganda.

Announcements

Prof. Paul Fallot, professor of geology in the University of Nancy, has been elected a member of the Section of Mineralogy of the Paris Academy of Sciences, in succession to the late Léon Bertrand.

The Stephen Paget Memorial Lecture of the Research Defence Society will be delivered by Prof. P. A. Buxton on the occasion of the annual general meeting of the Society, to be held at the Royal Society of Tropical Medicine, London, on June 8. Prof. Buxton's address will be on "Tsetse Flies and the Development of Africa", and it will be illustrated by a film in colour.

John A. Harrison, assistant education officer of Surrey County Council, has been appointed director of the Educational Foundation for Visual Aids. Mr. Harrison has had considerable experience of the use of visual aids to education both in the Services and in civilian teaching. During 1931–45 he used visual aids almost continuously in all types of education in 1938, while holding a Carnegie research scholarship, he visited many American schools, givin particular attention to the use of visual aids.

An appointment is to be made shortly to th Dewar Research Fellowship, tenable in the Dav Faraday Research Laboratory of the Royal Institution. The Fellowship, which is of the value of £1,00 a year, is open to persons of either sex, and is for period of three years. The subject of research mus be related to the chemical or physical science Previous holders have been Prof. A. R. Ubbelohd of the Queen's University, Belfast, and Dr. Kathlee Lonsdale, of University College, London. Applications must be made by letter to the General Secretar Royal Institution, 21 Albemarle Street, London, W. before June 30.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Branched-Chain High Polymers

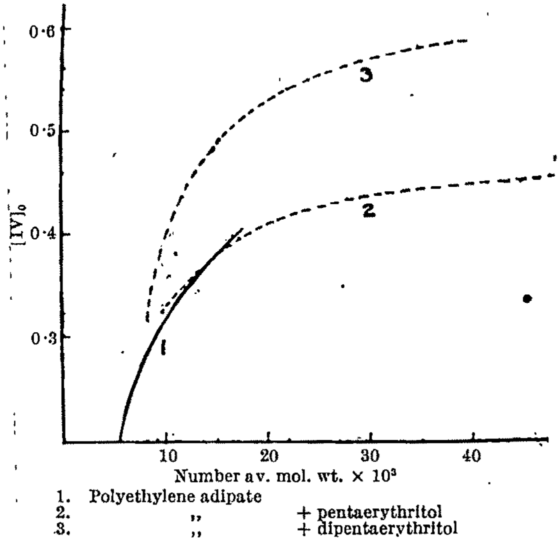
If two bifunctional molecules such as ethylene glycol and adipic acid are esterified in equal proportions, linear super-ester molecules are produced. In a similar way polyamides and polyurethanes may be produced, the chemistry of the process being such that only linear polymers are, in fact, formed. On the other hand, if one of the reactants contain three or more functional groups, for example, glycerol, then instead of linear molecules, branched molecules are first formed ; but these branched products soon join up into three-dimensional networks which are insoluble and, therefore, not suitable for detailed investigation. Between these two extremes there must inevitably be produced molecules containing branched chains which, if the chains are not indefinitely long, should be soluble. Owing to the rapidity with which the network stage is reached, it has not hitherto been possible to isolate and characterize branched-chain molecules possessing long branches. Yet it is of great interest to know something of the thermodynamic and hydrodynamic behaviour of solutions of such molecules. The only branched molecule of which the structure has been determined is amylopectin. Here, however, it is not possible to vary the length of the branches while keeping the number fixed. It is, moreover, just the kind of variation that must be produced if the necessary information about branched-chain molecules is to be obtained. The present communication describes the attempts that have been made to synthesize, characterize and measure the properties of branched-chain super-ester molecules.

The principle of the method involves the copolymerization of a small amount of polyfunctional compound such as pentaerythritol, dipentaerythritol, trimethylol propane, with ethylene glycol and adipic acid. The polyfunctional compound is added to a polyethylene adipate of a high degree of polymerization ; the polymer is then slightly depolymerized by heating at atmospheric pressure in nitrogen and then repolymerized, with the incorporation of the pentaerythritol, at 0·1 mm. of nitrogen. It proved possible to stop the reaction just short of the gel point, when polymers of a molecular weight much greater than that of the polyethylene adipate were obtained.

In order to characterize these polymers, it is necessary to measure the number average molecular weight by osmometry, and the number of chain ends or the number of points at which branching takes place. End-group determination proves to be most suitable. The method was tested with the parent polyethylene adipate, which was prepared by heating adipic acid with a threefold excess of glycol, no catalyst being present. The diglycol ester of adipic acid is first formed. This on further heating loses glycol, finally resulting in the formation of a super-ester with terminal hydroxyl groups.

A given weight of this ester was analysed for the total number of hydroxyl groups and the total number of molecules present measured by osmometry. It turned out there were on the average two hydroxyl groups per polymer molecule.

Using the same method with the supposedly branched polymers, it was found that those molecules containing pentaerythritol had four hydroxyl groups per molecule, and consequently must be cruciform in shape with the pentaerythritol nucleus at the centre. With dipentaerythritol, six hydroxyl groups per molecule are found, corresponding, therefore, to a molecule with six arms radiating from the dipentaerythritol nucleus as a star-shaped molecule. With trimethylol propane, $C_2H_5C(CH_2OH)_3$, the molecules contain six hydroxyl groups, implying, therefore, the incorporation of two trimethylol propane units before gelling sets in. Thus the structure of this polymer will be double *Y*-shaped, the two branches which it contains originating from two different points instead of the same point as with the pentaerythritol polymers. By varying the proportion of the polyfunctional alcohol, it is possible to prepare a series of molecules of the above-mentioned structures of different molecular weights from 10,000 up to about 50,000. This fact proves conclusively that these molecules contain long branches, because by this technique it is difficult to prepare linear super-esters with molecular weights exceeding 10,000.



The intrinsic viscosity of solutions in chloroform are plotted as a function of molecular weight in the accompanying graph. With the linear molecules (curve 1) the intrinsic viscosity $[\eta]$ is not linearly proportional to molecular weight ; the exponent in the equation $[\eta] = K(MW)^a$ is 0·9. With the branched-chain polymers, the intrinsic viscosity increases rapidly at first but tends to a maximum, the maxima being different for curves 2 and 3. The fact that the value of $[\eta]$ tends to become independent of molecular weight is in agreement with the Einstein theory of the viscosity of colloidal solutions, if it is assumed that the molecules are tending to a spherical shape in solution. The maximum value of the intrinsic viscosity of 0·6 is, however, much smaller than the Einstein value of 2·5. It will be observed that the linear polyethylene adipate and the cruciform adipate have similar intrinsic viscosities in the range 10,000–20,000 in molecular weight. Thus it would not be possible by measurements of intrinsic viscosity and number average molecular weight above to discriminate between molecules of such different structure. In fact, one general conclusion from these experiments is that branching in a high-polymer molecule is unlikely to be easily detected even though an authentic linear polymer of the same number average molecular weight were available for comparison. In a similar way, the variation of viscosity with concentration of the branched-chain molecules as compared with linear molecules is in qualitative agreement with the theories already put forward, but the results are not nearly so clear cut as the theories would predict.

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Catalytic Poisons and Magnetic Susceptibility

THE alkyl sulphides are powerful catalytic poisons for palladium, and the nature of the adsorption link is therefore of great interest. On chemical grounds, Maxted[1] has suggested a co-ordinate link from the sulphur atom to the metal. Here we record some preliminary measurements on the change in magnetic susceptibility of palladium due to adsorption of dimethyl sulphide. We conclude that electrons from the sulphur atom enter the *d* band of the metal (in an analogous way to the electrons from *dissolved* hydrogen atoms[2]).

A finely divided sample of palladium powder (prepared by reduction of palladium chloride in glycerine by hydrogen gas at 150° C.) was evacuated in an ampoule at 150° C., sealed off, and its susceptibility measured by the Sucksmith method[3]. The ampoule was then reattached to the vacuum apparatus and the palladium saturated with dimethyl sulphide gas at 20° C. The amount adsorbed was measured, the ampoule resealed and measured in the magnetic balance.

Column 2 of the accompanying table shows the change in susceptibility of the palladium powder expressed as a percentage change on the original value χ. Column 3 gives the percentage change in χ due to the effect of adsorption on the palladium alone; that is, it is the value in column 2 *minus* the calculated diamagnetic susceptibility of the adsorbed dimethyl sulphide.

$\frac{100\ a^*}{b}$	$100\frac{\Delta\chi}{\chi}$	$100\left(\frac{\Delta\chi}{\chi}\right)_{\text{Pd}}$	$100\left(\frac{\Delta\chi}{\chi}\right)_{\text{calc.}}$
27	10·1	8·0	13·5
23	7·9	6·0	11·5

* *a* moles dimethyl sulphide adsorbed on *b* gm. atoms palladium powder.

The effect of the dimethyl sulphide is outside the experimental error of 2 per cent on χ, and is of the right order to be expected if one electron from the dimethyl sulphide enters the *d*-band of the metal. Since dimethyl sulphide is an easily condensable gas, the adsorption will correspond to *at least* two monolayers; that is, a van der Waals layer on top of a chemisorbed layer. Only the chemisorbed layer will affect the susceptibility, and this will contain *up to* half the adsorbed quantity in column 1. At this stage we can do no more than assume that a chemisorbed molecule transfers an electron to a vacant surface *d* orbital, and thus the susceptibility of the surface palladium atoms is reduced to zero (there is 0·55 mole in the *d*-band per palladium atom[2]). This would then yield the calculated decrease in susceptibility shown in the last column.

It is not worth discussing the discrepancy between observed and calculated figures until experiments with clean surfaces have been made. The main point of contrast is that if the electrons entered the *s*-band of the metal, the susceptibility change would have been immeasurably small.

It is hoped to develop this experiment along more quantitative lines, since it offers an approach to an important aspect of adsorbed layers. These preliminary measurements were made in the Physics Department of the University of Bristol, and we are grateful to Drs. H. Heitler and L. C. Jackson for their help and advice.

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Feb. 2.

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Synthetic Pentapeptides Related to Gramicidin-*S*

THE polypeptide nature of several antibiotics is of considerable interest. As recent work in this field overlaps to some extent with our own, we wish to give a preliminary account of our studies on synthetic peptides related to gramicidin-*S*.

Synge[1] extended the limited data published by Russian workers[2–4], and suggested that gramicidin-*S* was the hydrochloride of a basic peptide with a stoichiometric minimum unit containing equimolecular proportions of the five amino-acids, *L*-ornithine, *L*-proline, *L*-valine, *L*-leucine and the unnatural *D*-phenylalanine. Each stoichiometric unit contained one free amino group but no free carboxyl groups. The free amino group was later identified[5] as the δ-amino group of ornithine, and gramicidin-*S* was formulated as a cyclic peptide of five amino-acids linked through their α-amino and carboxyl groups. Degradative studies involving the technique of partition chromatography furnished strong evidence for the structure [α-(valyl-ornithyl-leucyl-phenylalanyl-prolyl-)]$_n$ [6]. On the basis of the physical information so far available, gramicidin-*S* is best formulated as a cyclopentapeptide, or as a cyclodecapeptide where the above unit occurs twice in a closed peptide chain.

In the hope that some light might be thrown on the origin of the striking antibiotic action of this peptide, we decided to carry out parallel syntheses so as to obtain two pentapeptides with phenylalanine present in both its optically active forms. Numerous alternative routes to such a pentapeptide might be envisaged. After several different combinations had been tried, it was decided that for ease of handling, which was a dominant consideration, synthesis of a tripeptide from leucine, phenylalanine and proline, and the coupling of this tripeptide with a dipeptide from valine and ornithine, would have a reasonable chance of success. For all syntheses carbobenzoxy derivatives were employed according to Bergmann's general procedure, and coupling was effected in each case through the acid azide.

Cbzo-L-phenylalanine hydrazide was converted to the azide, coupled with *L*-proline ethyl ester, and the carbobenzoxy group removed by catalytic reduction. The dipeptide ester with *Cbzo-L*-leucine azide gave *Cbzo-L*-leucyl-*L*-phenylalanyl-*L*-proline ethyl ester. The acylated tripeptide ester could not be crystallized, but analysed satisfactorily (found: C, 67·2; H, 7·3; N, 8·18; theory: C, 67·1; H, 7·3; N, 7·84 per cent). It was used for coupling with the appropriate dipeptide without further purification.

For the synthesis of the isomeric tripeptide a modified procedure was used which gave crystalline intermediates. *Cbzo-L*-leucine azide coupled with *D*-phenylalanine methyl ester to give *Cbzo-L*-leucyl-*D*-phenylalanine methyl ester, m.p. 110°. The hydrazide (m.p. 170°) from this ester gave an azide which was condensed with *L*-proline methyl ester; the resulting acyltripeptide ester was purified as the hydrochloride after removal of the carbobenzoxy group. The tripeptide methyl ester hydrochloride $[\alpha]_D^{20} = -38{\cdot}9°$ [anhydrous methanol, $C = 2{\cdot}0$] melted at 240°.

The two optically isomeric tripeptide hydrochlorides were tested *in vitro* against *Staphylococcus aureus*, *Streptococcus hæmolyticus* and *Escherichia coli*. Both peptides inhibited growth at a concentration of 1–2 mgm./ml., but were inactive at lower concentrations.

For preliminary experiments on open-chain pentapeptides we used the readily obtainable *DL*-ornithine rather than the rarer *L*-ornithine, as we did not consider that use of an optical mixture of *L*-valyl-*L*-ornithine and *L*-valyl-*D*-ornithine would affect the validity of our conclusions. *Cbzo-L*-valyl-δ-*Cbzo-DL*-ornithine methyl ester, was prepared by the azide method and crystallized readily, m.p. 150°. This was converted through the hydrazide to the azide, and coupled with both the tripeptide esters already described. Both the dicarbobenzoxypentapeptide esters were difficult to handle; they set to stiff gels when attempts were made at recrystallization. After repeated precipitation of one gel, a product, m.p. 128–132°, was obtained which analysed satisfactorily for *Cbzo-L*-valyl-δ-*Cbzo-DL*-ornithyl-*L*-leucyl-*L*-phenylalanyl-*L* proline ethyl ester (found: C, 65·0; H, 7·4; N, 9·85; theory: C, 65·2; H, 7·2; N, 9·5 per cent). After five further 'crystallizations' from aqueous methanol, the small quantity of material remaining melted at 164° and again analysed satisfactorily.

The second, isomeric acylated pentapeptide ester melted at 198–200°, after purification by the same means, and analyses were satisfactory for *Cbzo-L*-valyl-δ-*Cbzo-DL*-ornithyl-*L*-leucyl-*D*-phenylalanyl-*L*-proline methyl ester (found: C, 64·5; H, 7·1; N, 10·0; theory: C, 64·8; H, 7·1; N, 9·7 per cent). As a final check on the identity of the two peptides, these were hydrolysed and the hydrolysates subjected to chromatographic analysis on paper by the usual technique[7]. The presence of the required five amino-acids was demonstrated by comparison with an artificial mixture.

The above work was essentially of an exploratory nature and was carried out on the smallest scale consistent with the requirements of the biological tests. We are now repeating the synthesis of the *LLLDL*-pentapeptide on a larger scale using *L*-ornithine so as to eliminate any doubts about the optical purity of the final product.

No significant difference in antibacterial action was apparent between 'natural' and 'unnatural' isomers at either the tripeptide or the pentapeptide stage. These results support the view already expressed[8] that antibiotics containing *D*-amino-acids are active, not because they have this character in common, but rather in virtue of their specific structures, of which the *D*-amino-acids must be regarded as an integral part.

Crowfoot (private communication) has expressed the opinion from a study of models that *D*-configuration of some of the constituent amino-acids in a peptide such as gramicidin-*S* would facilitate cyclization. It is thus reasonable to postulate that the activity of this peptide is a function of its cyclic nature. When larger supplies of open-chain pentapeptide become available, we hope to study the effect of polymerization and, if possible, of cyclization, on antibacterial action. A full account of this work will be published elsewhere.

We are indebted to Dr. A. T. Fuller for carrying out the biological tests.

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April 6.

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Reversion: a New Procedure in Absorptiometry

MANY metals form coloured complexes with dithizone, and the successful use of this reagent for estimating one of them in a mixture demands a careful selection of organic solvent, a rigorous control of *p*H and other variables such as duration of shaking, nature and amount of neutral salts present, the concentration of excess dithizone, and the concentration of 'masking' reagents capable of competitive complex formation with interfering metals[1]. The coloured metal complexes (yellow, red, violet, etc.) modify the colour of the green solution containing excess dithizone giving a 'mixed-colour' extract, and by absorptiometric measurements the proportion of metal complex can be estimated with reference to calibration curves obtained by treating known amounts of metal by the standardized procedure. Such curves are commonly valid only for one initial concentration of dithizone, and error may be introduced in view of the well-known impermanence of this reagent. The theoretically obvious solution for such systems with two coloured components is to measure the transmittency at two appropriate wave-lengths; but this involves a burdensome amount of preliminary work for, in effect, a family of calibration curves must be constructed to cover all possible variations in reagent concentration and in the amount of metal taken for analysis[2].

In a systematic study of the estimation with dithizone of traces of mercury in biological materials[3], we have shown that in the absence of suitable masking reagents mercury cannot be extracted quantitatively, even under optimum conditions, without co-extraction of more or less copper. Both theoretically and practically it is to be anticipated that this interference by copper (which is returned as mercury) will increase as the concentration ratio copper/mercury in the analysis sample increases. A similar situation will be encountered in other metal dithizone systems should the prescribed conditions of extraction be inadvertently departed from or the masking agent prove inadequate to the demands made upon it. In these circumstances the 'mixed-colour' extract will contain, besides excess dithizone and the metal complex being estimated, varying amounts of one or more unwanted metal complexes. No provision has been made for this contingency in any of the procedures described hitherto, and we have therefore developed a new approach.

If E_m is the optical density of a mixed-colour extract measured in a cell of length l, containing concentrations C_c of metal-dithizonate of formula MDz_n, C_d of excess dithizone, and C_i of other coloured impurities (foreign metals co-extracted as dithizonates, coloured impurities from the decomposition of reagent or from biological digests, etc.) of extinction coefficients ε_c, ε_d and ε_i respectively, then

$$E_m = l\,(C_c\varepsilon_c + C_d\varepsilon_d + \Sigma C_i\varepsilon_i).$$

If now the organic extract is shaken with an aqueous solution of some *specific* reagent which will decompose only the desired metal complex, returning the ions M^{n+} to the aqueous phase and liberating nC_c equivalents of dithizone in the organic layer, the optical density (at the same wave-length) will change to a value given by

$$E_r = l\,(nC_c\varepsilon_d + C_d\varepsilon_d + \Sigma C_i\varepsilon_i).$$

This process we term 'reversion'. The change in optical density, the reversion value, given by

$$R = E_r - E_m = l\,(n\varepsilon_d - \varepsilon_c)\,C_c,$$

is seen to be a linear function of the concentration of metal being estimated, and is independent of the concentration of dithizone taken.

Using a Hilger 'Spekker' absorptiometer with an Ilford Orange Filter No. 607, our reversion curve for mercury is linear over the range 0–2·4 p.p.m. A change in optical density of 0·1 corresponds to 0·33 p.p.m. of mercury, a sensitivity materially greater than that of the best contemporary methods[4]. Since $\varepsilon_d \gg \varepsilon_c$ at the wave-length chosen, all measurements involve essentially estimates of the same species (dithizone), and the same lamp-filter combination is used when determining both E_m and E_r. Indeed, if the concentration axis is graduated in units of gram-equivalents, a single calibration curve can be used, with no serious loss of accuracy, for the estimation of such varied metals as silver, lead, mercury and bismuth[5].

The major advantages of reversion procedure are: (1) standard solutions of dithizone are not required and changes in strength on keeping are unimportant; (ii) errors due to metals or other coloured materials co-extracted (term $\Sigma C_i\varepsilon_i$ above) are eliminated; and (iii) when estimating metals such as lead and cadmium where excess dithizone passes into the aqueous layer to an extent dependent upon the alkalinity of this medium, slight variations in the pH of extraction can introduce no error. The general principle of reversion is equally applicable to other suitable systems; for example, metals and oxine, or *o*-nitrosophenol, etc., or to measurements on mixtures absorbing in the ultra-violet or infra-red.

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Gases Liberated from Explosions Initiated by Impact

TRUE detonation in high explosives normally gives as the major products gases such as carbon dioxide and monoxide, water, nitrogen and hydrogen[1,2], the relative quantities obtained being in general accordance with calculations based on equilibrium considerations. The thermal decomposition of explosives, on the other hand, gives more complicated products such as nitrogen oxides, aldehydes and complex condensation products, which may undergo further secondary reactions[3,4]. It was of interest to see whether the products from impact-initiated explosions would approximate more closely to those of detonation or thermal decomposition. Results with the two nitric esters, nitroglycerin and pentaerythritol tetranitrate, and the nitroamine, *cyclo*-trimethylenetrinitramine, reveal an intermediate behaviour. The figures are given in the accompanying table. The impacts were carried out in a vacuum apparatus[5]. For comparison, some figures for the explosive decomposition of nitroglycerin and pentaerythritol tetranitrate are quoted.

COMPOSITION OF GASES (PER CENT)*

	NO_2	NO	N_2O	N_2	CO_2	CO	H_2	O_2
Nitroglycerin								
Detonation[6]	—	—	—	32·0	63·1	—	—	4·9
Impact	—	29·7	2·3	11·7	28·8	22·5	5·0	—
Decomposition (180° C.)	—	50·3	1·0	2·1	17·2	28·9	0·5	—
Pentaerythritol tetranitrate								
Detonation[2]	—	5·3	—	22·8	37·0	26·7	6·8	1·4
Impact	—	24·3	5·3	9·4	19·1	35·4	6·5	—
Decomposition (210° C.)	12·0	47·6	9·5	1·6	6·3	21·0	2·0	—
cyclo-Trimethylene-trinitramine								
Impact	—	—†	11·3	43·3	18·8	21·3	5·3	—
Decomposition (267° C.)	—	22·5	22·8	31·0	13·2	8·7	1·8	—

* The water content was not determined. Considerable quantities of formaldehyde were noted in impact and decomposition experiments with *cyclo*-trimethylenetrinitramine and pentaerythritol tetranitrate.

† On some occasions a little nitric oxide was formed.

The results are consistent with the view that the decomposition under impact conditions occurs by a very similar mechanism to that operative in thermal decomposition, the secondary reactions of aldehyde oxidation proceeding to a further extent probably on account of the higher temperatures. The results are in harmony with the hypothesis of a thermal origin of impact-initiated explosions and with the slow initial burning velocities observed with the rotating-drum camera[7].

Our thanks are due to Mr. L. Phillips for analysing the gases from the thermal decomposition of nitroglycerin. This communication is published by permission of the Chief Scientist, Ministry of Supply.

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'Semaphore' Numerals

ENOUGH is now known, as the Royal Society discussion on the subject on March 4 made clear [see *Nature*, May 8, p. 712], about the logical, physical and mechanical principles, and of the engineering, to make the existence of a number of high-speed digital computing machines a matter of time, and of comparatively short time, only. We can, in fact, do arithmetic at very high speed.

But the speed of any composite process is governed mainly by the speed of its *slowest* component. At present, 'input' and 'output' cannot take place at speeds in any way comparable with the attainable speed of computation. The machine should be able to do *all three* of the 'three R's' at comparable speeds—it must learn to Read and to wRite, and to do these quickly, as well as to do aRithmetic! Reading is the most important, for it should occur at a rate per digit comparable with an 'addition time'; but 'output' will not slow down the process if recording a result takes no longer than the chain of arithmetical operations which produces it.

Towards the end of the recent discussion, Mr. Wilkinson remarked that he had given some thought to the processes by which the human eye recognizes the numerals as printed or written, and seemed to imply that present forms would prove difficult for the low-grade intelligence of the robot to recognize. The alternative is, presumably, to introduce a new, simple and systematic set of numerals, simple enough for the robot but usable also by the human, so that mathematical tables might be printed in a form universally available, needing *no further coding* for the robot. We present here a possibility in this direction. While it would be unwarrantable optimism to presume that it is the last word, it is upon some such lines that progress depends, and a concrete suggestion may stimulate thought and discussion which vague generalities would not.

Working in the binary scale would be too cumbersome; working in some power of 2, say, 8 or 16, would not be too remote from the decimal scale—but it would entail the re-learning of arithmetic, 'multiplication tables and all that'. Indeed, a proposal to abandon the decimal system would be too revolutionary to stand any chance of general acceptance. But, fortunately, $10 - 1 = 3^2$, so that a dual use of a trinity of symbols will suffice. Such a possibility is presented by the three positions of a semaphore, upright, or inclined to left or right. The combination of upward-pointing and downward-pointing triads gives us the nine digits. A scheme, easy to write, easy to read—and *very* easy to remember—is presented in Fig. 1.

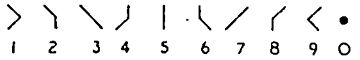

Fig. 1

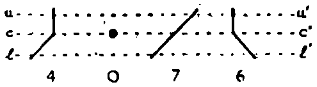

Fig. 2

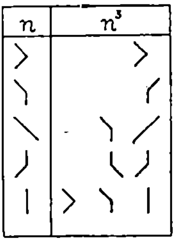

Fig. 3

The provision of a zero can be met by a central dot (a mere blank is not satisfactory). In writing, the comma can (as it now does in many countries) serve as a decimal point, and a lower point could—if desired—be used to indicate multiplication, but these would not be relevant to 'reading' by the robot.

The machine 'scanning' of the new numerals could be horizontally, for serial operation. Two 'eyes' are essential, but a third central one is desirable, to provide a time-scale and to sense the zeros.

The method is indicated by the dotted lines in Fig. 2. The three eyes will scan the lines uu', cc', and ll', and the impulses due to crossing the lines or the dot will be interpreted by circuits in the machine, so that the number read is fed into the appropriate register.

If this, or some similar, suggestion is accepted, it remains to fix an agreed standard size and spacing, and to use these numerals in printing all new mathematical tables. Re-coding of existing tables could also be undertaken. Some idea of appearance is given in Fig. 3, representing the beginning of a table of cubes.

Visual users of mathematical tables could rapidly master (and indeed use) the new code, and the problem of making robots wRite would be in no way more difficult.

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Angular Distribution of Radioactive Disintegration Products

THE thermodynamics of the orientation of nuclei by strong magnetic fields at very low temperatures was worked out by Simon[1] in 1939. He found that with fields of 100,000 gauss and temperatures of 0·01° K., that is, under conditions which can be realized experimentally, the entropy of nuclear spin systems should be decreased by about 20–30 per cent, and would remain, of course, at this reduced value after adiabatic demagnetization. This would be sufficient to influence properties which depend on nuclear orientation, and the first experiments he contemplated were on the angular distribution of radioactive disintegration products originating from a partially oriented nuclear spin system. Preparations for these experiments, which were interrupted by the War, are now going ahead at the Clarendon Laboratory. It should be added that in the meantime experiments on nuclear induction have shown that the 'reaction velocity'—at least in some nuclear spin systems—is still very high even at temperatures as low as 1° K. [2].

In the present note, theoretical calculations have been made of the nature and magnitude of the effects to be expected. These are based on the state of the oriented system before the adiabatic demagnetization, as this is easier to realize in experiment. In making these calculations, the use of any particular 'models' of the process of disintegration has been avoided so far as possible, since it is possible to go a long way by applying some of the more elementary results of the theory of representations of the group of rotations to eigenstates of angular momentum.

The results so far obtained are as follows. Let $F(\theta)$ denote the angular distribution of the emitted particles (intensity in direction of emission θ, θ being the angle between the direction of emission and the direction of the orienting magnetic field). Then for a nucleus of initial spin J,

$$F_J(\theta) = \sum_M c_0{}^M \cosh M\beta + \sum_p \{\sum_M c_p{}^M \cosh M\beta\}.\cos^{2p}\theta, \qquad (1)$$

where p is a positive integer $\leqslant J$; M is $-J, -J+1, \ldots, +J$; β is $\mu H/kTJ$; μ is magnetic moment of initial nucleus; H is magnetic field; T is absolute temperature; k is Boltzmann's constant; $c_0{}^M$, $c_p{}^M$ are constants independent of H, T, θ, but otherwise dependent on the particular transition considered;

$$\sum_M c_p{}^M = 0, \text{ for all values of } p > 0.$$

This form of the function $F(\theta)$ holds irrespective of the nature and angular momenta of the particles emitted, and of whether they are emitted singly or together with other particles (as, for example, in beta emission). The term particle here includes photons. The constants $c_0{}^M$, $c_p{}^M$ are undetermined by the general method used in establishing this formula.

A particular result is that for $J = 1/2$ there can be no directional effects.

If $\mu H/kT \leqslant 1$, a sufficiently accurate form of expression (1) is

$$F_J(\theta) \propto 1 + (\mu H/kT)^2 (k_1 \cos^2\theta + k_2 \cos^4\theta + \ldots + k_p \cos^{2p}\theta).$$

Here $p \leqslant J$; the constants $k_1, \ldots k_p$ are, of course, also undetermined.

These formulæ do not include the deflecting effect after emission of the magnetic field on the emitted particle (if charged), as this effect depends on the experimental arrangement, and can be calculated classically since the de Broglie wave-length of the particles will be small compared with the dimensions of the apparatus.

A more detailed method has also been used to calculate the angular distribution of γ-rays emitted from oriented nuclei in a 2^l-pole transition; this method is also being applied to alpha and beta emission.

Let $F_{JJ'}(\theta)$ denote the angular distribution resulting when a nucleus of initial spin J emits a 2^l-pole γ-ray and the final nucleus has spin J'. Then

$$F_{JJ'}(\theta) = \sum_{M=-J}^{+J} e^{M\beta} \sum_{M=-l}^{+l} \left(c_{M-m,m}^{\;JJ'l}\right)^2 . T_{lm}(\theta),$$

where

$$T_{lm}(\theta) = \tfrac{1}{2}(l-m+1)(l+m)(P_l{}^{m-1})^2 + m^2 (P_l{}^m)^2 + \tfrac{1}{2}(l+m+1)(l-m)(P_l{}^{m+1})^2.$$

Here M is z minus component of total angular momentum J of initial nucleus; m is z minus component of total angular momentum l of emitted photon (that is, $m = -l, -l+1, \ldots, +l$); $P_l{}^m$ is a normalized associated Legendre function of order l; β has the same meaning as above.

The coefficients $c_{M-m,m}^{\;JJ'l}$ are those which occur in the group theoretical derivation of the formulæ for the 'vector addition' of quantized angular momenta. They may be calculated from the formula,

$$c_{m_1 m_2}^{Jj_1j_2} = \sum_{\nu=0}^{\lambda} (-1)\, \frac{\nu\sqrt{\{(j_1+m_1)!\,(j_1-m_1)!\,(j_2+m_2)!\,(j_2-m_2)!\,(J+M)!\,(J-M)!\}}}{(j_1-m_1-\nu)!\,(j_1+m_1-\lambda+\nu)!\,(j_2+m_2-\nu)!\,(j_2-m_2-\lambda+\nu)!\,\nu!\,(\lambda-\nu)!}$$

where $\lambda = j_1 + j_2 - J$ and $M = m_1 + m_2$ (see Van der Waerden[3]).

The expression for angular distribution has been evaluated in the case of dipole transitions ($l = 1$). In this case we can have $J' = J+1, J, J-1$, and then, provided $J \geqslant 1$ (there are no effects for $J = 0$ or $\tfrac{1}{2}$),

$$F_{J,J+1}(\theta) \doteq 1 + \left(\frac{H\mu}{kT}\right)^2 . \frac{1}{40} . \frac{2J-1}{J}. \cos^2\theta,$$

$$F_{J,J-1}(\theta) = 1 + \left(\frac{H\mu}{kT}\right)^2 . \frac{1}{40} . \frac{(J+1)(2J+3)}{J^2} \cos^2\theta,$$

$$F_{J,J}(\theta) = 1 - \left(\frac{H\mu}{kT}\right)^2 . \frac{1}{40} . \frac{(2J-1)(2J+3)}{J^2} \cos^2\theta,$$

provided in each case $H\mu/kT \leqslant 1$.

Inserting numerical values, we may write

$$F_{JJ'}(\theta) = 1 + 3{\cdot}34 \times 10^{-11} \left(\frac{H(\text{kilogauss}) \times \mu(\text{nuclear magnetons})}{T\,(°\text{ K.})}\right)^2 f(J, \delta J). \cos^2\theta.$$

Some values of $f(J, \delta J)$ are given in the table below:

δJ	$f(J, \delta J)$	Values of $f(J, \delta J)$ $J = 1$	$3/2$	$9/2$	$11/2$
$+1$	$(2J-1)/J$	1	1·3	1·8	1·8
-1	$(J+1)(2J+3)/J^2$	10	6·6	3·3	3·0
0	$-(2J-1)(2J+3)/J^2$	-5	$-5{\cdot}3$	$-4{\cdot}7$	$-4{\cdot}6$

If we take, say,

$T\,(°\text{ K.}) = 0{\cdot}01$;
$\mu(\text{nuclear magnetons}) = 3$;
H/K gauss $= 100$;

the resulting departure from spherical symmetry is of the order of $0{\cdot}03\,f$, that is, it lies between 3 and 30 per cent.

No definite conclusions can, of course, be drawn from this last calculation as to the magnitude of the effect in the case of higher multipole emission, though it seems possible that this will be of the same order as in the dipole case.

I would like to express my thanks to Prof. M. H. L. Pryce for the interest he has taken in these calculations.

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Capture of Negative Mesons by Nuclei

Several writers[1] have commented on the unexpectedly long period which has been found for the nuclear capture of negative mesons from cosmic radiation at low altitudes (about 10^{-6} sec. in aluminium[2]). It has been estimated[3] that if this radiation fell on matter, the mesons would take about 10^{-12} sec. to be slowed down by Coulomb interactions and to fall into 'K-orbits' around the nuclei. Consequently, the experimental value of 10^{-6} sec. is the period for nuclear capture of a meson from the K-orbit[4], in marked contrast to the value of 10^{-16} sec. or less which has been predicted[3] on the assumption that nuclear particles interact with each other through this meson field alone (apart from Coulomb interaction). The estimate of 10^{-12} sec. for the slowing-down time has been questioned by Fröhlich[5], but it seems to be generally believed that the time taken is much less than 10^{-6} sec. and that there is, in fact, a big discrepancy between the experimental and theoretical values for the nuclear capture period.

It has been suggested[6,7] that the observations can be explained on the hypothesis that there are two kinds of meson: a heavy meson which interacts strongly with nuclear particles and which does not penetrate appreciably to sea-level, and a light meson which interacts only weakly with nuclear particles and which is found at low altitudes. The observations of Powell and co-workers[7] suggest that the heavy meson is capable of disintegrating spontaneously into a light meson and a neutral particle of comparable mass; other experimental evidence indicates that the light meson is also unstable, decaying spontaneously with a half-life of about 2×10^{-6} sec.[8] into an electron and, presumably, a neutral particle. (Recent experiments by Hincks and Pontecorvo[9] indicate that this neutral particle, if it exists, ionizes less strongly than a gamma-ray.)

It is tempting to suppose that the interaction of the heavy mesons with nuclear particles is connected with the nuclear forces and that there is no *direct* coupling between the light mesons and nucleons. There is, however, an indirect interaction between light mesons and nucleons by virtue of the coupling implied in the disintegration of heavy mesons into light mesons. According to the hypothesis which we wish to discuss, positively and negatively charged heavy mesons exist, which differ only in their electric charge and which are to be identified with Powell's π- and σ-mesons respectively. For the present discussion, we shall use the single symbol π to represent them. We use the symbol μ to denote a light meson of either charge, and ρ the neutral meson associated with the disintegration of π-mesons.

The μ-decay of the π-meson can be written in symbolic form

$$\pi\text{-meson} \rightarrow \mu\text{-meson} + \rho\text{-meson}. \qquad (A)$$

Most theories of neutral particles lead to the conclusion that, if such a reaction is possible, then so is the reaction:

$$\mu\text{-meson} \rightarrow \pi\text{-meson} + \rho\text{-meson}. \qquad (A')$$

The forces between nuclear particles are due to reactions of the type

$$\text{neutron} \rightarrow \text{proton} + \pi^{-}\text{-meson}. \qquad (B)$$

We can now assume that the reactions

$$\begin{tikzcd}
 & \begin{array}{c}\text{Proton} + \\ \pi^{-}\text{-meson} + \\ \rho\text{-meson}\end{array} \arrow[dr] & \\
\text{Proton} + \mu^{-}\text{-meson} \arrow[ur] \arrow[dr] & & \text{Neutron} + \rho\text{-meson} \quad (C) \\
 & \begin{array}{c}\text{Neutron} + \\ \pi^{+}\text{-meson} + \\ \mu^{-}\text{-meson}\end{array} \arrow[ur] &
\end{tikzcd}$$

account for the nuclear capture of μ^{-}-mesons, in contrast to the reaction

$$\text{proton} + \mu^{-}\text{-meson} \rightarrow \text{neutron}$$

on which the estimate of 10^{-16} sec. mentioned above was based. In consequence of our assumption of zero direct coupling between nucleons and μ-mesons, we would have zero probability for such a one-stage reaction; we must have recourse to a second-order perturbation calculation with intermediate states as shown in (C).

For the sake of obtaining orders of magnitude for the half-lives of reactions A and C, we consider the case in which the meson wave-functions are scalar and the interaction terms involve no derivatives. We then find that the half-life τ for spontaneous disintegration of a π-meson (of either charge) at rest (A) is given by

$$\frac{1}{\tau} = \frac{1}{8\pi} \frac{f^2\hbar^3}{m_\pi^2 c} \frac{m_\mu c^2}{\hbar} \frac{v_\mu}{c}, \qquad (1)$$

where f is the coupling constant for the reaction (A), m_μ, m_π are respectively the masses of the μ- and π-mesons and v_μ is the velocity with which the μ-meson is emitted. We estimate that the half-life τ_c for nuclear capture of a μ-meson from the 'K-orbit' through the mechanism (C) is given by

$$\frac{1}{\tau_c} \sim \frac{1}{4\pi^2} \frac{f^2\hbar^3}{m_\pi^2 c} \frac{g^2}{\hbar c} \left(\frac{e^2}{\hbar c}\right)^3 Z^4 \left(\frac{m_\mu}{m_\pi}\right)^2 \frac{m_\rho c^2}{\hbar} \frac{p_\rho}{m_\rho c}, \qquad (2)$$

where g is the coupling constant for reaction B, Z is the atomic number and m_ρ, p_ρ are respectively the rest mass and momentum of the emitted ρ-meson. In obtaining this estimate, we performed the calculations for the case of a free μ-meson; we then assumed that the probability per second for capture from the K-orbit was proportional to the probability density near the nucleus, given by the ordinary wave mechanics of a Coulomb centre of attraction. The result then also depends on the square magnitude of a nuclear matrix element, similar to those occurring in the theory of nuclear β-decay; the value of this matrix element will depend on the initial and final nuclear states and may accordingly be difficult to compute very accurately. It seems plausible to us to assume the value Z for the square magnitude of this matrix element, averaged over the initial nuclear states and summed over the final ones.

Substituting the following numerical values in (1) and (2): $Z = 13$, $\tau_c = 10^{-6}$ sec.[2], $e^2/\hbar c = 1/137$, $g^2/\hbar c = 0{\cdot}1$ (from the strength of nuclear forces), $m_\pi/m_\mu = 1{\cdot}6$ (Powell's latest results are $m_\pi/m_\mu = 1{\cdot}64 \pm 0{\cdot}11$, $m_\mu/m_e = 205 \pm 20$ [10]), $p_\rho/m_\rho c = 1$, m_ρ/m_μ

$= \frac{1}{2}$ (our estimates based on Powell's results for m_π/m_μ), and $v_\mu/c = \frac{1}{3}$ (from Powell's results[7]); we obtain the value 10^{-14} for $f^2\hbar^3/m_\pi^2c$, the dimensionless constant for the strength of the π-meson interaction with the μ- and ρ-meson fields.

This gives 4×10^{-8} sec. for τ, the half-life for spontaneous μ-decay of the π-meson.

Marshak and Bethe[6] have estimated that the available experimental data impose upper and lower limits of 3×10^{-7} sec. and 4×10^{-11} sec. respectively on the value of τ; the upper limit may with less certainty be reduced to 2×10^{-8} sec. Our estimate for τ agrees with these figures, showing that the theory discussed above is consistent with the value of 10^{-6} sec. for τ_c.*

Other similar theories can be formulated; indeed, if one assumes (as we did above) that the π-mesons alone have direct coupling with nucleons, then the data on nuclear forces can probably best be explained by taking a pseudoscalar wave function to describe the π-meson field. Any variations of this type would probably not alter the above estimates for τ by more than a factor of ten, and consequently such theories would probably also be consistent with the above-mentioned data. Marshak and Bethe[6] have shown that the above data can be accounted for on a similar theory; on their theory a π-meson decays into a μ-meson and a neutrino, and nuclear particles have a direct coupling to both π-meson and neutrino fields.

Another consequence of the above theory may be noted. The experimental evidence indicates that the scattering of negative μ-mesons by nuclei is effectively due to the Coulomb forces alone. The very small value for the interaction constant $f^2\hbar^3/m_\pi^2c$ which we obtained above shows that on this theory the effects of 'π-meson forces' on the nuclear scattering of μ-mesons are indeed negligible compared with the effects of Coulomb forces.

I wish to thank Prof. Pryce for suggesting these calculations and for helpful discussions.

* *Note added in proof.* Our estimate agrees with the value $\tau = 6 \times 10^{-8}$ sec. suggested recently (Greisen, K. I., *Phys. Rev.*, **73**, 521; 1948) to explain the experimental data on the energy spectrum of heavy mesons far underground.

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Cloud Chamber Investigation of Straggling of Short-Range Particles Produced by Slow Neutron Reactions

A STUDY of the range distribution of particles produced by slow neutron disintegrations of gas nuclei in a cloud chamber offers especially favourable conditions for determining the straggling coefficient since, in such circumstances, the difficulty of producing a source of homogeneous particles is avoided.

In previous investigations of the reaction energy in slow neutron processes[1], a cloud chamber was used which was filled with air at low pressure or with a gas mixture containing the vapour of boric acid ester; the following reactions were studied:

$$^{14}_{7} + {}_{0}n \rightarrow {}^{14}_{6}\mathrm{C} + {}^{1}_{1}\mathrm{H}, \qquad (1)$$

$$^{10}_{5}\mathrm{B} + {}^{1}_{0}n \rightarrow {}^{7}_{3}\mathrm{Li}^* + {}^{4}_{2}\mathrm{He}, \qquad (2)$$

where ${}^{7}_{3}\mathrm{Li}^*$ denotes the ${}^{7}_{3}\mathrm{Li}$ state of 0·45 MeV. excitation energy. By a careful examination of the tracks, it is possible to discriminate those produced in the disintegrations of boron or nitrogen from the background tracks due to gas atoms (hydrogen or helium atoms) set in motion by fast neutrons. The distributions of the total ranges are given in the histograms Figs. 1 and 2.

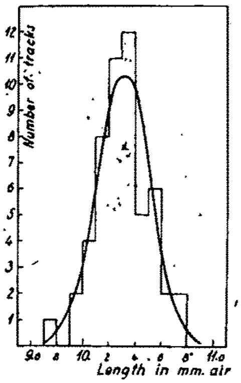

Fig. 1. DISTRIBUTION OF TOTAL RANGES OF 54 TRACKS PRODUCED BY THE REACTION ^{14}N (n,p) C^{14}

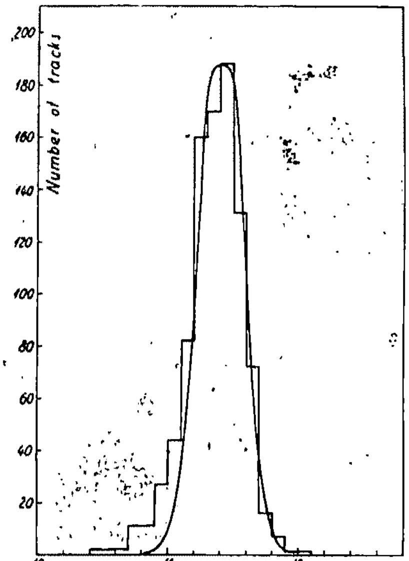

Fig. 2. DISTRIBUTION OF TOTAL RANGES OF 926 TRACKS PRODUCED BY THE REACTION ^{10}B (n,α) ^{7}Li

The range distribution $W(R)$ in Fig. 1, corresponding to reaction (1), can be fitted to a Gaussian curve

$$W(R) = \frac{1}{\sqrt{2\pi}\,\Omega} \exp - \frac{(R - R_0)^2}{2\Omega^2}, \qquad (3)$$

and leads to a straggling coefficient $\Omega = 0{\cdot}20$ mm. The mean ranges of the protons and the ^{14}C particles are found to be 10·0 and 0·3 mm. of air at N.P.T., respectively, and since the contribution of ^{14}C to the straggling must be expected to be small, we find for the relative straggling coefficient of the protons

$$\left(\frac{\Omega}{R_0}\right)_H = 0{\cdot}020.$$

This result is in good agreement with the theory[2] according to which the straggling for protons of not too short range, where the effect is primarily due to electronic collisions, should just be about 2 per cent, approximately independent of range and stopping material.

The range distribution in Fig. 2 could not be represented by a simple Gaussian curve, since the histogram is distinctly unsymmetrical. This circumstance may be taken as an indication that nuclear collisions contribute appreciably to the straggling effect. In fact, in this case, the possibility of the particle losing a comparatively large part of its energy in a single encounter may give rise to a dissymmetry in the straggling curve of the type found.

The straggling curve may, in such cases, be interpreted as an approximately Gaussian peak with a tail extending considerably beyond the peak towards smaller R-values[3]. For the measurements shown in Fig. 2, representing the distribution of total ranges for a helium and a lithium particle combined, the tail is estimated to contain about 15 per cent of the tracks. (The tail is somewhat depressed, since tracks containing side branches of more than 0·2 mm. of normal air were excluded from the statistics.)

The best fit to the Gaussian peak corresponds to a width Ω^* of 0·16 mm., leading to a relative straggling coefficient of

$$\frac{\Omega^*}{R_0} = 0{\cdot}014.$$

Under the experimental conditions it was not possible to ascertain at what point of the track the boron disintegration takes place, and the individual straggling coefficients for the helium and lithium particles cannot, therefore, be obtained. If the two relative straggling coefficients were equal, a simple calculation gives about 0·02 for each when taking into account that the mean ranges are estimated to be 7·0 and 4·35 mm. for the helium and the lithium particles[4], respectively. This result obviously implies that, for one of the particles, the relative straggling is at least about 2 per cent. The theoretical estimates of the contribution of electronic collisions to the straggling give, however, only about 1 per cent and $\frac{3}{4}$ per cent for α-particles and ^{7}Li nuclei, respectively.

Whereas the straggling of the protons by reaction (1) could be accounted for by electronic collisions, it thus appears that the width as well as the shape of the experimental straggling curve, corresponding to the process (2), give evidence of an essential contribution of nuclear collisions. This circumstance is in accordance with general theoretical arguments, according to which the relative importance of nuclear collisions on stopping and straggling increases rapidly with increasing charge and decreasing velocity of the penetrating particle. Further measurements to improve the analysis of the range distributions are going on, and it is hoped thereby to obtain more detailed estimates regarding the straggling effect of nuclear collisions.

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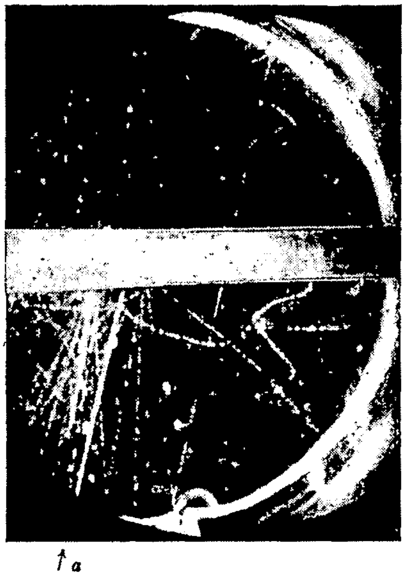
A Doubly Charged Cosmic Ray Particle

AMONG more than a thousand stereoscopic counter-controlled cloud chamber photographs of mesons which we have obtained during the past six months while studying the scattering of mesons of different energies in lead plates, we have obtained the photograph reproduced herewith. Each one of the stereoscopic cameras made an angle of 22½° with the normal to the chamber. The chamber was triggered by a triple coincidence Geiger–Müller counter system with 25 cm. of lead below the chamber and above the lowest counter, so at least one of the particles must penetrate 25 cm. of lead. There was no lead on the top of the chamber. The usual argon–alcohol mixture was used in the chamber.



HEAVILY IONIZING DOUBLY CHARGED PARTICLE EJECTED FROM THE LEAD PLATE BY A NEUTRAL PARTICLE AND ACCOMPANIED BY ELECTRONS AND MESONS

The photograph reproduced and its stereoscopic partner show several cascades produced by electrons in the 2-cm. lead plate inside the chamber, accompanied by penetrating particles which have gone through the plate without appreciable deflexion. They also contain a thick track (a) which emerges from the bottom of the lead plate and is produced by a particle accompanying the electrons and the penetrating particles.

A careful stereoscopic re-projection of this thick track through the lead plate into the top of the chamber shows that it would lie just within the illuminated region near the lead plate, and would thus be visible if it were a heavily ionizing particle going right through the lead plate. The heavily ionizing particle therefore appears to have been produced by a non-ionizing ray entering the top plate and accompanying the other electrons and mesons in the shower. Careful consideration shows that the heavily ionizing particle is probably doubly charged.

The heavy track shows four delta-rays along its length, of which two have ranges in air of 0·75 cm.–1 cm. From this it can be calculated that their energy must be between 20 and 25 keV., and hence they must have a velocity v approximately equal to 0·3 c, c being the velocity of light. The heavy track must be due to a particle of mass large compared with that of an electron. Hence the minimum velocity of the particle must be $v/2 \cos \theta$, θ being the angle which the delta-ray makes with the heavy track. This angle is 45° in the present instance. It follows that the velocity of the particle must be at least $0{\cdot}21\ c$, and so the density of ionization of this particle could be at most eleven times the minimum density of ionization if it were singly charged. The density of ionization of a doubly charged particle of the same velocity would be four times the above value, namely, forty-four times the minimum. The average density at the end of the range of the delta-ray track ($v = 0{\cdot}1\ c$) would be of the order of forty to fifty times the minimum density of ionization, and from the present photograph and other enlargements of the track it can be seen that the density of the main track is at least of the same order as that of the delta-rays, namely, forty to fifty times minimum, which is about the same as that of a doubly charged particle. Therefore, we conclude that the heavily ionizing particle must be doubly charged.

It is possible that it is an α-particle thrown out of an explosion process; if it were so, its energy would be 80×10^6 eV. Since the origin of this particle is in the back portion of the lead plate, and since it is coming towards us, it is possible that the other explosion particles, if any, have gone to the back of the chamber and so out of the field of view. The particle might also be a doubly charged proton[1]. The importance of the photograph is, however, that it shows that a doubly charged particle has been ejected by a neutral particle accompanying a shower of electrons and mesons.

It must be noted that similar heavy tracks have been obtained by others[2,3]. But it is remarkable that this photograph of a rare event was obtained at sea-level in a total of only a thousand pictures. The other small thick track to the left of the particle (*a*) is possibly a superposition of two tracks in the direction of the camera. Unfortunately, this track in the right-hand stereophotograph has been completely obscured by the bright background.

I have great pleasure in acknowledging my thanks to Prof. H. J. Bhabha for his guidance and suggestions on the analysis of the photograph.

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Interpretation of Data from Electrical Resistivity Geophysical Surveys

Electrical resistivity surveys are all based on the method of Wenner[1]. A current, I, is passed into the earth through one point electrode and returns to the apparatus through a second. The potential difference between two points on the earth's surface, V, is measured. Let

$$R = V/I. \tag{1}$$

Then R can be related to the resistivity of the earth and the electrode spacing. Usually the four electrodes used are spaced in a straight line, and frequently a symmetrical arrangement is used. If the distance between the current electrodes is $2a$ and between the potential electrodes is $2\alpha a$ for a symmetrical arrangement, it is easily shown[2] that, for a homogeneous earth, the resistivity ρ is given by

$$\rho = \pi a \frac{(1-\alpha^2)}{2\alpha} R. \tag{2}$$

If the earth is not homogeneous, the value of ρ obtained from (2) will vary with a. This variation will be related to the nature of the earth, and hence the usefulness of the method.

The theory of the variation of ρ for different earth structures has been considered by many authors. The general conclusion is that the mathematical treatment is excessively complex for any but the simplest structures. Further, the number of parameters entering into the equation becomes large, and this alone would make the interpretation of practical curves difficult. The case of an earth composed of parallel layers of homogeneous material is of especial interest as other geophysical methods are not suitable. For this case it has been shown[2,3] that the more complex earths can be approximated to by the use of the solution of the two-layer case.

For this case, Hummel[2] has shown that

$$\frac{\rho}{\rho_1} = 1 + \sum_{n=1}^{\infty} k^n \left\{ \frac{1/\alpha + 1}{\sqrt{1 + \left(\frac{2nh}{a(1-\alpha)}\right)^2}} - \frac{1/\alpha - 1}{\sqrt{1 + \left(\frac{2nh}{a(1+\alpha)}\right)^2}} \right\}, \tag{3}$$

where $k = (\rho_2 - \rho_1)/(\rho_2 + \rho_1)$ = reflexion factor; (4)

and h is the thickness of the upper layer of resistivity ρ_1 and the lower layer has a resistivity ρ_2 and an infinite depth. This curve has no maximum or minimum and so it is difficult to fit it to field results.

A method of applying (3) to practical cases has been suggested by Tagg[3], but this involves considerable calculation on each occasion it is used. On the suggestion of Prof. L. S. Palmer, the point of inflexion of (3) was found as a function of k and α. This method was abandoned because of the difficulty in calculating the point of inflexion and also the difficulty of obtaining it from experimental data.

Further investigation suggested that a graphical method of solution was possible. Referring to (3), it will be seen that all curves for a given k and α can be reduced to the same form by plotting ρ/ρ_1 against a/h. As h is the unknown on which most interest is centred, this cannot be done directly. If, however, a set of curves of $\log \rho/\rho_1$ against $\log a/h$ for different values of k and the constant α (universal curves) is prepared, these can be used to interpret logarithmic plots of the experimental results. The logarithmic plot will be identical with the universal curve with the same value of k except that the axes will be displaced by $-\log h$ and $-\log \rho_1$ from the $\log \rho/\rho_1$ and $\log a/h$ axes respectively.

By adopting a standard scale for the graphs and working with a constant α, the universal curves can be plotted on transparent material and the axes marked. The transparency is then fitted over the experimental graph and the position of the axes of the universal curves give h and ρ_1 directly, and k is found from the actual universal curve used. The computation of universal curves is simplified by using the tables of Roman[4].

The universal curves can be used for multilayer earths to the same degree of approximation as the methods discussed by Hummel and Tagg, and, in fact, this approximation can be rapidly and easily accomplished.

This method has been used on four experimental curves obtained by L. S. Palmer. In one case, bore-hole data were available and the result was in excellent agreement for the depth of the layer.

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Annealing of Glass

S. M. Cox[1] has considered the departure from the 'Maxwellian' law of the annealing-rate in glass. He attributes that part of the discrepancy which cannot be accounted for on the basis of a progressively changing viscosity to changes in the equilibrium condition of the glass under the action of the stresses present. An expression for the rate of release of stress is obtained, based on a theoretical derivation of the laws governing these changes and the rate of approach to equilibrium. Unfortunately, in his brief account only the final expression is given, so that it is not possible to comment on the derivation, nor on the extent to which a fit with Morey's experimental results provides a confirmation of the theory.

However, these 'approaches to an equilibrium condition in the presence of stresses are well known as observed phenomena, appearing as the 'delayed elastic effects' in ordinary experiments. Under constant stress, glass and many other substances obey the following expression :

$$\text{strain} = a + bt + c.f(t),$$

where a, b, c are constants proportional to the stress and dependent upon the temperature, composition, etc. The three terms represent respectively the instantaneous reversible elastic strain, the irreversible purely viscous flow at constant rate, and the reversible delayed elastic strain. The function $c.f(t)$ has the value 0 at $t = 0$ and c at $t = \infty$.

It is scarcely surprising that the rate of release of stress during annealing is not 'Maxwellian', when it is remembered that Maxwell's equation of visco-elasticity (which suggests the 'Maxwellian' or exponential rate of release of stress) leads to an expression for the behaviour under constant stress which does not include any delayed elastic effect, namely : $\text{strain} = a + bt$. The original theory of annealing, in fact, considered only relaxation of stress through the mechanism of viscous flow. The representation of the more complicated behaviour of real materials has, however, been extensively discussed (see, for example, Alfrey and Doty[2]), and it is possible to derive a theoretical 'stress release' curve from any 'creep' curve obtained under constant applied stress, and vice versa.

I have recently shown[3], by considering the mechanism of the annealing process and the experimental data on the delayed elastic effects in glass, that it would be possible on this basis to account for the discrepancies remaining in the theory of annealing. I pointed out also that a further complication existed, since the rate of release of stress must depend partly on the form of the previous cooling schedule for the glass, during which partially developed delayed elastic strains might have been 'frozen-in'. Experimental data in this field are at present insufficient for a quantitative formulation of the annealing laws.

The description of the phenomena proposed by Mr. Cox appears to be analogous to the explanation of delayed elasticity under uniform compression described by Frenkel[4]. It is of interest that this explanation, and apparently Mr. Cox's theory, both lead to a single exponential term of the form $\{1 - \exp(-t/\tau)\}$ for $f(t)$, although the experimental results on the ordinary delayed elastic effects can only be represented as the sum of a number of such terms with differing coefficients and 'relaxation times'. For glass the function is probably of the form $\{1 - \exp(-\sqrt{t/\tau})\}$, which implies a continuous distribution of such terms. There are other discrepancies between this theory and the experimental facts, and added complications in considering stresses, such as shear stresses, which do not involve a change in volume. It is more satisfactory to look to the existing (although incomplete) experimental data for an explanation of the anomalies in the annealing process.

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It is true that such theoretical work on problems associated with annealing of glass must be of a tentative nature until adequately supported by experiments, but its value lies in that it provides guidance for the design and interpretation of experiments. Without such guidance there is, for example, confusion between delayed elasticity and viscosity change with time ; the influence of stabilization with respect to temperature is also enigmatical. In Dr. Jones's own experiments[1] no attempt was made to stabilize the glass with respect to temperature. His results are particularly interesting for this very reason, because in his bending test—involving an averaged effect for both tension and compression together—there are theoretical grounds for supposing concurrent temperature stabilization to be without influence. Dr. Jones, in finding this experimentally, erroneously concludes the effect to be absent.

A feature which reduces the usefulness of the experimental results is that glasses of different composition have been used, and unfortunately there is a sparsity of experimental work on 'dilute' silica glasses—the study of which is most likely to be amenable to theoretical treatment.

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Failure of Adrenal Cortical Extracts to Cause Lysis of Living Lymphocytes *in vitro*

In a series of papers by Dougherty, White and Chase, it has been claimed that the rate of lymphoid tissue dissolution is under the control of the adrenal cortex[1–5], and that injections of pituitary adrenocorticotropic hormone or adrenal cortical extract accelerate this dissolution and release antibody globulin which, it has been claimed by themselves[6,2,7,4,5] and by other workers[8,9] is present in the lymphocytes. The evidence adduced by Dougherty, White and Chase in support of this contention was the histological finding of cellular destruction and increased phagocytic activity in the lymphoid organs, and the reduction of weight of these organs, which they[10] and others[11–14] had shown to follow such injections. The present work was undertaken to investigate by quantitative methods the action of adrenal cortical extracts on lymphocytes, and to determine whether any direct lytic effect could be demonstrated.

Adult albino rats were bled from the heart into a sterile paraffined syringe, the blood allowed to clot in a 'Pyrex' tube and the serum removed. Next day the inguinal lymph nodes of the animal were removed with aseptic precautions; and macerated in sterile Simms'[15] saline solution containing 5 units of crystalline sodium penicillin per ml. By this means a suspension of cells comprising approximately 96 per cent lymphocytes was obtained. The suspension was centrifuged in a sterile tube at a slow speed to throw down the cells and to separate fat and cell fragments. The supernatant was discarded and replaced with a nutrient fluid consisting of equal volumes of the homologous serum and Simms' saline solution, the latter containing penicillin (5 units/ml.), and the appropriate dilution of the hormone preparation under test. After mixing, the tubes were incubated at 37° C. for 8–12 hours in an atmosphere of 95 per cent oxygen and 5 per cent carbon dioxide. Sterile samples were withdrawn at intervals after careful resuspension of the cells, and the cell population enumerated. Control tubes containing hormone inactivated by prolonged heating, and others of serum and saline only, were set up for each experiment.

Two adrenal cortical preparations were employed: 'Eschatin' (Parke Davis and Co., Ltd.) (for which I am indebted to Dr. J. Stanley White of Parke Davis and Co.) and 'Eucortone' (Allen and Hanbury, Ltd.). In one series of experiments the hormone ('Eschatin') was added directly to the nutrient medium in concentrations ranging from 1 : 500 to 1 : 10,000. In another series the animal was given a large dose (1–2 ml.) of hormone ('Eschatin' or 'Eucortone') by intraperitoneal injection three hours before withdrawing blood for the preparation of serum.

The results were negative in all experiments but one. No significant diminution occurred in the number of lymphocytes in the suspensions in any of the tubes, except in one experiment in which heterologous and not homologous serum was employed. In this case the regression of lymphocyte density on time did show that a significant lysis of cells had occurred, even though many of the surviving cells exhibited active movements at the end of the experiment.

It was concluded that if adrenal cortical extract does act on the lymphocyte, its action is not directly to cause lysis of the cell. The recent reports of Eisen *et al.*[16] and of Stoerk, John and Eisen[17], that the adrenal cortex does not influence the level of ci culating antibody or the turnover of serum protei are also evidence against the conception of adren cortical control of antibody release from lymphocyt by causing lysis of the antibody-bearing cells.

The reduction in weight of the lymphoid organ reported by the investigators already mentione above[11–14] to follow injections of pituitary adren corticotropic hormone or adrenal cortical extrac or the similar reduction in the weight of these organ occurring in the course of the alarm reaction o Selye[18,19], is explicable on the basis that the physic logical action of the adrenal cortex on the lymphoi organs is not so much to cause lysis of adult cells a to control the maturation and mitotic-rate of youn lymphocytes. However, with very severe sub-letha stimuli the effect on the dividing cells may be s marked that actual cell destruction occurs, especiall in the thymus, where the mitotic-rate is high.

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Formation of Oxime-Nitrogen in *Torula*-Yeast Fed with Potassium Nitrate

The question of the formation of hydroxylamin and oxime as intermediate products in the fixatio of nitrogen has been under investigation for man years[1]. Formation of oxime-nitrogen has bee established both with Azotobacters and higher plant when nitrate has formed the source of nitroge nutrition. Examination of oxime-nitrogen is no easy because of its small amount and because th methods of analysis are not satisfactory, in particular, if the solutions to be examined are not quite colourles and clear.

In this Laboratory, synthesis of amino-acids wa recently studied with low-nitrogen yeast (*Torula utilis*) by suspending yeast in ammonium sulphat solution (Roine[2]). A great increase was then noted in the soluble nitrogen' of yeast due to amino-dicarboxylic acids and their amides as well as to alanine. Roine was not able to find other amino-acids; accordingly, his investigation supports the view that the amino-dicarboxylic acids are formed as primary amino-acids in accordance with the findings regarding nitrogen fixation.

Recently, we have carried out corresponding experiments by suspending low-nitrogen yeast (*Torula utilis*) in a 1·5 per cent solution of potassium nitrate. The increase of amino-dicarboxylic acids, their amides, and alanine in yeast was similar to that with ammonium sulphate feeding. Besides, a very rapid formation of oxime-nitrogen was observed. The maximum amount of oxime-nitrogen was attained in about ten minutes, after which a drop followed. The procedure employed was as follows: low-nitrogen yeast was suspended in nutrient solution free from sources of nitrogen and carbon, potassium nitrate was added to a concentration of 1·5 per cent and a vigorous current of air was passed through the suspension. Samples taken at different intervals were put in centrifuge tubes placed in ice, centrifuged and washed once with ice-cold water. Twice the volume of trichloracetic acid (8 per cent) was added and the acid suspensions were allowed to stand in an ice-box for 24 hours, centrifuged, filtered through a Jena glass filter and the clear solution was used for determinations. Centrifugation and washing the yeast took about twenty minutes; decomposition of oxime possibly occurred during this time. The quantities of oxime-nitrogen found may thus represent only a part of the actual amount. Oxime-nitrogen was determined by hydrolysing with 3 N sulphuric acid for six hours in a boiling water-bath and determining hydroxylamine according to Blom[3]. The solutions were colourless and transparent, and determination of the red colour formed was easy. The intensity of the colour was measured with a photo-electric colorimeter. The accompanying table gives the results.

AMOUNTS OF OXIME-NITROGEN IN μGM. PER 100 GM. FRESH YEAST

No. of expt.	Time (min.) 0	5	10	15	20	30	60	240	Source of nitrogen and treatment of samples
	With low-nitrogen yeast								
1*	0			+		+	0	0	Potassium nitrate. Extraction with trichloracetic acid
2	0			70		44	47	41	
4	0	31	280		80	0			
5	0	49	84		57	42			
3	0			0		0	0	0	Potassium nitrate. Extraction with water after freezing
6	0	0	0		0	0			Ammonium sulphate. Extraction with trichloracetic acid
	With normal yeast								
7	0	54	167		31				Potassium nitrate. Extraction with trichloracetic acid.

* Oxime-nitrogen shown qualitatively only.

A very small amount of free hydroxylamine was found in every experiment where oxime was noted. It might have originated from oxime in trichloracetic acid solution. Nitrite, hyponitrite and nitrohydroxylamic acid, which also give the colour reaction, are quantitatively destroyed during 6 hr. on boiling with 3 N sulphuric acid[4]. Accordingly, only hydroxylamine is determined by Blom's method.

The results show that the low-nitrogen yeast kept in nitrate solution always contained oxime-nitrogen (Expts. 1, 2, 4 and 5), whereas the same yeast in 1 per cent ammonium sulphate solution did not give even a trace of oxime-nitrogen (Expt. 6). Yeast with normal protein content (normal yeast) also forms oxime-nitrogen from nitrate (Expt. 7). In this respect there seemed to be no difference between normal and low-nitrogen yeasts. Some hydroxylamine was found in addition to oxime; this, however, may have originated from the oxime in the trichloracetic acid solution. Oxime-nitrogen in the table comprises both free hydroxylamine and that set free by sulphuric acid hydrolysis. In some experiments the low-nitrogen yeast suspended in nitrate solution was frozen and then extracted with water in an ice-box. No oxime-nitrogen could then be detected (Expt. 3), or at the most only traces. Accordingly, detection of oxime-nitrogen requires that the reduction be rapidly inhibited, as will happen when the sample is placed in trichloracetic acid solution.

Torula grows on the surface of agar with hydroxylamine as its sole source of nitrogen in concentrations up to 1 : 5,000, the highest concentrations after adaptation. In the nutrient solution *Torula* did not grow in the hydroxylamine concentrations used. With nitrohydroxylamic acid *Torula* grows well also in solutions after an incubation period of about 20 hours. Some hydroxylamine is then formed. The growth depends probably on the formation of nitrite from nitrohydroxylamic acid.

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Bacterial Hydrolysis and Utilization of Polysaccharide-like Substances ('Mucin') in Saliva

AMONG the very heterogeneous bacterial population of the mouth are to be found large numbers of organisms such as streptococci, staphylococci and lactobacilli, which require some source of fermentable carbohydrate from which to obtain energy for growth and to maintain their normal metabolic processes. It has generally been assumed that, in the mouth, food constituents such as starch, after breakdown by salivary amylase (ptyalin), or simple sugars, provide this source. The observations presented in a preliminary form here show that some groups of organisms in raw saliva are able to break down and make available the salivary mucins themselves.

The amount of glucosamine, estimated after acid hydrolysis of the saliva by the method of Elson and Morgan[1], was used to measure the amount of polysaccharide present. This criterion was chosen rather than more obvious ones, such as the amount of reducing sugar or the total amount of sugar determined by Sørensen and Haaguard's method[2], since such measurements would also include any carbohydrate food constituents, for example, starch and sucrose, which might be present in the samples; glucosamine is a well-recognized constituent of many polysaccharides, including those present in the saliva.

The amount of glucosamine remaining in five samples of raw, unstimulated saliva after they had been incubated for various times was determined (see

BACTERIAL UTILIZATION OF POLYSACCHARIDES ('MUCINS') IN SALIVA INCUBATED AT 37° C.

Time (in hr.)	Glucosamine hydrochloride (mgm./ml.)				
	H.J.	A.P.	L.C.	H.F.H.	D.C.
0	0·55	0·43	0·42	0·21	0·27
24	0·42	—	0·22	0·09	0·12
48	0·18	0·10	0·20	0·01	0·05
72	0·08	0·09	—	—	—

table). The rate of disappearance of glucosamine was, in fact, shown to be paralleled by that of both total sugar and reducing sugar, the latter being measured after acid hydrolysis.

The utilization of glucosamine was completely inhibited by bactericidal substances such as phenol, toluene, thymol and penicillin, or by heating to 100° for five minutes. There was partial inhibition by 1 per cent glucose or maltose, but not by powdered solid starch.

In the presence of the bactericides, a substance accumulated in some samples which reacted as N-acetyl glucosamine in the Morgan and Elson[3] test. This substance was diffusible through 'Cellophane' and its liberation was due to enzymes associated with the cellular material present in the saliva, and not to enzymes formed by the salivary glands. The relation of the observed hydrolysis of the polysaccharides to the breakdown of the 'blood group substances'[4,5,6] present in relatively high concentration in the saliva of 'secretors'[6] is of interest.

The significance of these observations in connexion with the well-known pathological conditions of the mouth is, of course, unknown; but it is clear that organisms in stagnation areas would be able to obtain considerable amounts of fermentable material by breaking down the salivary mucins.

I should like to express my thanks to Mr. A. Parkinson for his enthusiastic and competent technical assistance during the work.

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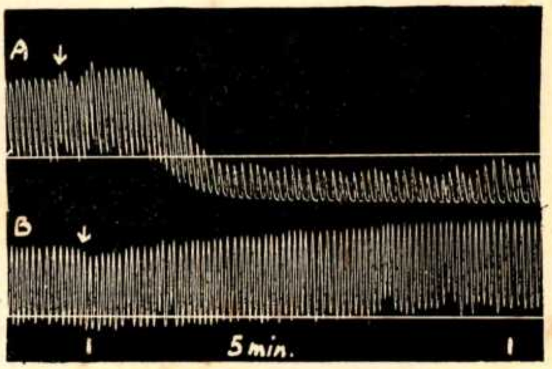
A Possible Relation Between the Action of Clover Juice on Isolated Muscle and 'Bloat' in Cattle

THE disturbance known as bloat, or hoven, in cattle arises through the inability of the animals to expel the gases formed in the rumen. Bloat can be expected when cattle graze young luscious clover or lucerne, but occasionally young grass can also cause the trouble.

A favoured view of the cause of bloat is that the muscles of the rumen wall lapse into relative immobility in the absence of adequate fibre in the diet and so fail to urge the gases to the œsophagus. Another view is that an allergic shock, resulting from some food constituent, may cause a spasm of the smooth muscle of the cardiac sphincter and so prevent escape of gas. In view of the possible association between bloat and rumen muscle activity, experiments were carried out to see if various herbage juices have any action on isolated smooth muscle.

Using rabbit intestine in Tyrode solution, twelve juices of legumes (*S* 100 white clover, wild white clover and lucerne) and nine grass juices were tested. One *S* 100 white clover was taken from a field in which two cows had just died through bloat. Very marked differences were obtained: the legume juices, when added in quantities of 0·7–2 ml. to a Tyrode bath of 55 ml. capacity, caused a rapid and very marked diminution in the amplitude and frequency of the gut movements. In some cases 2 ml. juice almost completely arrested the movements. At times this partial paralysis was accompanied by a relaxation of the muscle, as shown by a slight fall in the level of the tracing, or was occasionally preceded by a brief stimulation of movement.

Juices from two permanent pastures (one an irrigated pasture) gave effects resembling the clover, although the frequency of movements was not reduced. All other grass juices, from permanent grass and leys, gave quite different tracings. 1–2 ml. generally produced stimulation, but movements were occasionally uneven. The two types of effect are shown in the accompanying photograph.



A, CLOVER JUICE ; *B*, GRASS JUICE

Tests have shown it is unlikely that inorganic ions are responsible for the clover effect, and attempts are being made to separate the substance or substances responsible.

Heat only partially reduces the effect, and the loss may be caused by absorption of material on protein precipitated by the heating. The active substance passes through a 'Cellophane' membrane. An alkaloid fraction showed no effect.

Preliminary tests have indicated that the addition of very small quantities of adrenalin to muscle affected by clover juice can cause recovery after a brief period. This observation needs confirming, but it is of interest since injections of adrenalin are commonly given to treat bloat in cattle.

The peculiar effect of clover juice may, or may not, be of significance in bloat; but further work on the isolation of the substance or substances appears justified. If this is achieved, direct animal confirmatory tests will be possible.

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Feb. 3.

PHARMACOLOGICAL ACTIVITIES IN DIFFERENT RODENT SPECIES OF *d*-TUBOCURARINE CHLORIDE AND THE DIMETHYL ETHER OF *d*-TUBOCURARINE IODIDE

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THE molecule of *d*-tubocurarine chloride contains two phenolic hydroxy groups as well as two methoxy groups attached to the aromatic nucleus[1]. The hydroxy groups can be alkylated; when they are methylated, the resulting dimethyl ether differs in a striking way from *d*-tubocurarine chloride in its pharmacological properties[2].

d-Tubocurarine chloride was treated with two molecular equivalents of sodium hydroxide and then with two molecular equivalents of methyl iodide, all in methanol solution. The solution was evaporated, acetone added, and the precipitate repeatedly extracted with boiling acetone. The acetone solution on evaporation left the dimethyl ether of *l*-tubocurarine iodide as a white to pale yellow rystalline residue. This was recrystallized from thanol/ether. Analysis corresponded to the formula $_{40}H_{48}O_6N_2I_2.3H_2O$.

The effect of a curarizing substance on the neuromuscular junction can be considered from the points f view of both its intensity and its duration. Our xperiments show that the dimethyl ether of *l*-tubocurarine iodide differs markedly from *d*-tubourarine both in the intensity and the duration of ts effects on the neuromuscular junction in different pecies of rodents.

In the experiments reported here, the dimethyl ther of *d*-tubocurarine iodide has been compared vith *d*-tubocurarine in the following ways: (1) in he intact mouse, rat and rabbit; (2) in a preparation f the rat, under nembutal anæsthesia, similar to that f Raventós[3], in which the contractions of the rectus emoris muscle, in response to repeated condenser lischarges applied to its motor nerve at a rate of 5–50 per min., are recorded on smoked paper; 3) in the rat phrenic nerve-diaphragm preparation *n vitro*[4].

OMPARISON OF THE ACTION OF *d*-TUBOCURARINE CHLORIDE AND THE DIMETHYL ETHER OF *d*-TUBOCURARINE IODIDE IN THE INTACT MOUSE, RAT AND RABBIT. ADMINISTRATION BY THE INTRAVENOUS ROUTE

Substance	Test	Mouse		Rat*		Rabbit	
		Result (μgm./kgm.)	No. used	Result (μgm./kgm.)	No. used	Result (μgm./kgm.)	No. used
d-Tubocurarine	*ED*50 *LD*50	81·3 ± 7·2 200·6 ± 5·4	32 114	55·6 ± 3·7 100·9 ± 2·6	22 31	110–115 200–210	7 6
Dimethyl ether of *d*-tubocurarine iodide	*ED*50 *LD*50	120·0 ± 2·1 206·3 ± 5·65	42 46	13·6 ± 0·6 42·7 ± 2·1	25 22	9–12 30–33	6 6
Ratio of *ED*50 for the dimethyl ether compound to *d*-tubocurarine		0·7		4·1		9–13	
Ratio of durations of paralysis at 2/3 × *LD*50 for the dimethyl ether compound to *d*-tubocurarine		1		11		2–3	

* Young rats, weighing 35–65 gm.

All the results given are based on the weights of hydrated salts. Since *d*-tubocurarine chloride has the formula $C_{38}H_{44}O_6N_2Cl_2.5H_2O$, the ratio of molecular weights of the dimethyl ether of *d*-tubocurarine iodide to *d*-tubocurarine chloride is as 1·22 to 1.

In the intact animal the effect of curarizing substances is indicated by the inability of the animal to right itself after being turned on its back or side. The dose at which 50 per cent of animals are thus paralysed (*ED*50) may be regarded as an inverse measure of the intensity of this effect. The duration of the paralysing effect can be measured directly. The results of comparative experiments with the two substances in intact animals are summarized in the table, in which the values for *ED*50 and *LD*50 and their standard errors in the mouse and the rat were estimated by the method of Miller and Tainter[5].

In Fig. 1 the mean duration of paralysis in each species following the administration of various doses of *d*-tubocurarine or the dimethyl ether of *d*-tubocurarine iodide is plotted against the logarithm of the dose in μgm. per kgm. body-weight.

It is noteworthy that the duration of paralysis bears an approximately linear relationship to the logarithm of the dose over a considerable part of the dosage range in all three species and for both substances. It could, therefore, form the basis for a method of assay of either substance. As the slopes of the curves are a measure of increased duration of effect for unit increase of log-dosage, it can be seen that the slopes are inverse functions of the rates of elimination of the drugs, whether by destruction or excretion. Since the duration – log-dosage curves are not parallel, the durations of action of the two compounds have been compared in the table at the arbitrary dosage-level of two-thirds of the *LD*50.

In the Raventós preparation of the rat, the weight of the dimethyl ether of *d*-tubocurarine iodide required to reduce the tension of the muscular

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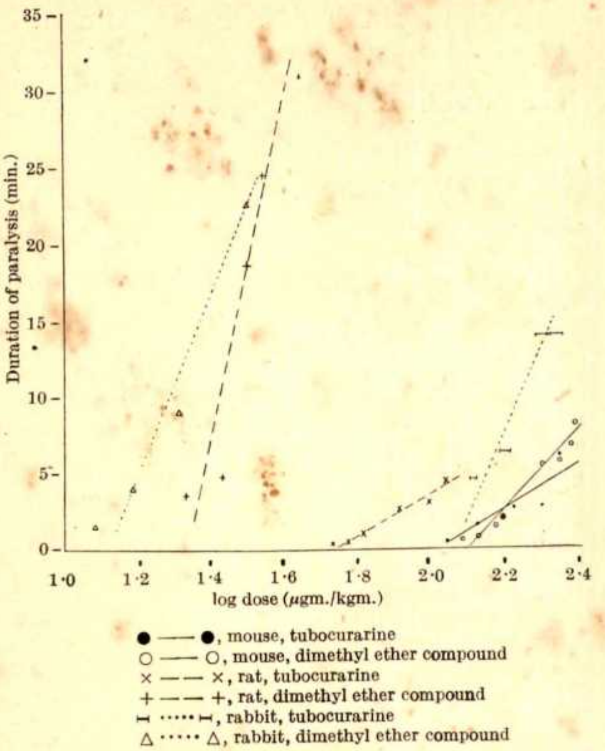

Fig. 1. DURATION OF PARALYSIS FOLLOWING INTRAVENOUS ADMINISTRATION OF *d*-TUBOCURARINE AND THE DIMETHYL ETHER OF *d*-TUBOCURARINE IN THE INTACT MOUSE, RAT AND RABBIT

response to a given extent was one-third to one-half that of *d*-tubocurarine, when each drug was administered by jugular cannula. Administration of either drug below a threshold-level of dosage (about 8 μgm. of *d*-tubocurarine and 3 μgm. of the other compound in a 200-gm. rat) causes no reduction of muscular tension. When, however, two sub-threshold doses of 3 μgm. of the dimethyl ether compound were given to a preparation at an interval of 15 min., the second dose reduced muscular tension by 95 per cent (roughly to the same extent as a single dose of 6 μgm.). The existence of this threshold is in keeping with the fact that the individual muscle fibre obeys the all-or-none law. The summation of the sub-liminal depression of neuromuscular transmission, so clearly seen with the dimethyl ether of *d*-tubocurarine iodide (Fig. 2), is also consistent with this law.

In rat preparations of this type the reduction of muscular tension following administration of the dimethyl ether of *d*-tubocurarine iodide lasts very considerably longer than that following the administration of *d*-tubocurarine, as is seen in Fig. 2. As the dosage of both drugs is raised, so the ratio of duration of effect of the dimethyl ether compound to that of *d*-tubocurarine increases (cf. Fig. 1). The prolonged existence of the former in the circulation is shown by the fact that, after full recovery from a preliminary effective dose of this substance, a second dose (or a dose of *d*-tubocurarine) given within the limits of one to two hours has a greatly increased effect (see above). A similar cumulative effect is produced by a preliminary dose of *d*-tubocurarine, but it is very transitory.

Ligation of the renal arteries and veins in the Raventós preparation prior to the administration of either substance, increases the duration of action of each drug but does not prevent recovery of the muscular contraction. Thus, in a typical preparation with the renal vessels ligatured, a recovery of 20 per cent of the original tension of muscular contraction occurred 10 min. after administration of 14 μgm. of *d*-tubocurarine, while in another similar preparation 20 per cent recovery occurred 58 min. after administration of 4 μgm. of the dimethyl ether compound.

Efforts have been made to estimate the urinary excretions of the dimethyl ether of *d*-tubocurarine iodide and *d*-tubocurarine in the intact rat. Preliminary results suggest that the former is excreted quantitatively, while *d*-tubocurarine is not.

Using the *in vitro* method of Chou[4], it was found that the dimethyl ether of *d*-tubocurarine iodide was 3·3 times as active as *d*-tubocurarine on the rat's phrenic nerve-diaphragm preparation.

In the rabbit, the intensity of action of the dimethyl ether of *d*-tubocurarine iodide is many times greater than that of *d*-tubocurarine (see table), while the slopes of the two duration curves in Fig. 1 are closely similar, indicating that the two substances are removed from their site of action at similar rates. This shows that the dimethyl ether compound has a greater specific action at the myoneural junction in this species. It is noteworthy that both rates of elimination are low, suggesting that the rabbit lacks the special mechanism of the rat (see below) for dealing with *d*-tubocurarine (cf. McIntyre[6]).

The greater specific myoneural effect of the dimethyl ether of *d*-tubocurarine iodide is again shown in the rat, though to a somewhat lesser extent than in the

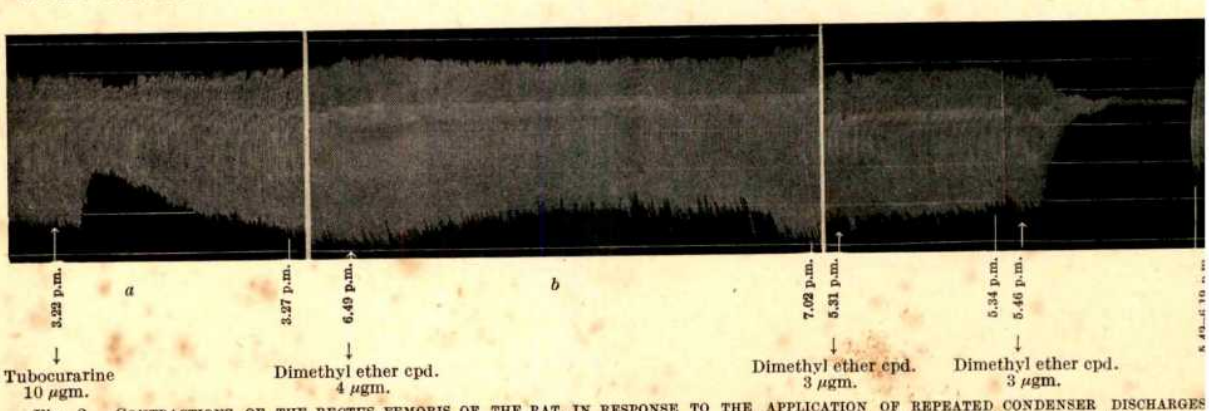

Fig. 2. CONTRACTIONS OF THE RECTUS FEMORIS OF THE RAT, IN RESPONSE TO THE APPLICATION OF REPEATED CONDENSER DISCHARGES TO ITS MOTOR NERVE, AFTER INTRAJUGULAR ADMINISTRATION OF (*a*) 10 μGM. OF *d*-TUBOCURARINE; (*b*) 4 μGM. OF THE DIMETHYL ETHER OF *d*-TUBOCURARINE IODIDE; AND (*c*) 3 μGM. OF THE DIMETHYL ETHER COMPOUND FOLLOWED 15 MIN. LATER BY A SECOND DOSE OF 3 μGM. IN (*c*) THE DRUM WAS STOPPED SEVERAL TIMES DURING THE RECOVERY PHASE

rabbit, by the *in vitro* experiments on the phrenic nerve-diaphragm preparation. In the intact mouse (see Fig. 1) it is seen that the myoneural junction is slightly less sensitive to the dimethyl ether compound than to *d*-tubocurarine, but the rate of elimination of the former is slightly less than that of the latter.

The fact that, in the rat *in vivo*, the duration of action of the dimethyl ether of *d*-tubocurarine iodide is many times greater than that of *d*-tubocurarine, whereas the intensity of its action is only about three times that of *d*-tubocurarine, indicates that the dimethyl ether compound is removed much more slowly than *d*-tubocurarine from its site of action in this species. That removal of both substances is partly effected by the kidneys is shown by the delayed recovery which follows ligation of the renal vessels. It is, however, clear that, in the rat with the kidneys eliminated, a mechanism exists for fairly rapid destruction or removal from the circulation of *d*-tubocurarine, but this mechanism does not operate, or operates very slowly, in the case of the other substance.

The dibenzyl and di-isopropyl ethers of *d*-tubocurarine iodide were prepared by methods similar to that described above. As judged by the *ED*50 and *LD*50 in the mouse, the dibenzyl compound possesses about one-third, and the di-isopropyl compound in preliminary experiments about one-half, of the activity of *d*-tubocurarine. In the rat and the rabbit, the dibenzyl compound exhibits about one-half the intensity of action of *d*-tubocurarine. In the rat, the dibenzyl ether gives no evidence of having an action more prolonged than that of *d*-tubocurarine at corresponding dosage-levels.

The dimethyl ether of *l*-bebeerine di-methochloride was prepared from *l*-bebeerine (from *Chondrodendrum platyphylum*) essentially by the method of King[1] (cf. Dutcher[2] and Brazil *et al.*[7]). The *ED*50 and *LD*50 of this compound in the mouse are approximately twice those of *d*-tubocurarine. The duration of paralysis in the mouse at two-thirds of the *LD*50 is approximately equivalent to that caused by *d*-tubocurarine at the same fraction of its *LD*50. In a Raventós preparation of the rat, 30 μgm. of the dimethyl ether of *l*-bebeerine dimethochloride reduced the tension of muscular contraction to the same extent as 10 μgm. of *d*-tubocurarine, but the effect of the bebeerine compound lasted four times as long. It is noteworthy that the dimethyl ether of *l*-bebeerine dimethochloride and its diastereoisomer, the dimethyl ether of *d*-tubocurarine iodide, both exhibit prolonged curarizing action in the rat as compared with *d*-tubocurarine.

We wish to express our thanks to the directors of Messrs. Allen and Hanburys, Ltd., for permission to publish this work; to Mr. C. J. Eastland for originally suggesting that the dimethyl ethers of *d*-tubocurarine and of *l*-bebeerine dimethochloride be synthesized and investigated; and also to Mr. S. H. Pegg and Miss P. B. Jacks for technical assistance in the pharmacological work.

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THE FLOW OF GLACIERS

A JOINT meeting of the British Glaciological Society, the British Rheologists' Club, and the Institute of Metals, held at the Institute of Metals on April 29, had as its main object the bringing together of glaciologists and those physicists and metallurgists who are interested in the theoretical problems of glacier flow. The exchange of experience and ideas between these two groups was a most stimulating feature of the meeting.

The meeting was in two sections. In the first part, with Sir Arthur Smout in the chair, Mr. Gerald Seligman, president of the British Glaciological Society, presented a film illustrating the methods of glacier research in the field used by the Jungfraujoch Glaciological Research Party in 1937 and 1938. The principal aim was to trace the transition of the tiny snow crystals which accumulate at the top of the glacier, first into the compacted glacier snow called 'firn', and then into the larger crystals of glacier ice. To illustrate this transition, slides were shown of photomicrographs taken between crossed nicols in which the growth of the individual crystals could be clearly seen.

The audience was introduced to the terrain investigated by a series of slides which, besides illustrating its purely geographical features, left no doubt about the beauty of the scenery in which the expedition worked. The film showed the construction of the expedition's 'cold laboratory', a small room excavated out of the glacier ice near the summit of the Jungfraujoch. This laboratory remained at a temperature of −4° C. throughout the summer months, and it was here that much of the work on the growth of ice crystals was done. There were, in addition, experiments on the distribution of velocity at the surface of the glacier and on the walls of a tunnel cut into the ice.

Mr. Seligman also described the work of the expedition last summer on the same subject. He pointed out that very large crystals (10 cm. or more in diameter) are only found in the 'dead' (non-flowing) ice left behind in patches when a glacier recedes. In flowing ice the crystals are much smaller (up to 1–2 cm. diameter). In his view, time and radiation (heat and light) are the main factors influencing the crystal size. The increase in crystal size from the head of a glacier to the snout is due to the fact that the crystals in the lower parts of the glacier are older than those higher up. To support this, he showed graphs giving the crystal sizes at the centres of the snouts in eleven glaciers plotted first against the length of travel and secondly against the mean angle of the glacier slope. The influence of radiation was shown by the fact that in the vicinity of an electric lamp in an ice cave the crystals were abnormally large. It appeared from Mr. Seligman's remarks that both grain growth and work recrystallization play a part in determining the size of the ice crystals. The large size of the crystals in dead ice is a consequence of the former process, and the abnormally rapid growth of new crystals near the end of the Upper Grindelwald Glacier is an example of the latter.

For the second part of the meeting, Dr. Richard Seligman took the chair, and the discussion on the flow of ice was opened by Dr. M. F. Perutz, who gave a short summary of the current theories. The main feature of the movement of a glacier, he said, is that it does not move rigidly, but that the centre travels faster than the sides. Attempts made to treat the ice mathematically as a liquid of constant viscosity flowing in an evenly inclined channel have had some success, although there are also discrepancies. Lagally's development of Somigliana's theory has led to a relationship between the surface velocity at the centre of a glacier and its depth. Starting from the measured value of the velocity, the depth of the Pasterze in Austria, for example, has been calculated to be 280 m., a value confirmed by seismic soundings. In spite of this agreement, however, these theories have started from false premises, for ice is far from behaving as a liquid of constant viscosity. On the contrary, small differences in shear stress can produce large changes in velocity.

After referring to the importance of the large-scale thrust planes studied by Mr. W. V. Lewis, Dr. Perutz showed photographs taken by Dr. Winterhalter of Zurich of a thin sheet of ice placed between crossed nicols and loaded by sustained tension. The deformation of the constituent grains could be watched and there were indications of both gliding and mechanical twinning.

Dr. E. Orowan, who spoke next, took as his starting point the simplest laws of the theory of the plastic behaviour of crystalline bodies, and showed how many of the phenomena in glaciers, which at first sight appear to contradict common sense, can be understood from this point of view. Common sense in these matters is largely the accumulated experience of the behaviour of viscous liquids; but ice, like crystalline solids in general, is not a viscous but a plastic material. The flow of ice and that of viscous liquids corresponds to two distinct physical mechanisms and laws of irreversible deformation. However, the stress-strain relationship customarily used in engineering to describe the plastic behaviour of materials is not a complete description, because it omits time effects. The rate of change of strain with time under constant stress, that is, creep, is of primary importance in the flow of glaciers. Andrade has distinguished between two types of creep, the first dying away rapidly with time after the application of a stress, and the second being a permanent flow, the viscous creep. In glaciers, viscous creep seems the more significant part.

The idealized behaviour of ice on which Dr. Orowan bases his theory is that flow is negligible up to a certain critical stress, the yield stress. After that point a slight further increase of stress produces an extremely rapid increase of the rate of flow. The coefficients of viscosity 'measured' in experiments on glaciers are, he believes, of little physical significance. The three-dimensional nature of the stress system in large masses of ice is an important factor. Yielding depends on a critical value of the difference of two principal stresses being attained; pure hydrostatic tension or compression has no appreciable effect, contrary to a view often expressed by glaciologists.

The first simple problem Dr. Orowan discussed was that of a rectangular slab of ice resting on an inclined plane. Movement would be by shear in the lowest layer, and to each angle of slope would correspond one thickness of ice in plastic equilibrium. This implied that, when the ice reached a more steeply sloping part of the glacier bed, its thickness would be greater than the equilibrium thickness and this part of the ice would exert a pressure on the ice in front of it. This longitudinal pressure is the fundamental physical quantity in the flow; when it reaches a critical value, depending on the compressive yield stress of ice, longitudinal compression will occur. The observed thrust planes are a consequence of the compression; one cannot say exactly how they arise, but that they are a common phenomenon can be seen by attempting to clear away a fall of snow by pushing at it horizontally.

The thrust plane is usually the plane next to the bed of the glacier. However, at sills, that is, at places where there is a sudden fall in the level of the bed, other thrust planes become geometrically possible. This, combined with the fact that the thickness of the ice, and hence its pressure, is less at the lip of the sill, relieves the bed in its neighbourhood of wear. On the steeply sloping downhill side of the sill, on the other hand, conditions are such as to favour wear, for the sliding will be concentrated in the lowest layer of the ice. This is the explanation of the steps so often seen in glacier beds.

Dr. Orowan went on to discuss the problem of a tall column of ice standing on a rigid horizontal plane. If the column were sufficiently high and slender, its weight would cause flow to take place at the bottom, and it would subside to an equilibrium height. In the Greenland ice-cap conditions are different, because, owing to the great extent of the ice mass, the shear stress acting on the lower strata impedes the flow there and at the same time tends to initiate flow in the upper strata. By the use of a simple theory of the process, the yield stress of ice can be calculated from the known height and width of Greenland. The figure so calculated, which is of the order of 1 kgm./cm.^{2}, is in agreement with the results of laboratory experiments. A warning is necessary, however, because even a slight slope (1 : 300) would be sufficient to explain the spreading without invoking any other influence.

In the general discussion which followed, Mr. W. V. Lewis expressed the pleasure felt by glaciologists and those concerned with the land forms produced by glaciers at the interest that physicists are beginning to show in the subject. The uplifting of the thrust planes at the ends of glaciers would naturally cause less grinding to occur there than elsewhere, and this explains very satisfactorily why glaciers erode hollows in their beds. The formation of the lakes which are such a striking feature of Alpine scenery is now no longer so mysterious. Answering a question by Sir Geoffrey Taylor, Mr. Lewis expressed the opinion that the remarkably regular series of curves seen on the surface of the Mer de Glace, of which Dr Perutz had shown a slide, are the result of successive overthrusts which have been afterwards drawn out into curves by the general flow of the ice. Severa speakers referred to the slides Mr. Lewis presented which showed the striking way in which large rocks and other debris, which had originally fallen into the Bergschrund at the head of the glacier, are later brought up to the surface on thrust planes lower down, and Mr. Webster Smith suggested an experiment in which coloured objects were to be carried down underneath the glacier. Dr. Perutz, however thought that the slowness of the flow would make the experiment impossible. Mr. Webster Smith also emphasized the important influence of the varying hardness of the rocks constituting the glacier bed.

Dr. C. H. Desch drew a distinction between ic and metals by pointing out that, whereas ice expands on freezing, metals in general contract. That difference in behaviour should not be overlooked, and h suggested the use of bismuth at a few degrees below its melting point for laboratory experiments. Bismuth, although brittle under certain conditions, can be extruded and, in addition, expands on freezing; the analogy with ice is therefore complete.

Mr. C. Gurney took up this point later by saying that, whereas the effect of hydrostatic pressure on the melting point is of opposite sign for ice and metals, the effect of uniaxial compression is always to lower the melting point, even in metals.

In reply to Dr. G. W. Scott Blair's suggestion that ice might be found to behave more like a Bingham solid than a material obeying St. Venant's law of plasticity, Dr. Orowan said that the existence of transient creep is evidence that ice is not a Bingham solid; on the other hand, the existence of creep in general shows that it does not exactly obey St. Venant's law either.

Dr. Perutz had observed that in Alpine glaciers the crevasses were never more than about 30 m. deep, and Mr. W. H. Ward pointed out that this depth could be correlated in order of magnitude with the known yield stress of ice.

The discussion provided a happy illustration of the benefit of applying the simplest of physical reasoning to a science as yet largely empirical. In the words of one of the contributors, it was "better to think exactly with simplified ideas than to reason inexactly with complex ones". J. F. NYE

PROGRESS IN ARTIFICIAL ILLUMINATION

ALTHOUGH lip-service is commonly paid to the value of research, it is seldom that its direct benefits are so attractively displayed to the general public as has been done in the "Darkness into Daylight" Exhibition at the Science Museum, London, S.W.7. A visit to the Exhibition reminds one how very primitive were the means of artificial illumination only two centuries ago, while less than one hundred years ago the oil lamp was still the common form of lighting. We are all of us aware of the progress and achievements made during the past century. But how many realize that since only 1921 the efficiency of the ordinary 60-watt electric lamp has increased by 55 per cent while the cost has decreased by 75 per cent.

The exhibition has been organised by the Science Museum with the co-operation of the electrical industry of Britain, mainly to set forth the story of the development of electric lighting, but also to give a lead, and an example of the form of artificial illumination in the future.

A brief introductory section includes examples of some of the primitive forms of lighting used by early man—a hollow stone with fibre burning in animal fat, a wicker-work cage of fire-flies, sea-shell and oyster-shell lamps, a burning fish and a wick threaded into the body of a stormy-petrel are typical examples.

Passing from these primitive forms of lighting, a brief survey of the stages from the Middle Ages to the nineteenth century is made in a series of dioramas, showing the gradual changes brought about as candles and tallow-dipped rushes gave place to oil lamps and then in turn to the gas lamps of the last century. We can see the dawn of electric lighting with Swan's invention of 1878, its temporary eclipse by the Welsbach incandescent gas mantle and then the final triumph of the electric filament lamp.

The filament lamp has had a long career, and since its invention by Swan in 1878 and Edison in 1879 it has passed through innumerable stages of development. Swan had spent many years of research before he produced his carbon filament in 1878 and, incidentally, he laid the foundation stone of the rayon industry by his subsequent development of the squirted nitrocellulose filament in 1883. In stages, the carbon filament with its low efficiency of 2–3 lumens per watt gave way, first to the osmium filament, then to tantalum and finally to tungsten, when the difficulties of drawing tungsten wire had at last been overcome.

The tungsten-filament vacuum lamp had an efficiency nearly three times that of the carbon filament lamp, but to improve it still further a higher operating temperature was required. This resulted in an early blackening of the bulb, and although this could be overcome by filling the bulb with an inert gas, the heat lost by convection more than compensated for the gain until Langmuir's invention of the coiled filament in 1913. Still higher efficiencies were obtainable from the 'coiled-coil' filament invented soon after, but manufacturing difficulties prevented its introduction until 1934.

The efficiency of the modern filament lamp varies from the order of 12 lumens per watt for the smaller domestic sizes to about 25 lumens per watt for the largest projector lamps and, regarded as a source of artificial illumination, it must be agreed that the filament lamp is a remarkably cheap device. Indeed, as the visitor to the 'Darkness into Daylight' Exhibition is reminded at one stage, the average 60-watt lamp will burn for 1,000 hours at a cost, including that of the bulb, of only about 8*s.* 4*d.*; but were he by some whim or fancy to select candles as an alternative illuminant, he would need no less than 25,000 of them to give the same level of illumination for the same period and he would find himself faced with a bill of about £100!

As is perhaps inevitable, the accent of the Exhibition is on fluorescent lighting, and as one passes through this section one is forced to wonder whether the life of the filament lamp is doomed and whether it will eventually be replaced, like the oil lamp and the gas lamp before, by the low-pressure fluorescent tubes now being so widely used. Hitherto, these fluorescent lamps have only been available in lengths of 4 and 5 ft., but the recent announcement that 2-ft. tubes of 20- and 40-watt ratings will soon be introduced suggests a much wider application for domestic purposes. The fluorescence section of the Exhibition opens with a brief historical account of the discovery and developments which have contributed to the perfection of the modern tubes—the early observations of fluorescence, the Becquerel lamp of 1867 in which fluorescent materials were excited in a discharge tube, and the discovery in 1923 of a means of applying fluorescent materials to the walls of a mercury lamp. The stories of the search for a better colour spectrum, the first 'daylight' lamps and the finding of a single powder for producing a warm-white light are told by subsequent exhibits.

In imagination one is encouraged by a variety of fluorescent exhibits to regard such lamps as the lighting of the future. For industrial and commercial applications this indeed appears inevitable, but in spite of the three-fold improvement in efficiency and in spite of the three-fold increase in the average life, it still seems likely that the higher initial installation costs will reprieve the filament lamp for many years for ordinary domestic purposes.

In a brief review such as this, it is not possible to refer to the many stages of development in the various types of discharge lamps—the low-pressure sodium lamp with hot cathode, the low-, medium- and high-pressure mercury lamps, or to mention more than briefly the 5 kW. high-pressure water-cooled xenon arc now being shown to the public for the first time. Many of these developments are illustrated by exhibits and are described in greater detail with diagrams and photographs in the official handbook, "Darkness into Daylight", by W. T. O'Dea, which has been published in connexion with the exhibition (London: H.M. Stationery Office. 1*s*.).

The exhibition will remain open until September from 10 a.m. until 6 p.m. daily, and from 2.30 p.m. until 6 p.m. on Sundays; admission is free at all times.

PLANKTONIC COPEPODS AND HYDROCORALS OF THE JOHN MURRAY EXPEDITION

COLONEL SEYMOUR SEWELL'S account* of a large collection of free-swimming copepods from the Indian Ocean is an important critical study and a most valuable contribution to our knowledge of copepods in general.

In a previous paper (Sewell, 1920–32), seventeen species of free-swimming planktonic copepods were recorded from the northern part of the Indian Ocean, which up to that time were not known from any region other than the Atlantic Ocean or the Atlantic section of the Antarctic. The present collection contains twenty-one other species that so far have not been recorded beyond the Atlantic Ocean. As the author remarks, such a comparatively large number of deep-sea species that are common to the Atlantic and the Indian Ocean, but are at present unknown from any other region, indicates that there either is or has been a close connexion between the two regions. He has suggested (Sewell, 1940) that the explanation is to be found in the trend of the deep currents of the present day. He promises to deal later with the geographical distribution.

Well over two hundred species are recorded, with notes and remarks on most of them which are interesting and instructive. The new family Megacalanidæ is formed to include *Megacalanus*, *Bathycalanus* and *Brachycalanus*, all of which differ from the Calanidæ in several features and show a corresponding resemblance to the Centropagidæ.

Only one specimen of *Calanus finmarchicus* was found, a male, from the northern area of the Arabian Sea, 1,500–0 metres. It is rare in the Indian Ocean and it is suggested that its presence is explained by individuals being carried from the Atlantic Ocean round the Cape of Good Hope in the North Atlantic intermediate waters or the West Wind Drift, and then that they are caught up in the Sub-Polar Intermediate Current and so are carried northwards into the Arabian Sea.

Among the Sapphirinas it was found that *Sapphirina iris* was associated with the aggregated form of the salp *Pegea confederata*, some being inside. In this genus there were numerous cutaneous glands, opening on both dorsal and ventral aspects of the body in special positions in the different species. It is tempting to regard these as luminous organs, but the author does not wish to express an opinion on this point.

There is a long list of copepods with parasites both from surface-living and deep-dwelling species. This includes twenty-one species infested with the dinoflagellate *Blastodinium*. Comparing these with Chatton's seventeen species from the Mediterranean infested with *Blastodinium*, it is found that six are common to both lists.

Dr. Hjalmar Broch has found three new species in the four hydrocorals brought home by the John Murray Expedition to the Indian Ocean*. These include two new stylasters (*S.* (*Eustylaster*) *ramosus* and *S.* (*Eustylaster*) *lonchitis*), and one new *Crypthelia* (*C. clausa*), the fourth species being *Crypthelia stenopoma* Hickson and England. The two stylasters were from the Pemba Canal and the *Crypthelia* from the Maldives. It is interesting to note that in neither of these localities have Stylasteridæ been found before, and these reported localities of the John Murray Expedition are at the present day the most northerly localities of the Western Indian Ocean from which Stylasteridæ have as yet been found.

Another very interesting point is that whereas the two *Stylaster* species from the Pemba Canal have been collected in that zone of the bathymetrical region where the genus is known to be comparatively abundant in all seas, the localities of *Crypthelia* at the Maldives belong to the uppermost parts of its habitat, and its occurrence in these depths seems to be very scanty. The depth of 229 metres is the shallowest record of the genus, and *Crypthelia stenopoma* has hitherto only been taken in 1,300 metres or deeper in the Indo-Malayan Sea. *Stylaster ramosus* was abundant in two stations, its structure indicating that, like *Crypthelia stenopoma* and other Stylasteridæ, it is probably inhabited by commensal polychætes. The cirripede, *Pyrgoma*, is also commonly found in it.

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* The Free-Swimming Planktonic Copepoda: Systematic Account. By Lieut.-Colonel R. B. Seymour Sewell. (The John Murray Expedition, 1933–34, Scientific Reports, Vol. 8, No. 1.) Pp. 304. (London: British Museum (Natural History), 1947.) 30*s*.

* Stylasteridæ (Hydrocorals) of the John Murray Expedition to the Indian Ocean. By Dr. Hjalmar Broch. (The John Murray Expedition, 1933–34, Scientific Reports, Vol. 8, No. 2.) Pp. 305–361 + 1 plate. (London: British Museum (Natural History), 1947.) 2*s*. 6*d*.

THE ELECTRICITY GRID IN GREAT BRITAIN

THE twentieth and last annual report of th Central Electricity Board has recently bee published (Whitehead Morris, Ltd., 72–78 Fleet Street London, E.C.4. 1*s*. net). Just short of attaining it majority, the Board loses its identity in the infan British Electricity Authority, this sturdy infant inheriting the Grid system of some 150 generatin stations, capable of an output of nearly 12 millio kilowatts. Appropriately appearing at about th same time as this report is an interesting and informative paper dealing with the British grid syste ("Load Dispatching and the British Grid System"—A. R. Cooper, Institution of Electrical Engineer March 18, 1948), a paper which is wider in scop than its title might suggest.

Mr. Cooper describes first the long-term plannin associated with the extension of such a system planning which, as the Central Electricity Boar report makes clear, has had to yield to some exten to the stern demands of economic necessity, so that there is likely to be a serious shortage of plant for an indefinite number of years.

When assessing the need for future extensions, an estimate is required of the availability of existing plant, and some striking figures are given indicating that the technical advance in operating conditions has carried with it a general reduction in availability, so that breakdowns are more frequent on modern than on older plant. Leading sources of trouble are said to be turbine-blading failures due to vibration, and alternator rotor failures due to copper distortion, both of which are the subject of intensive research. Also responsible for reduced availability, as well as reduced output capacity, is the supply of unsuitable and low-grade fuels to the boiler plant, a war-time inheritance which persists in spite of the very great increase in the price of fuel.

Proceeding to the short-term planning associated with the daily operation of the Grid system, the paper reveals that the system was originally designed to operate as seven independent sections, and it was not until the load position in some areas had become very grave in 1939 that it was decided to try the experiment of operating the whole of the system in parallel. This operation was successful and has been continued ever since, though the possibility of sequential tripping of lines, accentuated by the existence of only two interconnectors between the north and south of Great Britain, has demanded careful consideration.

After an interesting description of the sequence of events in the planning of a single day's operation of this complex system, from the nerve centre at national control in constant communication with the seven area controls, the paper concludes with a brief review of future developments. The most significant changes foreseen are the introduction of the gas turbine for peak-load working, and of atomic energy for base-load generation. Here it is of interest to turn again to the report of the Central Electricity Board, which is able to cite the arrangements the Board has made for the installation of two 15,000 kW. gas turbine sets, at Dunston and Stretford respectively; though the application of atomic energy remains a subject for study, and a hope for the future.

R. W. Haywood

MOSSES AS SOIL INDICATORS

It is pleasing to see that the attention of foresters is being directed to the mosses as indicators of soil conditions. H. Watson, forest officer instructor at the Benmore Forest School, Argyll, has produced an attractive booklet introducing this subject (Forestry Commission Booklet No. 1. Woodland Mosses. London: H.M. Stationery Office, 1947. 2*s.* net).

The brief introductory account of the life-history of a moss is followed by descriptions of twelve species likely to be encountered in afforestation areas. The descriptions are accompanied by 'turf' photographs to show the habit of growth in mass, and photographs of single shoots to illustrate the more detailed growth-form and include the salient features by which the species may be recognized in the field. There are also notes on the soil conditions favoured, especially as regards the degree of humus decomposition and soil acidity, and brief reference is made to the suitability or otherwise of the soil conditions indicated for afforestation purposes.

The mosses constitute a fascinating group of plants of which all too little is known. Many of them, after a little experience, can be recognized in the field by the naked eye or with the use of a hand lens, and type specimens may be kept dry in packets and soaked out again when required. Forest officers should be in a position to extend considerably our knowledge of the soil conditions indicated by the presence of particular moss species along the lines of the present booklet; and the recent production by Johnson and Sons, Ltd., of Hendon, N.W.4, of Universal and Comparator Test-papers for the measurement of *p*H values to within 0·3 *p*H, provides a very simple method for estimating the soil acidity with some degree of exactitude. Information of this kind would not only be of value to practical foresters, but would also extend our knowledge of this group of plants.

The British Bryological Society has recently asked its members to make observations on mosses with particular reference to times of production of capsules and reproductive organs in different carefully recorded localities and altitudes. The time of capsule production offers no difficulty, and in many cases the reproductive stage may be recognized by the opening of the antheridial cups, as illustrated in the booklet for *Mnium hornum*. It is to be hoped that foresters will be attracted by this aspect of ecology and that Forestry Commission Booklet No. 1 will be followed by others.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, May 24

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting.

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5.30 p.m.—Mr. E. W. Gilbert: "The Boundaries of Local Government Areas".

Tuesday, May 25

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. E. R. Leach: "Some Features of Social Structure among Sarawak Pagans".

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. Brinley Thomas: "Migration and the British Commonwealth".*

Society of Instrument Technology (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Annual General Meeting; Mr. J. K. Burkitt: "Proposed System in Instrumentation Symbols".

Wednesday, May 26

Society of Chemical Industry, Chemical Engineering Group (at the Waldorf Hotel, Aldwych, London, W.C.2), at 12 noon.—Annual General Meeting.

Royal Microscopical Society, Section of Industrial Microscopy (at B.M.A. House, Tavistock Square, London, W.C.1), at 6 p.m. —Dr. K. M. Greenland: "Principles of Interference Films used in Optical Instruments".

Thursday, May 27

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Edward Salisbury, F.R.S.: "The Royal Botanic Gardens, Kew".

Royal Statistical Society, Research Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. D. G. Champernowne: "Sampling Theory Applied to Autoregressive Sequences".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. A. Gouge: The 36th Wilbur Wright Memorial Lecture.

Friday, May 28

Society of Chemical Industry, Food Group (joint meeting with the Royal Sanitary Institute, at the Royal Hall, Ripon Road, Harrogate), at 10 a.m.—Discussion on "The Cleaning and Sterilizing of Plant in the Food and Drink Industry" (to be opened by Dr. E. B. Hughes).

Institute of Physics, Electronics Group (joint meeting with the Industrial Spectroscopic Group, at 47 Belgrave Square, London, S.W.1), at 2.30 p.m.—Discussion on "The Application of Electron-Multipliers to Spectroscopy".

Chemical Society (in the Washington Singer Laboratories, Prince of Wales Road, Exeter), at 4.30 p.m.—Prof. M. Stacey: "Advances in Immunochemistry".

British Institution of Radio Engineers, Midland Section (at the Technical College, The Butts, Coventry), at 6.30 p.m.—Mr. G. L. Hamburger: "An Automatic A.F. Response Curve Tracer".

Chemical Society (joint meeting with the Werner Society, in the Department of Chemistry, Trinity College, Dublin), at 7.45 p.m.—Dr. A. E. Gilliam: "Absorption Spectra as Chemical Tools".

Saturday, May 29

Biochemical Society (in the Department of Biochemistry, University Museum, Oxford), at 1 p.m.—Scientific Papers.

British Psychological Society, Social Psychology Section (at the Tavistock Institute of Human Relations, 2 Beaumont Street, London, W.1), at 3 p.m.—"Social Change as a Problem for Social Psychology".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Provincial Specialist Advisory Officers and Assistant Advisory Officers in soil chemistry, the chemistry of animal nutrition, entomology, plant pathology and bacteriology—The Secretary, Ministry of Agriculture and Fisheries, 1–4 Cambridge Terrace, London, N.W.1, endorsed 'N.A.A.S.' (May 29).

Senior Laboratory Technician (male)—The Medical Superintendent, Glamorgan County Mental Hospital, Bridgend, Glam., endorsed 'Laboratory Technician' (May 29).

Lecturer in Mechanical Engineering, and a Teacher of Engineering Drawing—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (May 29).

Bacteriologist—The Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland (May 29).

Assistant Lecturer in Agricultural Chemistry—The Registrar, Wye College, Wye, Ashford, Kent (May 29).

Lecturer/Senior Lecturer in the Department of Anatomy—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (May 29).

Research Assistant to the Reader in Psychology in the Faculty of Education—The Registrar, The University, 46 North Bailey, Durham (May 29).

Senior Lecturer in Mathematics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (May 29).

Agricultural Economist and Assistant Agricultural Economist—The Professor of Agricultural Economics, University of Reading, 7 Redlands Road, Reading (May 30).

Assistant Lecturer or Lecturer in the Department of Agriculture (Animal Husbandry)—The Registrar, University College of Wales, Aberystwyth (May 31).

Assistant Lecturer in Metallurgy (with special qualifications in ferrous process metallurgy)—The Registrar, The University, Manchester 13 (May 31).

Lecturer in Physiology—The Secretary and Registrar, The University, Bristol (June 1).

•Lecturer on the staff of the Royal Society's Computing Machine Laboratory, Department of Electrical Engineering—The Registrar, The University, Manchester 13 (June 4).

Readership in Biochemistry at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 9).

Readership in Biology at St. Mary's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 14).

Occupational Psychology Research Officer, Department of Scientific and Industrial Research, Wellington—The Official Secretary, High Commissioner for New Zealand, 415 Strand, London, W.C.2 (June 15).

Readership in Mathematics at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 16).

Lecturer in Philosophy—The Registrar, University College, Cathays Park, Cardiff (June 21).

Senior Lecturer in Political Science, University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (June 30).

Botanist (plant breeder) for research on the selection and breeding of *Hevea*, a Botanist for research and advisory work on botanical problems related to the cultivation of rubber, an Advisory Officer to undertake general agricultural advisory work, an Agricultural Engineer to investigate all aspects of the problem of mechanical cultivation in rubber, an Advisory Officer to undertake general advisory work in connexion with the cultivation of rubber by smallholders, and a Chemist to undergo a course of preliminary training in rubber latex technology and research at the Imperial Institute, at the Rubber Research Institute of Malaya—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7.

Head of the National College for Heating, Ventilating, Refrigeration and Fan Engineering, a Lecturer in Fan Engineering, and a Lecturer in Heating and Ventilating Engineering—The Clerk to the Governors, Borough Polytechnic, Borough Road, London, S.E.1.

Assistant Research Officers (chemists and physical chemists), and Laboratory Assistants—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

Technician in the Research Laboratory to work in the Department of Neurohistology—The Director of Research Laboratory, University of London Institute of Psychiatry, Maudsley Hospital Medical School, Denmark Hill, London, S.E.5.

Senior Laboratory Steward to take charge of the laboratories in the Chemistry Department—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

Lecturer (Grade II) in the Department of Physics—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

Head of the Textile Testing Department, an Organic Chemist, and Physicists (7)—The Acting Secretary, British Rayon Research Association, 58 Whitworth Street, Manchester 1.

Physical Chemists to build up a team to carry out fundamental research on the background physical chemistry of iron and steelmaking—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Man with good research experience for work on the physical chemistry of airborne dusts, especially those occurring in coal-mines—The Director, M.R.C. Pneumokoniosis Research Unit, Curran Works, Curran Road, Cardiff.

Librarian (with a good science degree, preferably in physics or chemistry)—The Director, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering.

Technician in the Pathological Department—The House Governor and Secretary, Queen Mary's Hospital for the East End, Stratford, London, E.15.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Anti-Locust Memoir 3: Seasonal Breeding and Migrations of the Desert Locust (*Schistocera gregaria* Forskål) in Western and North-Western Africa. By U. Donnelly. Pp. 43. (London: Anti-Locust Research Centre, c/o British Museum (Natural History), 1947.) 5*s*. [112

Journal of the Institute of Navigation. (Published Quarterly.) Vol. 1, No. 1, January. Pp. viii+102. (London: John Murray, 1948.) 6*s*.; 25*s*. per annum. [112

Proceedings of the Aristotelian Society. New Series, Vol. 47: Containing the Papers read before the Society during the Sixty-eighth Session, 1946–1947. Pp. xx+300. (London: Harrison and Sons, Ltd., 1947.) 30*s*. net. [192

Science and Religion: a Quarterly Review of Current Literature and Thought. Vol. 1, No. 1. Pp. 48. Vol. 1, No. 2, January–March. Pp. 49–96. (London: Paternoster Press, 1948.) 1*s*. 6*d*. net; 6*s*. 6*d*. per annum. [192

Rubber in Textile Factories. By Colin Macbeth. Pp. 135. (London: British Rubber Development Board, 1948.) Free. [192

Department of Scientific and Industrial Research. Science at War. By J. G. Crowther and R. Whiddington. Pp. vi+185+51 plates. (London: H.M. Stationery Office, 1947.) 2*s*. 6*d*. net. [242

Land and Poverty in the Middle East. By Doreen Warriner. (Middle East Economic and Social Studies.) Pp. vii+149. (London and New York: Royal Institute of International Affairs, 1948.) 7*s*. 6*d*. net. [13

Other Countries

Maria Moors Cabot Foundation. Publication No. 1: The Use of Auxins in the Rooting of Woody Cuttings. By Kenneth V. Thimann and Jane Behnke. Pp. iii+272. (Petersham, Mass.: Harvard Forest, 1947.) 1 dollar. [232

National Bureau of Standards. Circular 461: Selected Values of Properties of Hydrocarbons. Prepared as part of the work of the American Petroleum Institute Research Project 44 by Frederick D. Rossini, Kenneth S. Pitzer, William J. Taylor, Joan P. Ebert, John E. Kilpatrick, Charles W. Beckett, Mary G. Williams and Helene G. Werner. Pp. xiii+483. (Washington, D.C.: Government Printing Office, 1947.) 2.75 dollars. [232

Polska Akademia Umiejetności (Polish Academy of Sciences and Letters). Wykaz prac z działu nauk matematyczno-przyrodniczych wykonanych w polsce w okresie okupacji niemickiej w latach 1939–1945 (List of the works achieved in the field of Mathematics and Sciences in Poland during the German Occupation, 1939–1945). Pp. iii+289. (Kraków: Polska Akademia Umiejetności, 1947.) [242

Silviculture Research Code. Vol. 2: The Statistical Manual (Being the Application of Statistical Methods to Silvicultural Research in India). By A. L. Griffith and Bakshi Sant Ram. Pp. viii+214. (Dehra Dun: Forest Research Institute, 1947.) 11.2 rupees; 17*s*. 6*d*. [262

Bulletin of the American Museum of Natural History. Vol. 90: Stingless Bees (Meliponidae) of the Western Hemisphere—Lestrimelitta and the following subgenera of Trigona: Trigona, Paratrigona, Schwarziana, Parapartamona, Cephalotrigona, Oxytrigona, Scaura and Mourella. By Herbert F. Schwarz; with a Bibliography by Herbert F. Schwarz and Annette L. Bacon. Pp. xvii+546. (New York: American Museum of Natural History, 1948.) [13

Annals of the New York Academy of Sciences. Vol. 49, Art. 2: Chromatography. By Harold G. Cassidy, Norman Applezweig, Stig Claesson, Victor R. Deitz, Beveridge J. Mair, A. J. P. Martin, Stanford Moore, Robert L. Peck, W. A. Schroeder, Leo Shedlovsky, William H. Stein, Henry C. Thomas and L. Zechmeister. Pp. 141–326. (New York: New York Academy of Sciences, 1948.) 2.75 dollars. [23

United Nations: Department of Public Information. Guide to the United Nations Charter. Pp. vi+53. (Lake Success, N.Y.: United Nations; London: H.M. Stationery Office, 1947.) 50 cents; 2*s*. 6*d*. net. [33

Catalogues

SCIEX Scientific Precision Equipment. Pp. 72. (London: Scientific Exports (Great Britain), Ltd., 1948.)

Annual Circular, 1948. Pp. 32. (King's Lynn and Boston: West Norfolk Farmers Manure and Chemical Co-operative Co., Ltd., 1948.)

50-kV Electron Microscope, Type EM2. (Descriptive Leaflet 436/1–1.) Pp. 8. 100-kV Electron Microscope, Type EM3. (Descriptive Leaflet 436/2–1.) Pp. 4. (Manchester: Metropolitan-Vickers Electrical Co., Ltd., 1948.)

Electrothermal Heating Mantles. Pp. 4. (London: Electrothermal Engineering, Ltd., 1948.)

NATURE

No. 4100 SATURDAY, MAY 29, 1948 Vol. 161

CONTENTS

Page
Local Government in Britain 825
E. S. Beaven, a Great Barley Expert. By Sir John Russell, O.B.E., F.R.S. 828
Elementary Physiology. By Prof. W. C. Cullis, C.B.E. 828
Fundamentals of Heat Engines. By R. W. Haywood . . . 829
Elementary Theory of Electricity and Magnetism. By Prof. L. F. Bates 829
The Gas Industry in Britain. By Dr. E. V. Evans, O.B.E. . . . 832
Chromatographical Study of Meristematic Plant Tissues. By Dr. A. Allsopp 833
Paper Chromatography of Anthocyanins and Related Substances in Petal Extracts. By E. C. Bate-Smith 835
Obituaries :
  Prof. A. S. Eve, C.B.E., F.R.S. By Sir George Thomson, F.R.S. . 838
  Dr. J. G. Parker 838
  Dr. Vaughan Cornish 839
News and Views 840
Letters to the Editors :
  Anomalous Distribution of Nuclear Disintegration in Photographic Emulsions Exposed to Cosmic Rays : Double Stars.—Dr. L. Leprince-Ringuet and J. Heidmann ; T. T. Li and D. H. Perkins 844
  An Electrolytic Tank for Exploring Potential Field Distributions.—R. Makar, A. R. Boothroyd and E. C. Cherry . . 845
  Electron Emission from Oxide-coated Cathodes under Electron Bombardment.—T. J. Jones 846
  Total Emission Damping.—Dr. J. Thomson 847
  Theory of the Streaming Potential.—G. A. H. Elton 847
  A Large Field Compensator of the Berek Type.—W. A. P. Fisher 848
  Isolation of a New Androstenol-3(α)-on-17 from the Urine of a Patient with Adrenal Cancer.—Dr. Elizabeth Dingemanse, Leonora G. Huis in 't Veld and S. Lore Hartogh-Katz . . 848
  Evidence for an Electrostatic Field on Penicillin Assay Plates.—Dr. Jean Dufrenoy and Prof. Robertson Pratt 849
  Fœtal Hæmoglobin and Erythroblastosis.—Dr. J. H. P. Jonxis . 850
  Action of Sulphuryl Chloride on Wool.—A. J. Farnworth and Prof. J. B. Speakman 850
  Demonstration and Separation of Noradrenaline, Adrenaline and Methyladrenaline.—Dr. W. O. James 851
  Association of Xanthine Oxidase with Virus Multiplication.—Dr. D. J. Bauer 852
  Unsaturated Fatty Acids in Cotton Wool Plugs.—Dr. M. R. Pollock 853
  Regulation of Oviposition in Social Hymenoptera.—M. V. Brian and A. D. Brian 854
  Ciliate Protozoan Fauna of Soil and Inland Waters.—Ernest Gray 854
  Separation of Polar from Non-Polar Molecules.—Prof. G. Karagounis 855
  Transmission of Bactericidal Radiation through Glass.—J. E. Stanworth 856
  Stimulation of Growth in Pigs by Iodinated Casein and Stilbœstrol.—Dr. R. Braude 856
  A Radioactive Local Anæsthetic.—Frank Howarth 857
  "Plant Geography".—Prof. Ronald Good 857
Fractional Distillation and its Application in the Concentration of the Heavy Isotopes of Oxygen and Hydrogen. By Dr. I. Dostrovsky, Prof. E. D. Hughes and Dr. D. R. Llewellyn 858
Reversal of Vernalization by High Temperature. By Prof. F. G. Gregory, F.R.S., and Dr. O. N. Purvis 859
U.S. National Academy of Sciences 860
Norman Lockyer Observatory of the University College of the South West of England, Exeter 861
Long Ashton Research Station 862
International Aspects of the Radio-frequency Spectrum 863
Recent Scientific and Technical Books . . . . Supp. ii

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LOCAL GOVERNMENT IN BRITAIN

MORE than three years have now passed since the appearance of the White Paper of the Coalition Government on the reform of local government, and in presenting its second annual report the Local Government Boundary Commission, set up as a result of the sole recommendation of the 1945 report, has now reached the conclusion that in many areas of Britain—and these covering the great bulk of the population—the present powers and instructions of the Commission do not permit the formation of local government units as effective and convenient as they should be. In this report the Commission has chosen to set out its views and to detail recommendations which, if accepted, will require legislation and amendment of the 'General Principles' laid down by Parliament for its guidance. Much of the report is occupied by a discussion of the functions of local authorities, although the Commission has no jurisdiction in this aspect. Its experience has demonstrated the futility of considering functions and boundaries separately, just as it has shown the weakness of the original White Paper in refusing to contemplate any significant change in the existing structure of local government or the introduction of some form of regional development.

The first comment on a report which is characterized by realism and boldness, however strongly the application of some of its principles may be challenged in detail, is one of surprise that such a report could not have been produced in place of the original White Paper more than three years ago. There were then already available reports on local government reform from the Labour Party, the National Association of Local Government Officers and the Liberal Party, as well as numerous proposals from all the main associations of local authorities. The memorandum on local government areas, outlining the problems and opportunities of the Boundary Commission, issued over the signatures of Viscount Astor, Lord Simon and Mr. A. W. S. Burgess, the ex-Lord Mayors of Plymouth, Manchester and Bristol, and also several books which have been published since, ranging from Mr. G. D. H. Cole's "Local and Regional Government" (London : Cassell and Co., Ltd., 1947. Pp. xvi+295. 15*s*. net) to Mr. J. Blackburn's "Local Government Reform : the Two-Tier System" (Altrincham : J. Sherratt and Son, 1947. Pp. 146. 6*s*.), differ rather in the emphasis than in the character of their recommendations. In their analysis of the causes of weaknesses in local government and their criticism of the conditions for adequate reform, they foreshadow very closely the Commission's own recommendations, which might have been equally well forecast from a study of the numerous schemes for the reconstruction of the cities of Britain, or the planning studies of Herefordshire and other counties.

Agreement is now general on the need for far-reaching overhaul, and on the defects of the existing system and their causes ; but there is probably less prospect than in January 1945 of agreement on the nature of the changes required, or of ready acceptance of a scheme agreed by the majority. General reform is now even more likely to be contested hotly, while at the same time the deadlock now threatens the survival, not of the forms, but of the essence and spirit of self-government in local affairs. The multiplication of new public services and duties over the last thirty years and their concentration upon the major authorities to the detriment of the boroughs and district councils, with the tendency to remove altogether from the backward local authorities tasks which reformed authorities could well execute, is sapping the very foundations of local democracy upon which the effective working of democratic institutions upon a national scale depends.

The Boundary Commission's report is first and foremost an indictment of this neglect, of the policy of drift and of allowing piecemeal alteration of the responsibilities of local government authorities to distort the structure, so that it becomes less and less suitable for its task. The Commission has now, as already indicated, rightly decided that local government cannot be properly recast under the piecemeal terms of reference to which it is subject, and in the main the reasons given are endorsed by the large body of evidence already indicated.

At the outset, indeed, the Commission comments on the surprising adaptability of the system as a whole in practice, in spite of the fact that there has been no thorough-going overhaul of local government in Britain since the present system was established in 1888. The strain, however, is heavy, and is increased by various defects such as the disparity between individual counties and individual county boroughs in population and resources. This disparity is due partly to historical causes but mainly to the failure of adjustments of the local government structure to keep pace with changes in either population or functions; and the Commission observes that unless this defect in the system is remedied, Parliament may well hesitate to entrust to local authorities new functions which are in themselves entirely suitable for local administration.

Next, due partly to the weakness of the smaller units in all types of authorities, central control of local administration has increased and, if carried much further, will cut at the root of local government.

The report then reviews the types of local government units, discussing the relative merits of the 'one-tier' system, administered by a county borough council, or 'all-purpose' authority, and the 'two-tier' system, administered by county councils and county district councils. Finally, it recommends the creation of a new type of authority the area of which would form part of the county, but the scope of the functions of which would be intermediate between those of an 'all-purpose' authority and those of a 'minor-purpose' authority.

The broad outlines of the Commission's proposals and the general principles on which they are based have much in common with what has been advanced elsewhere, although most administrative authorities would regard the population limits suggested for the new county boroughs as too low for the autonomous conduct of some of the services, such as education and health, which it is proposed to entrust to them. In the memorandum on local government areas issued by the ex-Lord Mayors of Plymouth, Manchester and Bristol, the principles which it is suggested the Boundary Commission should bear in mind when determining the character of a major authority include the possession by each authority of the minimum standards of population, area and finance for the provision of services on an adequate and economic scale and for the employment of an efficient and specialized staff, and also the value of a satisfactory balance in each area of occupational classes and income groups. Each authority, too, should so far as possible form a satisfactory planning unit and should be based on the area of local political and civic consciousness.

The quantitative result of the Commission's proposals would be the division of England into sixty-seven new counties, none of which would have a population of less than 200,000. Twenty of these would be 'one-tier' counties, that is to say, large towns with precisely the same status as that of a county borough to-day. The remaining new counties would be administered on the two-tier system, with lesser authorities beneath them. The complete picture involves the elimination of seven counties and the insertion of five new two-tier counties, but three-quarters of the existing county boroughs would cease to be all-purpose authorities. On the other hand, there would be created initially sixty-three new county boroughs, authorities for most purposes; and while this may increase the acceptability of the scheme it introduces serious weaknesses and dangers in two-tier county administration. Even the importance of local interest can scarcely balance the reduction of the administrative unit for education and health to one of 60,000, and the attempt to please too many existing authorities, with disregard of administrative opinion, is unlikely entirely to avoid creating fresh jealousy and dissatisfaction between counties and expanding towns.

If this limit of 60,000 were raised to 100,000 or 150,000, a much more confident welcome might have been given to this scheme of reform, although it is still somewhat timid in dealing with the very difficult problems of the provincial conurbations, particularly in the face of such opposed views as those of Manchester or Liverpool and Sheffield or Bradford. It can also be urged further that at the other end the Commission has not faced squarely the real task of securing a more homogeneous lower tier of authorities with responsibilities which will attract the services and interest of the best elements in the local communities. Nor can it be said that the Commission's proposal to create an intermediate type of second-tier authority dealing with most purposes does anything to check the transfer to joint boards or nominated agencies of many functions which are suitable for democratic local control, but which require large administrative units.

It is the invasion, or erosion, of local government in this way that is the gravest danger to-day, and the great merits of the scheme and the careful study which the report undoubtedly merits should not be allowed to conceal that danger and the urgent need for dealing with it. It would undoubtedly have been better had either the Coalition Government or the present Government the courage and the time to reconstruct local government before the changes introduced by the recent education, health and planning Acts took effect. As it is, disappointment with the Commission's proposals as they affect individual towns or counties, or a possible feeling that the Commission has been excessively devoted to arbitrary standards of size, should not be allowed to stand in the way of a careful and objective study of what is a realistic and imaginative plan which calls for action without delay.

The opening chapters of Mr. G. H. D. Cole's book "Local and Regional Government" afford the student much assistance in appraising the Commission's proposals. Mr. Cole is inclined to eschew the intermediate unit, and urges that we need to create and to give real power to both larger and smaller units of administration than have been favoured by the trends of evolution of local government in Britain in recent years. In detail, for all his vision, he is sometimes unrealistic and discards the entities from which transition must be made; but the criticism that may justly be made of his own scheme does not affect the value of his book as a clear and interesting introduction to the problems of local government.

Mr. Cole himself describes his book as an attempt to influence the Boundary Commission in arriving at its plans for recasting local boundaries. It is much more correctly described as an important and valuable contribution to the formation of an intelligent public opinion capable of appraising the Commission's proposals impartially and securing prompt action upon them in so far as they meet the needs of democracy rather than suit the views and prejudices of local councillors and officials. His account of the growth of the existing system of local government is clear and concise, and the various approaches to local government are set out in a way which indicates not only the need for large-scale administrative units for some purposes, but also the immense possibilities in the preservation and recreation of really small communal units for other purposes closely related to the everyday lives of the people. The book is a useful contribution to the understanding of all the factors that are involved in the 'new towns' policy of the Government as well as of those that affect local government itself. It points to positive ways in which the community spirit might be revived and encouraged, and while giving a clear idea of what regionalism is, the different approaches to it and the dangers to be avoided, it should stimulate constructive and independent thinking about the nature of such authorities as well as of the technical and national boards dealing with water supply, power, transport and the like. Although, as already noted, the treatment of the problems of the great provincial cities or conurbations is not entirely adequate, at least the principles are indicated which could form the basis of more fundamental thinking about those problems.

Two of those main considerations emphasized by Mr. Cole are the immediate concern of scientific and technical workers and their professional associations. Recent debates on the Water Bill and the River Boards Bill have shown how technical development continues to call for the conduct of a number of essential public services under unified management over large areas. Water supply and drainage, sewage disposal, the control or prevention of flooding and pollution, fisheries, power supply and transport all present problems which may on occasion make impracticable for particular services the reconciliation of technical requirements with the adoption of areas of management that are suitable for other purposes, of regional or local government. The tendency may be unavoidable, but Mr. Cole's book should help the technician concerned to keep aware of the dangers inherent in such unification, and of the desirability of keeping it to the minimum consistent with genuine technical requirements.

Other services, such as gas and health and consultant services, may require to be co-ordinated and planned, but not administered, nationally; and it has already become apparent how much a professional body can contribute towards the solution of the problems involved in regional and local administration when national standards of service are to be observed and professional ideals and traditions maintained.

Primarily, the scientific and the technical worker is concerned with technical aspects of the problems which arise in local or in national government, and with seeing that technical requirements of efficiency are met. While, however, they must not be deflected from an impartial appraisal of the technical requirements by professional bias or sectional prejudice, they must be imaginatively alive to the human problems of government no less than to what is administratively practical. Something more than technical or professional competence is needed to resolve the deadlock in local government. Doubtless in time the British Institute of Management may be able to make its own contribution to the clear thinking that is essential, and especially by assisting in applying the lessons learnt under the stress of war in civil defence, the community centre and like fields.

Fundamentally, however, the second report of the Local Government Boundary Commission touches the scientific worker not so much because of its relation to special fields of professional responsibility but for its challenge to the constructive forces of democracy. On our response to that challenge now the future of local government and even of democratic government in Britain may well depend. The problem of relating knowledge and action in ways which satisfy both the technical need for planning over wider areas and the democratic need for execution of the plans by far smaller communities in which the personal touch, local knowledge and patriotism can play their vitalizing part, is an old one. Goodwill and active support of every scientific worker will be required, individually, through his professional associations, and perhaps not least in assisting the universities to recognize and discharge their regional responsibilities.

E. S. BEAVEN, A GREAT BARLEY EXPERT

Barley

Fifty Years of Observation and Experiment. By Dr. E. S. Beaven. Pp. xx + 394 + 27 plates. (London: Gerald Duckworth and Co., Ltd., 1947.) 30*s*. net.

IT is difficult to convey to this generation any adequate impression of the giant personalities that gave the Victorian era such brilliance and distinction. E. S. Beaven was one of them. Barley was his great life interest: he was the son of a barley grower, and son-in-law of a maltster whose business he entered as a youth; all his life was spent in handling barley and he knew it more intimately than any of his generation or this. But it was not only as a barley expert that he was known and respected: he was typical of his time, a sturdy, vigorous, forceful personality, outspoken, scathing in his denunciation of anything State-aided or other spoon-feeding agency; a stout believer in self-help, in some of his contemporaries, and in himself.

Beaven entered his father-in-law's business in 1878 when the malting barley most commonly grown was probably 'Chevalier', a variety accidentally discovered by a farm worker John Andrews at Debenham, Suffolk, and multiplied by his landlord, the Rev. J. B. Chevallier, after whom it was named—an 'l', however, being dropped during the process. This barley is of excellent malting quality, but it has some disadvantages: its straw is liable to be weak, and its neck, that is, the part between the uppermost node and the ear, is long and liable to bend over as the ear gathers weight; it becomes brittle during the desiccation accompanying maturation, and is liable to break so that the ears are lost.

There were, however, numerous other sorts in cultivation, including 'Archer', an old English variety of unknown origin, characterized by rather late ripening, a short neck, rather grey-coloured grain, better yielding capacity than 'Chevalier' but of lower malting quality; and 'Spratt', described in Lisle's "Essays on Husbandry" (1757), which, however, was grown only locally, chiefly in a few scattered districts in the Fens and in Essex: it had very stiff straw, could stand up where many other sorts would 'lodge', and was capable of high yields. In Beaven's youth another variety came into general use: 'Goldthorpe', raised from a single ear found by Mr. Dyson of Goldthorpe, Yorks, in 1889 in a field of 'Chevalier' barley. This was a considerable improvement on the existing sorts, and the fact of its discovery and its spread made a deep impression on him.

Beaven knew also of the Danish experiments on barley begun in 1882, and was much impressed by the valuable results yielded by the variety trials made there between 1893 and 1902. He began field experiments at Warminster in 1895, starting with single-plant cultures of various established races of barley and gradually expanding his programme. Then in 1902, in order to cope with the disconcerting depredations of birds, he erected a large bird-proof wire structure (later enlarged) under which special cultures could be grown. In all, his experimental ground finally covered about four acres.

Large numbers of single-line cultures were made, and those that came out best were further tested on a larger scale at Warminster and Cambridge; two soon came into general cultivation: 'Plumage' (of Danish origin) and 'English Archer'. He quickly realized the limitations of the selection method: while it furnished strains of higher yielding capacity, it could not introduce any new characters. So with the active help of R. H. Biffen and T. B. Wood (who became his son-in-law) he commenced hybridization in his cage, discarding unsuitable plants from the F generation onwards, but carrying on the most promising to the F_6 generation. The surviving sorts were then transferred to small plots, replicated but not randomized—this refinement had not yet been introduced and in any event Beaven did not approve of it; the final selections were then multiplied up and compared with the standard sorts in the field, the seed being sown in a drill divided into two halves, so that two sorts could be sown in alternate half strips. His first great triumph was the production of 'Plumage–Archer', which speedily became very popular among farmers; but others of his productions achieved considerable fame, and undoubtedly his labours contributed largely to the marked increase in yield of barley that has occurred since 1900. No one in Great Britain has done so much and so well for barley as he.

Beaven's success was due to his amazing gift for recognizing the qualities of barley. He knew by some intuitive process which of his many seedlings to reject and which to retain. He combined the artist's eye and the scientist's recognition of the need for full and accurate records, though he always disclaimed any scientific merit.

It was well known that he had accumulated large numbers of data, but during his active life he could never be persuaded to work them up: it was, indeed, feared that they might be lost. Fortunately he did in the end summarize his results; and although he has not lived to see the book, the devoted labours of Miss N. Stallwood have ensured its completion. To her is owed a great debt of gratitude, for it would have been a tragedy had the records remained unavailable to later workers.

Work of this sort is not likely to be done in the future, for the day of the non-professional scientific worker is past: no one now has the necessary means. Yet it must be admitted that some of the greatest advances in agriculture, as indeed in other subjects, have been made by non-professional workers combining the scientist's skill in ascertaining facts with the artist's perception of what lies behind them—often seeing further than the facts seem to warrant. It still remains to be seen how far the organised labours of teams of trained workers can go in achieving comparable results.

E. JOHN RUSSELL

ELEMENTARY PHYSIOLOGY

Introduction to Physiology

By Prof. W. H. Newton. Pp. 284. (London: Edward Arnold and Co., 1948.) 7*s*. 6*d*. net.

PHYSIOLOGY is a subject covering such a wide range of interests, and involving so many other branches of science, that teachers of it tend to have their own individual ways of approach. Most of them, after trying various ways of introduction to the subject, end up by considering, first, what that great teacher of physiology, Sir Michael Foster, called the 'master tissues' of the body, the muscles and the nerves. Prof. W. H. Newton, when he comes to deal with the different systems, also adopts this order; but his approach is refreshingly individual. He begins with an interesting chapter on "The Fire of Life" and passes on to a study of the control of temperature in the body, before he deals with the nerves, from the double aspect of the mechanism of nervous activity and organisation of the nervous system, and with the muscles, which he considers from a wide point of view under the heading 'movement'.

Throughout the book there are evidences of wide teaching experience in the shape of simple illustrations and analogies. In the main these are useful, though occasionally some of the drawings seem so simplified as to be unnecessary and the analogies to be unduly strained. The early chapters, interesting and unusual as they are in their presentation in a book of this kind, are likely to be hard reading for the ordinary lay person, though admirable for students of physiology whether working in the medical or science faculties.

As, however, nearly one-third of the book is devoted to these introductory chapters, the rest of the body has to be less fully considered; though here again valuable and less usual aspects of the systems are stressed. There are, for example, good sections on the factors controlling the circulation in different organs, on the functions of the kidney, short but excellent paragraphs on integration, and instructive maps showing the relationship between the amount of iodine in water supplies and the incidence of goitre as shown by the Army recruiting figures from the United States.

Altogether the book provides an interesting and thought-provoking introduction to a subject of much practical importance, and is one which should help those for whom knowledge of physiology forms a part of their training to a realization of its fascination.

W. C. Cullis

FUNDAMENTALS OF HEAT ENGINES

Elements of Applied Energy

By Prof. Frederick T. Morse. Pp. ix+444. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 30*s*. net.

THIS book, by the professor of mechanical engineering at the University of Virginia, may best be described as an up-to-date heat engines text-book of an essentially descriptive character. It is intended as an introduction to heat power for second-year students, to show them "the how and why of machines and other equipment in which energy plays a part". As such, it should fulfil its purpose admirably, the subject-matter being presented and illustrated in a manner which makes its reading particularly easy and agreeable.

It makes no claim to deal with the underlying theory, the mathematics being limited to occasional formulæ inserted in the text, and presented without proof. The limitations imposed by this method of presentation inevitably lead to occasional difficulties, which on the whole are successfully overcome; but it is disappointing to find such inaccuracies and over-simplifications as "hence isentropic process is a synonymous expression" (for adiabatic process); or "in the reaction turbine the nozzles are themselves attached to the shaft", even though these statements be qualified later in the text.

The extent to which this book brings its subject up to date may be judged by the fact that sections are included on atomic energy, gas turbines, jet engines and the war-time rockets and flying bombs. These sections form a small proportion of the 435 pages, the greater part being devoted to a modern presentation of the subjects commonly met with in a heat engines text-book such as this. Useful tables of the properties of steam and other fluids are included in a supplement.

In general, the book might best be described as suitable for higher national certificate courses in Britain, though this does not mean that the book is unsuitable for courses leading to an honours degree; its agreeable manner of presentation makes it very suitable for spare-time reading by the honours student, to provide him with the necessary practical background to his more theoretical studies, and in that way to stimulate his interest.

R. W. Haywood

ELEMENTARY THEORY OF ELECTRICITY AND MAGNETISM

Electricity, Magnetism and Modern Physics

A Textbook for the use of Scholarship Candidates and University Students. By Dr. G. T. P. Tarrant. (Being Vol. 2 of Physics.) (Dent's Modern Science Series.) Pp. xii+468. (London: J. M. Dent and Sons, Ltd., 1948.) 15*s*.

THE author states in his preface that this book is intended for students of physics who have placed the higher school certificate examination behind them and are proceeding to university scholarships or degrees, and there is no doubt that he has succeeded in producing one ideally suited for them. Much care and thought have obviously been given to the elucidation of the more difficult points in the theory of electricity and magnetism which are so often passed over in silence. The opening synopses of the histories of electricity and magnetism are likely to be very helpful to those students who might otherwise be worried by our modern conventions and order of presentation of the subjects.

The author is particularly sound in his discussion of dimensions, although the reviewer prefers to take e as a fundamental quantity in these modern days. The mathematical portions of the book are set out fully and in a manner which the average student should find easy to follow, and there are tables of practical importance, such as that of magnetic quantities on p. 278, which are very valuable in a book of this kind.

About three-fifths of the book are devoted to what is usually termed modern physics, and of which there is a survey fully adequate for the pass or general degree student. There are one or two small blemishes in the chapter on the theory of magnetism; for example, it is desirable always to emphasize that it is the magnetization vector of a domain which rotates, and this is best done by inserting the word vector wherever possible. Again, the figure on p. 284 and the use of italics on p. 286 may give the impression that Bitter figures are formed only upon a surface to which an applied magnetic field is perpendicular. Most teachers will appreciate the clear and helpful diagram which illustrates Dunnington's (not Duddington) method for finding e/m; but the inclusion of an electron path in the Bainbridge mass spectrograph may put dangerous ideas into students' heads. But these suggestions should not be taken to detract from a book which is warmly welcomed.

L. F. Bates

Our Inner Conflicts

A Constructive Theory of Neurosis. By Dr. Karen Horney. Pp. 250. (London: Kegan Paul and Co., Ltd., 1946.) 10*s*. 6*d*. net.

MANY attempts have been made to modify the original Freudian technique and theories regarding the origin and treatment of neurosis. This book describes the variations which Dr. Horney has developed and gives an outline of her views on psychology, which are interesting and coherent. The first thing which strikes the reader is that the analyses she records are not transference analyses in the Freudian sense at all and, in fact, the word 'transference' does not appear in the index. She does not believe, with Freud, that neuroses are caused by some distortion of the instinct but that they are the product of abnormal personality. She thinks that anxiety is produced by isolation, for example, and not by castration fears or birth trauma; that obsessions are due to disturbed personal relationships and not to repressed sadistic impulses, and so on. Her views on personality are individual also. She believes that there are three types: (1) compliant, (2) aggressive, (3) detached. They are really devices to deal with the patient's basic anxiety. This anxiety is also avoided by idealization of the ego, so that the patient is able to see himself as more perfect than he really is. The neurotic conflicts, she thinks, often lead to diversion of energy from useful channels, so that there is an impoverishment and inertia, the final stages of which are an all-pervading feeling of hopelessness.

Dr. Horney's psychology is half-way between that of Freud and Adler. She has a moralistic approach and her analytical technique is purely interpretative, but her views are based on clinical work and will be of interest to the psychotherapist, particularly those with Adlerian inclinations. CLIFFORD ALLEN

Practical Physiological Chemistry

By Dr. Philip B. Hawk, Dr. Bernard L. Oser and Dr. William H. Summerson. Twelfth edition. Pp. xiv+1323. (London: J. and A. Churchill, Ltd., 1947.) 50*s*.

THE rapidity with which advances are made in our knowledge of biochemistry and the fields of study with which it shares common ground makes the frequent revision of text-books dealing with these subjects a real necessity. It is ten years since the publication of the eleventh edition of Hawk's "Practical Physiological Chemistry", so that the appearance of a new edition is both timely and welcome. In the forty years since its first publication, this text-book has achieved a position which is probably unique. It is of value to teachers, research workers and routine analysts alike, the treatment of most aspects of the subject being both theoretical and practical and the scope of the experimental sections the widest possible.

The extensive additions and revision which have now been made will undoubtedly greatly increase its value to all its users. The changes embodied in the new edition are too many to mention in detail; but the following are some of the more considerable ones. A new chapter has been added, dealing with antibiotics, including penicillin, gramicidin, tyrocidine and streptomycin, and with metabolic antagonists, including analogues of vitamins and amino-acids. The chapter on enzymes has a new section concerned with cellular respiration, in which the Warburg manometric technique is described. The section on colorimetry has been extended to include a detailed account of various types of photometric technique. Other recently developed experimental techniques which are now discussed are microbiological assay of vitamins and amino-acids, polarography, use of isotopes and electrophoresis.

The chapters on hormones and vitamins have been extended to cover the enormous developments which have taken place since 1937, considerable attention being paid to the estimation of vitamins: it is in these sections more than in any others that the extent of the progress made in the last decade is apparent. Several new appendixes have been added, including one dealing with the analysis of variance, and a new feature is the inclusion in each chapter of a bibliography of relevant recent publications. These additions and many others have necessitated a considerable increase in the size of the book, which is, however, still very clearly printed and well indexed. In summary, it may be said that the new edition should ensure the maintenance by this book of its well-deserved popularity.

My Caves

By Norbert Casteret. Translated by R. L. G. Irving. Pp. xi+172+16 plates. (London: J. M. Dent and Sons, Ltd., 1947.) 15*s*. net.

THIS is a book which the general reader will enjoy and find exciting as well as informative. M. Casteret, well known already for his earlier study, "Ten Years under the Earth", has written it "not . . . as a technician, but as a dilettante", and in taking the reader "on a pleasure outing in the cave-country" he writes vividly of his experiences in pot-holing, in "reptation" and in the patient observation of the habits of bats. He devotes a chapter to each of these activities, and deals also with the purpose of spelæology and the equipment needed for its pursuit. He displays, as well as considerable courage, a sense of humour and an æsthetic, indeed almost mystical, appreciation of the wonders of the underworld. He writes with respect of the pioneers of cave exploration and marvels at the Palæolithic troglodytes. Enough is said of the value of spelæology to the geophysicist, the botanist and the hydro-electric engineer to show that it is more than a sport, though the appetite for scientific knowledge is no more than whetted.

The photographs, some taken underground by M. Casteret himself, are interesting and varied, and the translation is good and reads quite naturally, although English equivalents for some French technical terms had to be devised.

An Introduction to Filmstrips

By H. R. and I. W. Dance. Pp. 36. (London: George G. Harrap and Co., Ltd., 1948.) 2*s*. 6*d*. net.

THIS pamphlet contains a deal of common sense in a short space. Written with the needs of the classroom teacher firmly in mind, the technical processes of filmstrip production, the pros and cons of different types of apparatus and the basic principles involved in the use of this form of teaching aid are dealt with succinctly, lucidly and objectively. The line drawings and half-tone illustrations which accompany the text where necessary are admirably chosen for their purpose. On the most controversial point dealt with, the choice of frame size, the authors present a strongly argued case in favour of double-frame strip (24 mm. × 36 mm.) for general purposes, while agreeing that in certain instances single-frame strip (18 mm. × 24 mm.) will continue to be used.

There is still a tendency in many quarters to regard cinematograph film as almost the only form of visual aid worth mentioning. Ciné-film will always play an important part in education, but for regular classroom use the more humble filmstrip has much to commend it. The apparatus required is compact, weighs little and is easy to operate. The medium can be adapted to most classroom needs, is economical of time and allows considerable control of material by the user. Further, at very moderate cost the teacher can try out his own ideas in the way of filmstrip production—and will learn much in the process. Users of filmstrip, whether or not they are interested in amateur production, will find the practical suggestions in this little book helpful and stimulating without being dogmatic. ERIC LOWE

The Artificial Insemination of Farm Animals

By John W. Bartlett, George E. Taylor, Joseph Edwards, Clair E. Terrill, Victor Berliner and Fred P. Jeffrey. Enos J. Perry, Editor. Pp. v+265. (London: Chapman and Hall, Ltd., 1947.) 15*s*. net.

THIS book originally appeared in the United States in 1945. Since then much practical experience has been gained in the application of artificial insemination, both in the United States, where some million and a half cows are by now being registered annually for insemination, and in Britain, where a network of insemination centres will soon cover the country. Research work stimulated by this rapid advance has also made considerable progress, and improvements in method are continually being adopted. Quite new problems are arising. Although in consequence of this rapid advance this English edition is in many respects already out of date, it is still the most comprehensive work on the subject in the English language, and will prove very useful as a general introduction for the student of agriculture and veterinary science and for the farmer who takes an interest in the advance of scientific method. To the specialist it will be rather less useful. The treatment is on broad general lines, and exact quantitative data are not usually given to support the arguments. The chapters which describe the technical aspects are the most important. The ones which deal with the genetical aspects of livestock improvement are of less value. ARTHUR WALTON

Forest Valuation

With Special Emphasis on Basic Economic Principles. By Prof. Herman H. Chapman and Prof. Walter H. Meyer. (American Forestry Series.) Pp. xii+521. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 36*s*.

THIS book represents the development of earlier work on valuation and finance by Prof. Chapman of Yale. The wide scope of the applied part can be inferred from the main contents: the evaluation of real property producing annual income; present worth of forests producing periodic income; costs of production versus profits and the role of compound interest; rates earned and the profit margin; rotations; taxation; damages; fire insurance; methods of appraisal of stumpage value; determination and application of conversion returns; and the appraisal of forestry purchases for future operations. Appropriate formulæ, mainly concerned with compound interest and discount, are provided for the many and various problems which arise in forest finance. The importance of discount as applied to future net income in determining the present worth of an enterprise is stressed. Market values have limitations, and confusion in the past has been caused by the limitations in the use of compound interest. The authors hope that their treatment marks the final departure from the original European sources of forest evaluation and statics as set forth in Schlich's "Manual of Forestry". Many of the problems illustrated in the book are therefore specifically North American, although the principles outlined have wide applicability.

Teachers of applied economics will be interested to note the emphasis on the great advantage to students of a grounding in economic theory. The first six chapters have this need in mind, and the hope is that by stressing these principles in their direct relation to forest economics and valuation, the subject has been vitalized and its importance made clear to professional foresters and to owners and operators of forest property. J. J. MACGREGOR

Le forze creatrici dell'uovo

Questioni moderne d'embriologia. Per Prof. Pasquale Pasquini. (Sapienza, Vol. 3.) Pp. 334. (Pisa and Rome: Libreria Vallerini, 1948.) 700 lire.

PROF. P. PASQUINI has provided Italian readers with a clear and well-illustrated introduction to modern experimental embryology. He opens with a historical chapter, in which the seventeenth-century controversy between epigenesis and preformation gives him an opportunity to define the fundamental problems. The next chapter, on the maturation of the gametes, gives a good, if elementary, account of the cytoplasmic organisation of the ovum; but, as so often in embryological works, is old-fashioned in its treatment of meiosis. After these preliminaries, we come on to experimental embryology proper. Although there is nothing very original in the author's treatment, he covers the ground adequately, bringing his book right up to date by accounts of such new developments as Holtfreter's studies on the mechanism of gastrulation and the various theories of organiser action. The Italians are fortunate in having such a text-book for university students in their early years; there is nothing similar available in Great Britain. C. H. W.

Bird Recognition

1: Sea-Birds and Waders. By James Fisher. (Pelican Books, A.175.) Pp. 190. (Harmondsworth and New York: Penguin Books, Ltd., 1947.) 2*s*. 6*d*.

ALL too often the elaborate descriptions of birds that give each detail of plumage with minute exactitude are not much help to recognition in the field. Mr. James Fisher, in a 'Pelican' devoted to sea-birds and waders, and entitled "Bird Recognition", writes not with one eye but with both eyes on the field worker, and the novice at that. All persons interested in ornithology will find this little volume helpful but no one more so than the beginner, who will find it a valuable aid to the identification of the many species of waders and gulls to be found on and near the sea. The illustrations consist of monochrome portrait sketches by "Fish-hawk", maps chiefly by Mr. W. B. Alexander, and diagrams, consisting of circular calendars, showing the distribution of the species throughout the twelve months. Much information is thus packed into a small space and a useful, helpful book results.

FRANCES PITT

THE GAS INDUSTRY IN BRITAIN*

By Dr. E. V. EVANS, O.B.E.,
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COAL is the foundation of Great Britain's power of survival, and the gas industry is one of the instruments which the people of this country have created to use coal to the best advantage. In other lands oil and water power may take the place of coal, but Britain has neither oil nor any substantial quantity of potential water power. The liberation of energy by the fission of certain kinds of atomic nuclei has led to a great deal of speculation, but in the present state of knowledge we have no warrant to assume that this achievement represents unlimited supplies of exceedingly cheap power. Coal is likely to remain the staple fuel of Britain for very many years to come, and it is a matter of gratification to observe that during the last decade the nation has come to realize the importance of conserving its coal resources.

It is now generally realized that, if used wisely, every ton of coal can do much more work in industry and provide higher standards of comfort and cleanliness in the home.

The British gas industry treats annually about twenty-two million tons of coal and employs directly some 130,000 persons for the purpose of rendering a public service. It provides fuel in the form of gas, of coke and, to a relatively small extent, as oil fuel. With the other great fuel and power industries of coal, electricity and oil, it strives in healthy competition to serve industry and the public as effectively as possible, and it would be unfortunate if, as a result of the nationalization of the fuel industries, the healthy competition which has in the past been an incentive to progress ceased to exist. On the other hand, it would show great wisdom and prudence if the administrators of the future were to allot to each fuel industry those services which in the national interests it should best perform.

The basic processes which are operated to convert coal into gas fall into the two groups of carbonization and gasification.

Carbonization consists essentially in roasting the coal with the exclusion of air, the heat causing the coal substances to decompose with the evolution of gas and tar. Coal consists mainly of compounds of the elements carbon, hydrogen and oxygen, in such forms that the greater part of the carbon in the original coal remains behind in the carbonizing vessel as coke. This coke is carefully prepared for use in industry and in the home, or it may be used in the gas works for the production of gas by processes of gasification, employing the reactions which take place between incandescent coke and air or steam to manufacture either producer gas or water gas.

A modern works carbonizing coal for the production of gas operates with high thermal efficiency, recovering as much as 85 per cent of the heat potentially available in the coal in the form of gas, coke and other products.

Forty years ago, gas making was an art, full of tricks and intricacies learned by constant practice and enriched by ingenuity; but the gas engineer of that time understood little of the nature of the processes he was conducting. To-day the chemist and physicist have placed these processes upon a scientific basis. In those earlier days what we now know as consumer service was a relatively simple matter. The responsibilities of the gas engineer and manager of to-day are quite different. In order that the processes of a gas undertaking may be operated efficiently and the service to the public equally efficient and reliable, the industry has built up a complex organisation with specialist sections.

The gas-holder, so familiar that it is a symbol of the gas industry, is an appliance of the utmost importance. Without gas-holders the productive capacity of the gas-making plant of Britain would have to be about five times as large as it is at present to permit the peak demands to be met. During the midday cooking period on a Sunday, the demand may be five times the average over the whole day, while at midnight the demand may fall to about one quarter of the average. The gas-holder permits these wide changes in requirements to be met, while the manufacturing process continues to operate at a uniformly steady rate throughout the twenty-four hours.

Over the last sixty years the output of gas has grown steadily year by year at an almost constant rate, although at the present time the rate of growth is about twice the average rate over that period.

There are in Great Britain about twelve million families, and as nine out of every ten already use gas it follows that the industry cannot look forward to any large increase in the number of customers. This, however, does not mean that it cannot look forward to any further increase in sales and, indeed, the present abnormally high rate of increase is taking place with almost no change in the total number of users. What is happening is that gas is being used for more and more purposes.

Although the original purpose of public gas supply was to provide artificial illumination, gas lighting represents to-day only about five per cent of the total gas sales. About one half of all the gas sold is consumed by domestic users for cooking, and these same families use a further fifteen per cent of the total for other domestic services, such as water heating, the heating of rooms, the washing and drying of clothes, and refrigeration for food storage. The quantity of heat required for these other purposes, if they are to be performed adequately, is much larger than that required for cooking, and in this fact lies the great scope for the further use of gas in the home. Commercial consumers take about twelve per cent of the total sales, and some eighteen to twenty per cent goes to industry.

The industry has in recent years given attention to the formulation of tariffs which, as nearly as may be, relate the price charged to the actual cost of supply, and it is interesting to record that domestic consumers of one large undertaking who have adopted a two-part tariff system of charge have practically doubled the quantity of gas previously used by them.

The basis of the industry's service is a scientific understanding of the principles involved. This applies not only to the manufacture and utilization of gas but also to the manufacture, preparation and utilization of such by-products as coke and tar.

Coke is to-day a carefully prepared smokeless solid fuel for which a variety of highly efficient appliances have been designed, many of them with gas ignition. For the long-period heating of rooms and for the provision of hot water in the winter months, coke is playing an important part in the efficient use of coal and the abolition of smoke.

The largest use of tar is as a waterproof binder for holding together the stone aggregate of road surfaces, and here a study of physical properties and methods of application has enabled the science of road construction to keep pace with the increasing severity of the demands made by traffic.

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* Substance of a Discourse to the Royal Institution delivered on April 16.

The application of science to a practical problem may be illustrated by reference to the provision of comfortable warmth in the living-room of a dwelling house. The gas fire of the past was noisy, the fireclay elements were fragile and the sensation of heat was more often one of scorching than of comfort. The continuous noise of the fire when in use arose from the aerated flame burner in which the gas and air were mixed together before they reached the point of ignition. Much was done by studying the aerodynamics of the system to reduce the noise; but complete silence in operation was not achieved until the adoption of the non-aerated burner. These burners were not in themselves novel; but, so long as gas was sold for the intrinsic luminosity of its flame, the non-aerated type of burner could not be relied upon for heating purposes because of its liability to deposit soot. To-day, when gas is sold on its heating value and mainly for heating purposes, the rich hydrocarbons—benzene and its homologues—are recovered as motor benzole. This makes an important contribution to our supplies of motor spirit and at the same time produces a gas which can be burned in a non-aerated burner without risk of sooting.

The purpose of the fireclay element in a gas fire is to receive heat from the flame, being thereby raised to incandescence and emitting this heat by radiation. It was the practice to suspend the fireclay elements in the flame itself and if they were quickly to reach incandescence they had to be light, of small cross-section, and in consequence necessarily fragile. The difficulty was overcome by developing the observation that if gas flames are confined in a fireclay box and one wall of this box is perforated or slotted to a limited extent, the internal surfaces become incandescent and shine out through the slots or perforations. As the purpose of the perforated wall is to restrain the heat from escaping too rapidly, it can be made of robust material and the problem of fragility is overcome. The perforated fret has the further advantage that the apertures can be so arranged as to alter the geometrical distribution of the radiant heat, a matter of importance in the production of comfortable heating.

The study of heat comfort has revealed the necessity of providing such a degree of background heating that the temperature of the air, walls and furniture does not fall below 55° F., and ensuring that the radiant heat employed to supplement the background heating is emitted in a broad beam shining upwards and outwards. With these requirements satisfied a gas fire produces comfortable conditions within a few minutes of lighting and, what is more, the occupants of the room may sit in comfort around the fire for any length of time. The recognition of these requirements has led to the development of the convector gas fire which, in addition to providing the radiant heat, also recovers from the flue gases heat which is employed to warm the air of the room.

The application of scientific principles, of which the foregoing example is but one, has brought us to-day to the knowledge that greatly improved standards of comfort and hygiene may be provided with less consumption of fuel. The unsatisfactory standards of the past have involved the use of five to six tons of coal by a household each year. By employing gas and coke for cooking, water heating and space heating, and electricity for lighting and power, coal is saved and living conditions improved.

The gas industry has great potentialities for further development and goes forward into the future with pride in its past traditions, skill in its present technique, and confidence in its ability to play a large part in restoring the fortunes of Great Britain.

CHROMATOGRAPHICAL STUDY OF MERISTEMATIC PLANT TISSUES

By Dr. A. ALLSOPP

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Recent years have seen a revival of interest in the apical meristems of plants, but little has been done on the metabolism of these regions. The lack of suitable methods for dealing with small amounts of tissue may be held accountable for this state of affairs; but the development of paper partition chromatography seems likely to provide a method of first-class importance in metabolic studies of apical meristems, or indeed of any other tissues which are available only in restricted quantity.

Paper chromatography was first described in detail in 1944 by Consden, Gordon and Martin[1] as a method for the qualitative analysis of proteins. The same workers[2] have recently adapted it to the identification of lower peptides, while others have developed the technique for the qualitative[3,4] and quantitative[5,6] analysis of sugars. The quantitative analysis of amino-acids has also been reported in outline[7,8]. Lugg and Overell[9] have described a quantitative method for organic acids, while Crammer[10] has used paper chromatography in the separation of flavine nucleotides. Further developments may be anticipated; but the existing methods already provide valuable equipment for the investigation of plant materials.

The only work yet published which deals with a systematic examination of a plant tissue by paper chromatography is that of Dent, Stepka and Steward[11], who investigated extracts of the soluble nitrogen of disks of potato tissue. In the work outlined in the present communication, examination was made of the amino-acids contained in cold 70 per cent alcohol extracts and in acid hydrolysates of the residues of various plant tissues. The solvents used in the chromatography and other details of technique were similar to those described by Dent, Stepka and Steward[11].

The initial object of this investigation was the study of the amino-acids, free and combined, of apical growing points; but as the work progressed it was considered desirable to provide a basis of comparison by examining a range of materials from some of the principal taxonomic groups of plants. The following materials were examined: thallus of *Gigartina stellata* (Rhodophyceæ); old thallus and young branches of *Conocephalum conicum* (Hepaticæ); shoot of *Polytrichum commune* (Musci); developing synangia and mature stem of *Psilotum triquetrum* (Psilophytinæ); leaf of *Isoetes echinospora* and stem of *Lycopodium Selago* (Lycopodinæ); apices of aerial shoots, nodal tissue and young induced lateral branches of *Equisetum giganteum* and prothalli of

Equisetum arvense (Equisetinæ); shoot and root apices and central tissue of root-stock of *Dryopteris aristata*, prothallus of *Osmunda regalis*, and prothallus and leaf of *Angiopteris evecta* (Filicinæ); buds of *Ginkgo biloba* and young branches of *Ephedra altissima* (Gymnospermæ); and flower buds and mature stem of *Cheiranthus Cheiri* (Angiospermæ).

Analyses of root tips of *Dryopteris* were based on the terminal 3 mm. from seventy-six roots giving a total fresh weight of 0·057 gm. The meristematic tissue of the shoot was obtained from three well-grown stocks. After removal of scales and leaf primordia a cylinder of tissue carrying the apical cone was obtained by driving a cork borer vertically through the stock. A razor was then used to cut off a thin disk of meristematic tissue bearing the apical meristem and minute leaf primordia only. The combined fresh weight of the three disks was 0·032 gm. Growing-points of *Equisetum giganteum* were exposed by removing the sheathing leaves, and the terminal 2 mm. from a number of shoots were combined to give a total fresh weight of 0·05 gm. The single prothallus of *Angiopteris* was 0·151 gm. and a portion of a large prothallus of *Osmunda* of fresh weight 0·172 gm. was used. Similar amounts were used of the other tissues examined.

The tissues were weighed into small stoppered ignition tubes and crushed with sufficient 90 per cent alcohol to give a final concentration of 70 per cent. The extracts were removed by centrifuging, and extraction was repeated with 70 per cent alcohol (five to six times in all). Several volumes of 6 *N* hydrochloric acid were mixed with the residues and, after sealing, the tubes were placed in an oven at 100° C. for 20–24 hr. After cutting open the tubes, while wearing goggles, the insoluble residue was removed by centrifuging. Extracts and hydrolysates were evaporated to dryness under reduced pressure without heating. The product was redissolved in a small quantity of water (0·10 c.c. or less) and aliquots taken for chromatography. Usually one-tenth of the sample was used for one-dimensional chromatography, with phenol as solvent, as an indicator of the amount required for two-dimensional chromatography. Two-fifths of the extract was usually suitable for the latter.

In these small amounts of apical tissue, the protein content was sufficiently high to yield good chromatograms from the acid hydrolysates. Thus the following amino-acids were identified in hydrolysates of the shoot apex of *Dryopteris*: aspartic acid, glutamic acid, glycine, serine, threonine, alanine, arginine, lysine, proline, valine, methionine, leucine, phenyl alanine and tyrosine. Tryptophane is destroyed under the conditions of hydrolysis, while cystine and histidine do not yield well-marked spots under the conditions and concentrations utilized. Hydrolysates of the root apices and of tissue from the middle of the root-stock yielded chromatograms showing the same amino-acids, with no evident difference in their proportions, although the total amount was several times greater in the stem apex than in an equal fresh weight of the central tissue of the stock. The same amino-acids were obtained from *Equisetum* shoot apices and from nodal tissue of the same plant.

The free amino-acids, extracted from the apices by 70 per cent alcohol in both *Dryopteris* and *Equisetum*, formed only a small fraction of those liberated from the tissues by acid hydrolysis. In the *Equisetum* apex only glutamic acid and aspartic acid were found. In root and shoot apices of *Dryopteris*, glutamic acid was most prominent with aspartic acid also present in appreciable quantities. Glutamine was present in the root tips, but was not detected in the shoot apices, although tissues immediately behind the apex contained moderate amounts. Faint tyrosine spots were obtained from both root and shoot apices but were more prominent in the former. In both cases the chromatograms showed a well-marked spot in the leucine position. Methionine and *iso*leucine occupy the same position with the solvents used for the two-dimensional chromatography, but a one-dimensional chromatogram using 1 : 1 butanol-benzyl alcohol as solvent indicated that this spot was from leucine only. Tissue from the centre of the stock of *Dryopteris* was also relatively low in free amino-acid content, but in this case more acids were present and included aspartic acid, glutamic acid, glutamine, arginine, valine and leucine. It remains to be seen to what extent the free amino-acids are influenced by season and by varying experimental conditions.

Examination of the plant materials listed above has revealed marked differences in the free amino-acid content, and a truly striking correspondence between the chromatograms produced from the acid hydrolysates. Clear chromatograms were obtained from all the plant materials listed with the exception of *Equisetum* prothalli and *Lycopodium* stems, in both of which the protein content of the amount of tissue taken was insufficient for two-dimensional chromatography. In *Lycopodium*, however, it was possible to identify aspartic acid, glutamic acid, serine, valine and leucine. In chromatograms of all the other species the amino-acids already listed for *Dryopteris* were present in every case, with the possible exception of the leucines. In *Isoetes* leaf and *Psilotum* synangia only *iso*leucine was detected; but no hydrolysate remained to test whether this was also characteristic for the shoot tissue of *Psilotum*. Only leucine was detected in all parts of *Dryopteris*, in *Conocephalum* and in the prothallus of *Angiopteris*. Both *iso*leucine and leucine were present in the other materials tested, which included all those listed with the exception of *Angiopteris* leaf, *Equisetum* prothallus and *Lycopodium* and *Cheiranthus* stems. Apart from these differences in the leucines the chromatograms were virtually alike. In addition to the amino-acids named above, the stronger chromatograms showed a characteristically purple spot lying in advance of valine and the leucines in the direction of movement of the phenol and between them in the collidine direction. This spot occupies a position different from any amino-acid the R_F values of which have been published, and may prove to be new. It has been found in chromatograms from *Polytrichum*, *Psilotum*, *Isoetes*, *Equisetum*, *Ginkgo*, *Ephedra* and *Cheiranthus*. It is possible that more concentrated hydrolysates would have shown its presence in the other tissues investigated. All the amino-acids named here have recently been reported for hydrolysates of the bacterium *B. coli*[12]. This remarkable correspondence of amino-acids in so widely separated groups of plants raises the question whether the significance is one of phylogeny or of essential metabolic requirements, but our present knowledge of the functions of the amino-acids is insufficient to warrant an answer.

In contrast to the amino-acid pattern of the hydrolysates, wide differences were found in those of the alcohol extracts. The free amino-acid content was notably low in mature tissues not specially adapted for storage. This was the case in leaves of *Isoetes* and *Angiopteris*, in thalli of *Gigartina* and *Conocephalum* and in stems of *Lycopodium*, *Equisetum* and *Psilotum*. Resting buds of *Ginkgo* and prothalli of *Equisetum* were also low in amino-acid content. No amino-acids could be detected in the leaf of *Angiopteris* and stem of *Lycopodium*, but in the other materials glutamic acid was always prominent in spite of the low total amino-acid content. Aspartic acid was also present in every case. The rather bulky prothalli of *Angiopteris* and *Osmunda* contained appreciable quantities of a few individual amino-acids. *Angiopteris* contained only aspartic and glutamic acids and a larger quantity of a substance, possibly a peptide, giving a purple reaction with ninhydrin but not occupying the position of any known amino-acid on the chromatogram. The *Osmunda* prothallus contained aspartic and glutamic acids, glutamine, a larger quantity of serine and a still greater amount of a substance occupying the same position as that of the unknown of *Angiopteris*. Slowly developing synangia of *Psilotum* and shoots of *Polytrichum* occupied a middle place in amino-acid content. In both materials, aspartic acid, glutamic acid, asparagine, glutamine and smaller amounts of other substances not further characterized were present. The only materials yielding a high proportion of free amino-acids were the developing flower buds of *Cheiranthus*, actively growing branches of *Ephedra* and induced branches of *Equisetum* and *Conocephalum*. In the two cases investigated in detail, namely, *Ephedra* and *Cheiranthus*, the chromatograms corresponded in individual amino-acids to the hydrolysates, but contained, in addition, asparagine and glutamine and several substances not yet identified.

The connexion emerging from this survey between content of free amino-acids (and peptides) and growth activity of the tissues appears too close to be lacking in significance. The abundance of free amino-acids found in actively developing tissue is apparently in contrast with the observations of Dent, Stepka and Steward[11], who record that under conditions of protein synthesis in potato disks, certain of the amino-acids decrease in amount to such an extent that they are no longer visible on the chromatograms. In their work, however, the synthesizing tissues were isolated from other sources of amino-acids, whereas in the present instance the growing tissues could draw on nitrogenous substances from the rest of the plant. The connexion between active growth and abundant supplies of free amino-acids is supported by the observations on induced branches of *Equisetum giganteum* and *Conocephalum*. In *Equisetum* removal of the shoot apices led to the rapid growth of lateral branches from the nodes. In *Conocephalum* rapidly growing branches developed from the edges of an old thallus placed in a warm damp atmosphere. In both materials the actively growing branches contained an abundance of free amino-acids which were comparatively deficient in the adjoining mature tissues.

The several points of interest emerging from this survey may now be summarized. In the first place, these preliminary observations indicate that the combined amino-acids of the apical meristems are not appreciably different in nature or proportion from those in mature tissues. A striking correspondence is also noticed between the amino-acids of acid hydrolysates of representatives from widely separated groups of plants. A connexion is found between the amounts of free amino-acids and the activity of development of tissue, and among the free amino-acids the ubiquity of glutamic and aspartic acids is very striking. It is a reasonable anticipation that many additional points of interest will emerge from use of quantitative methods in conjunction with paper chromatography.

In conclusion, I wish to thank Prof. C. W. Wardlaw for his encouragement and helpful criticism and Dr. C. E. Dent for his valuable advice on the technique of paper chromatography.

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PAPER CHROMATOGRAPHY OF ANTHOCYANINS AND RELATED SUBSTANCES IN PETAL EXTRACTS

By E. C. BATE-SMITH

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THE work of Lawrence and Scott-Moncrieff[1] indicates that in *Dahlia variabilis* five genetic factors control the development of petal colour. The factor *A* determines 'light' anthocyanin pigmentation, *B* 'heavy' anthocyanin, *Y* yellow anthoxanthin and *I* ivory anthoxanthin. A factor *H* inhibits the action of *Y*. In absence of *Y*, anthocyanin is mainly cyanin; but in presence of *Y* pelargonin preponderates. *Y*, when uninhibited by *H*, completely suppresses ivory anthoxanthin production by this factor *I*. The presence of *I* is indicated in cyanic types by a blueing effect on the petal colour.

The methods used by Lawrence and Scott-Moncrieff to identify these pigments were based on tests described by Robinson and Robinson[2]. An extract of the crushed petals in 1 per cent hydrochloric acid contains all the pigments, and from it the anthoxanthins can be extracted by repeatedly shaking with ethyl acetate. The anthocyanins react with sodium carbonate, giving a tint varying from blue to red-violet as the cyanic constitution varies from pure cyanin to pure pelargonin. Yellow anthoxanthin was detected by shaking the ethyl acetate extract with saturated sodium carbonate, giving an intense golden brown coloration[1]. Ivory anthoxanthin was detected by its giving a yellow or green reaction in these circumstances in absence of yellow anthoxanthin. In presence of the latter it was detected by the blueing effect of an acid anthoxanthin extract on a standard cyanin solution.

All four pigments, when present, can be readily demonstrated in a 1 per cent hydrochloric acid extract of petals by the paper chromatographic method of Consden, Gordon and Martin[3]. Phenol, collidine, and butanol–acetic acid–water (40 : 10 : 50 by volume) have been tried as solvents; the last-mentioned gives the best results, and has been used in all the present work. In this way the pigment

R_F VALUES IN BUTANOL–ACETIC ACID–WATER (40 : 10 : 50) AND COLOUR OF ANTHOCYANIDINS AND THEIR MONO- AND DIGLUCOSIDES

	Anthocyanin taken up in:	Cyanidin			Peonidin			Malvidin			Hirsutidin		
		R_F	Colour in air	Colour in NH_3 vapour	R_F	Colour in air	Colour in NH_3 vapour	R_F	Colour in air	Colour in NH_3 vapour	R_F	Colour in air	Colour in NH_3 vapour
	Water	0·19	Blue-mauve	Blue-green	0·27	Pink	Blue	0·24	Mauve	Blue-green	0·33	Mauve	Mauve
		(0·26)			(0·22)			(0·29)			(0·26)		
Diglucosides	1% HCl	0·14	,,	Blue	0·28	,,	,,	0·22	,,	,,	0·33	,,	,,
	5·5% HCl	0·12	,,	,,	0·20	,,	,,	0·23	,,	Blue	0·24	Rosy-mauve	Blue-mauve
	Water	0·32	Blue-mauve	Grey-blue	—			—			—		
Monoglucosides	1% HCl	0·31	Mauve	,,	—			—			—		
	5·5% HCl	0·21	,,	,,	0·32	Pink	Blue	0·32	Mauve	Blue	0·29	Rosy-mauve	Bluish
Aglucones	5·5% HCl	0·24	Mauve	Grey-blue	0·38	Pink	Grey-blue	0·54	Mauve	Grey-blue	0·51	Rosy-mauve	Bluish

The values in brackets in the first row of data refer to fainter spots accompanying the main spot. These were seen only in chromatograms of anthocyanin chlorides dissolved in water without further addition of hydrochloric acid. They are likely to represent tautomeric forms of the anthocyanin colour base. In hydrochloric acid only one spot corresponding to one anthocyanin type has been observed, and this forms an additional reason for preferring a hydrochloric acid to an aqueous extract.

constitution of a large number of seedlings can be demonstrated in a few hours, giving a permanent record which can be filed for reference purposes.

The results to be described were obtained mainly with *Dahlia variabilis* during the latter part of the 1947 season. Some at least of the R_F values quoted must be regarded as provisional. The values for cyanin, for example, vary to some extent from one run to another, and until the causes of this variation are understood and controlled the identity of an anthocyanin cannot be established by reference merely to its position on the chromatogram, nor with certainty even by comparison with a standard anthocyanin run side by side. Part of this variability has been traced to the effect of the hydrochloric acid with which the petals are extracted. In the case of cyanin, for example, the anthocyanin, changing colour at about *p*H 3, is present as the oxonium chloride in the original 1 per cent hydrochloric acid solution; but as it travels down the paper it is equilibrated with the acetic acid solution at a higher *p*H, and is partly converted into the colour base. The effect can actually be seen in a slight change in the colour of the spot from pink to mauve. The salt travels at a slower rate than the colour base, so that the R_F of an anthocyanin applied to the filter paper in hydrochloric acid solution is less than that applied in neutral solution.

In spite of this difficulty, the use of 1 per cent hydrochloric acid has a number of advantages. The spots formed are less diffused than those from aqueous extracts; and a uniform practice of running chromatograms from 1 per cent hydrochloric acid solutions smooths out any difficulties due to variation in sap *p*H and also makes it unnecessary to remove acid after carrying out mild hydrolysis.

The R_F values are, fortunately, not the only evidence upon which the identity of a pigment can be established. The spots formed by these substances have distinctive colours both in ordinary and ultra-violet light, and these colours also change in a distinctive way when the papers are treated with ammonia vapour. For example, cyanin forms a blue-mauve spot becoming blue-green in ammonia vapour, peonin a rose spot becoming blue. Apigenin forms an ivory spot scarcely visible in ordinary light but becoming lemon-yellow in ammonia vapour, and having a light-brownish fluorescence in ultra-violet light.

The ultra-violet source employed was an 'Osira' lamp having some emission in the visible region.

The identification of the sugars formed after hydrolysis of the glycosidic pigments by the application of Partridge's method[4] presents no difficulty provided sufficient material is available. It should be noted that certain polyphenols, for example, catechin, will reduce ammoniacal silver nitrate in the cold, and this will form an additional means of identification of such types.

Specimen Anthocyanins. A limited number of natural and synthetic anthocyanins have been available for comparison with the types found in petal extracts, namely: synthetic cyanin, peonin, malvin, and hirsutin chlorides; cyanin from cornflower (*Centaurea cyanus* Linn.) containing a second component thought to be cyanidin monoside; cyanidin monoside from blackberries (*Rubus fruticosus* Linn.) which proved to contain a second, unidentified component.

These have been chromatographed in aqueous and hydrochloric acid solution and also after subjection to progressive hydrolysis. The spots applied to the paper contained about 5 μgm. of the pigment chloride. The R_F values obtained in butanol–acetic acid are given in the accompanying table.

Anthocyanins of D. variabilis. All cyanic varieties examined to date have shown two spots with R_F values varying between 0·12 and 0·19, and 0·25 respectively. After removal of acetic acid from the paper the former is blue-mauve and corresponds exactly in behaviour with the natural and synthetic cyanin. The second is rose-pink, and can be taken, pending similar confirmation, to represent pelargonin.

D. Merckii, on the other hand, shows in the ray petals two blue-mauve spots, R_F 0·12 and 0·16, the first corresponding with cyanin and the second of uncertain identity, pelargonin being absent. The disk florets, shown by Lawrence and Scott-Moncrieff to contain cyanidin 3-monoside[1], also form two blue-mauve spots, one, unidentified, moving with R_F 0·06 and one corresponding with cyanidin monoside.

The presence of cyanidin monoside in deeply pigmented chocolate flowers of *D. variabilis*, reported by Lawrence and Scott-Moncrieff, is confirmed by the presence in the chromatograms of a mauve spot with R_F 0·31.

Anthocyanins of other species. Results with a number of other species which bring out points of particular interest may be mentioned.

Peristrophe speciosa (Necs.), reported to contain cyanidin diglycoside[5], shows no spot where cyanin would be expected, but shows a slow spot (R_F 0·04–0·06) of a bright rose colour. On hydrolysis with 5 per cent hydrochloric acid at 100° C. for five minutes, spots are formed which correspond with cyanidin monoside and cyanidin respectively.

Iris unguicularis Poir., reported to contain delphinidin diglycoside[5], gives two spots, $R_F \sim 0{\cdot}2$ and $0{\cdot}25$, both bluer in colour than cyanin and becoming green in ammonia.

Tibouchina semidecandra Cogn., reported to contain acylated malvin[5], has one very fast moving mauve spot, $R_F \sim 0{\cdot}63$, and a fainter one, $R_F \sim 0{\cdot}44$, becoming bright green with ammonia. On hydrolysis (as for *Peristrophe*) a spot corresponding with malvidin monoglucoside (R_F 0·31) appears.

Reviewing the data on anthocyanins as a whole, it can be seen that increase in hydrochloric acid concentration in the applied solution causes a fall, removal of a glucosidal sugar and methylation cause a rise, in R_F value. Certain regularities are apparent, but there are numerous anomalies in the way of consistent interpretation of the differences in R_F in terms of differences in constitution. Nevertheless, the position of a spot giving the colour reactions of a particular anthocyanidin type can already yield useful information as to its probable nature, especially if this knowledge is extended, as in the case of the *Peristrophe* and *Tibouchina* pigments, by chromatography of its hydrolysis products.

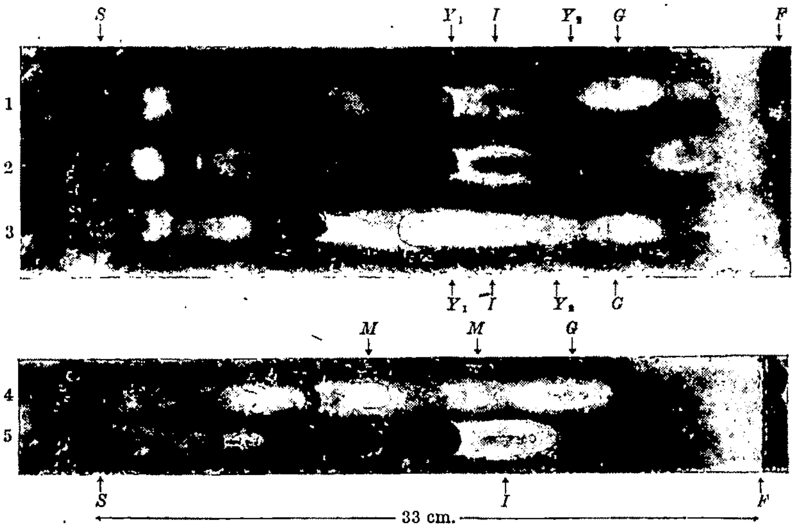
Yellow Anthoxanthin. In *Dahlia* this pigment has been identified by Price as the chalkone butein[6]. The pigment produces a long trail with all solvents tested, but there are concentrations into definite spots, the main one having R_F 0·55. After heating with 8 per cent hydrochloric acid for ten minutes at 100° C. the pigment becomes almost insoluble in water and its R_F increases to 0·85. This behaviour could be accounted for either by hydrolysis of a glycoside or by ring closure to the flavanone butin. That the former is more likely is indicated by the behaviour of a number of hydroxy chalkones (2- and 4-hydroxy, 2,3- and 2,4-dihydroxy and 2-hydroxy-4-methoxy chalkone), all of which had $R_F \sim 0{\cdot}9$. This would confirm Price's view that butein occurs as a glycoside in the dahlia petal. Owing to the trailing of this constituent it is advisable to remove it by extraction with ethyl acetate when studying anthocyanins.

Ivory anthoxanthin. Chromatograms of blue-red, rosy magenta and some white *Dahlia* petal extracts when treated with ammonia vapour show an evanescent lemon-yellow spot with $R_F \sim 0{\cdot}6$. Unless so treated this spot is not visible in ordinary light, but gives a characteristic light-brown or cream-coloured fluorescence in ultra-violet light (*cf.* accompanying illustration).

The ivory anthoxanthin in *Dahlia* was identified by Schmid and Waschkau[7] as apigenin and was thought to be non-glycosidic. This identification of the flavone has been confirmed by comparison with apiin, the 5-apioglucoside of apigenin. The following evidence suggests that the anthoxanthin is present in the petal as a glycoside.

Apiin gives a spot with the same characteristics as the *Dahlia* anthoxanthin spot, but with R_F 0·5. When subjected to mild hydrolysis in 1 per cent hydrochloric acid the R_F increases to 0·6. Hydrolysis in 10 per cent hydrochloric acid increases the R_F still further to 0·85, the fluorescent character of the spot remaining unchanged throughout. It is likely that these changes in R_F are due to the successive removal of apiose and glucose, and that the spots observed in the *Dahlia* extract chromatograms are due to a glycosidal derivative of apigenin, probably the 5-glucoside, rather than to the aglucone.

Other components of white petal extracts : substances giving colour reactions with ammonia. Lawrence and Scott-Moncrieff pointed out that white flowers free from apigenin may give a strong straw or maize colour when treated with ammonia vapour. The extract of one such flower, *DJ*/18 (an F_2 seedling from 'Murdoch' × 'Frau O. Bracht'), showed two spots, $R_F \sim 0{\cdot}4$ and 0·55, which gave permanent brownish stains when treated with ammonia. In ultra-violet light the untreated spots were barely visible ; but after treatment they fluoresced strongly (straw-coloured). It was suggested[1] that the substances responsible are tannins, and this possibility is being investigated by surveying the chromatographic behaviour of tannins and related substances.



CHROMATOGRAMS OF EXTRACTS OF PALE YELLOW AND WHITE FLOWERS. APPEARANCE IN ULTRA-VIOLET LIGHT

1. "Frau O. Bracht" (pale yellow). 2. "Ballego's Surprise" (white sport from 1). 3. "D.J.L." (pale yellow seedling from 1). 4. "*DJ*/18" (white seedling from 3). 5. "Snow Princess" (white)

Y_1, position of main butein spot, the only constituent of these flowers giving spots visible in ordinary light ; Y_2, light brown spot corresponding with a secondary concentration of butein colour ; *I*, apigenin (? glucoside) ; *M*, spots becoming brown in ammonia vapour ; *G*, spots showing bright green fluorescence ; *S*,*F*, start and finish of chromatograms. Note (*a*) absence of *G* as well as Y_1 and Y_2 from 2 : otherwise identity of 1 and 2 ; (*b*) similarity of closely related 1 and 3, markedly different from unrelated 5.

Osira lamp. Ilford Rapid Process Panchromatic plate. Ilford Micro 4 filter. (Photographs by Dr. R. Gane and Mr. D. P. Gatherum)

To sum up, this investigation has shown promise of the possibility of identifying the anthocyanins, flavones and related substances present in petal extracts, employing their colour in visible or ultra-violet light, with and without treatment with ammonia vapour, their reaction with ammoniacal silver nitrate and their R_F values as distinguishing characteristics.

Even without exact identification of all the substances responsible, the spots seen on the chromatogram provide a means of rapidly characterizing genetical material and of tracing relationships between genotypes (*cf.* accompanying illustration).

Its greatest potential value would, therefore, appear to lie in the field of chemical genetics opened up by the work of Lawrence and Scott-Moncrieff which inspired the present investigation.

The help afforded by Prof. A. R. Todd in supplying anthocyanin chlorides and chalkones and by Dr. R. Hill in supplying natural anthocyanins and flavones made this investigation possible. Mr. D. F. Elsden carried out the experimental work, and Dr. S. M. Partridge's advice in its interpretation is gratefully acknowledged.

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OBITUARIES

Prof. A. S. Eve, C.B.E., F.R.S.

Arthur Stewart Eve, who died on March 24 at his home at Puttenham in Surrey, was one of Rutherford's collaborators in early days at McGill. Throughout his life he had a fervent admiration for Rutherford, and his authoritative biography of Rutherford was a work of love.

The main facts of Eve's life are simple. Born in 1862 at Silsoe in Bedfordshire, he was educated at Berkhamsted School, whence he passed with a scholarship in 1881 to Pembroke College, Cambridge. He was fifteenth Wrangler and took a first-class in Part 2 of the Natural Science Tripos. He then went as a master to Marlborough, where he stayed for sixteen years, during the last five of which he was bursar. In 1903 he went to McGill, first in the mathematics and later in the physics department, and in the next year a series of papers began dealing with ionization by β- and γ-rays, with the ionization in the atmosphere and, somewhat later, with the amounts of radioactive substances present in rocks and in sea water. In 1909 he succeeded Rutherford as Macdonald professor of physics. Work was interrupted by the First World War, when Eve was responsible for raising the third and fourth University Companies as reinforcements for the Princess Patricia's Canadian Light Infantry. He went overseas as second in command of the 148th Battalion with the rank of major, and afterwards became a colonel in the Canadian Expeditionary Force. Though admirably suited to the command of men, the need for men with scientific training to deal with the submarine menace led to his becoming director of research at the Admiralty Experimental Station at Harwich. For his work there he was awarded the C.B.E. in 1918; in 1917 he had become a fellow of the Royal Society.

After the War he returned to McGill as director of physics, became dean of the Graduate Faculty in 1930 and retired with the title emeritus in 1935. In 1929 he was president of the Royal Society of Canada.

After his retirement to England came his 'life' of Rutherford, and he then undertook the heavy and long-delayed task of writing the life of John Tyndall from the large mass of material collected and partly arranged by Mrs. Tyndall. Eve produced a first draft, but a stroke prevented him from completing the book, which was eventually published in collaboration with C. H. Creasey and under their joint names.

Eve's true greatness lay in his personality, and this was at no time better shown than in his last years when by cheerful pluck and determination he recovered to a large extent from the stroke which had at first deprived him of speech and movement. He regained the power of speech and to some extent that of walking; he even managed to make his occasional lapses add piquancy to his always racy speech. It is a measure of his great-heartedness that he was able to turn these errors of speech into a joke embarrassing neither to his friends nor to himself. He had a rare sympathy and the widest of interests. It is primarily these that made him the successful teacher that he was, though his excellent text-books show the clearness of mind that is also essential. Few men have made so many friends and so few enemies.

In his researches on ionization Eve showed ability in handling the primitive apparatus of the day and in making clear and logical deductions. Reading them in the light of after-events, it is tantalizing to see how near he came to the discovery of cosmic rays. Though the ionization over land agreed reasonably well with what must be caused by traces of emanation and other known radioactive effects, all of which he carefully measured, it was difficult to account for the ionization over sea. This difficulty he clearly states, and perhaps if he had had more opportunities for measurements at sea he would have proved the existence of another source of ionization.

His text-book "College Physics", written in collaboration with Mendenhall and Keys and recently revised, is still widely used.

Eve was one of the first physicists of distinction to concern himself with the use of physical methods in prospecting in the nineteen-twenties. He published a series of papers, with D. A. Keys and others, dealing especially with the electrical and magnetic methods, and his influence was important in promoting the use of geophysics in Canada. His book on the subject, with D. A. Keys, is an admirable exposition well adapted for men with only a moderate knowledge of physics.

In 1905 he married Miss Elizabeth Brooks of Montreal. She survives him, as do one son and two married daughters.

G. P. Thomson

Dr. J. G. Parker

Dr. James Gordon Parker died on April 30 at his home in London in his seventy-ninth year. He was born on August 30, 1869, at Newport, Fife, and received his early education at the Madras College, Scotland, and then proceeded to Owens College, Manchester. With this foundation, he went for periods to the Universities of Heidelberg and Göttingen, and thence to the University of Strassburg. It was from here that he received his degree of Ph.D. in 1891, the subject of his thesis being "Ueber Neue Synthesen mit Brenztraubensäure".

Family associations gave him an interest in the leather industry, and for a short time he went to the University of Leeds with the late Prof. H. R. Procter and worked in the Leather Industries Department. Then, to obtain some experience in Continental leather manufacture, he went to Germany for a few years (he spoke German fluently).

So well equipped, he was appointed head of the Herolds Institute, Bermondsey, the first tanning school in London, which was opened in 1897. He remained here until 1909, when the school was transferred to the newly erected Leathersellers' Technical College, Tower Bridge Road, S.E.1, and he was principal of the College from that date until 1928, when he retired. He was elected a fellow of the Royal Institute of Chemistry in 1909. On retirement, he continued in private practice as a consulting chemist to the leather industry, and was internationally known as an authority in this branch of chemical technology.

During the First World War, Dr. Parker was appointed a member of the Leather Supplies Committee at the War Office, and of the Allied Commission of Supplies, where his experience was placed freely at the disposal of the Government. For many years he was examiner in leather manufacture for the City and Guilds of London Institute. During the period 1914–18 he was also honorary secretary of the London Tanners' Federation and the United Tanners Federation. He was an honorary liveryman of the Worshipful Company of Leathersellers, and held the Order of Leopold (second class) and the Order of the Crown of Italy. In 1904 he was awarded the Silver Medal of the Royal Society of Arts for his investigations into the causes of the deterioration of bookbinding leathers.

Dr. Parker will be best remembered for his work in the formation and development of the International Association of Leather Trades' Chemists. The Association was formed in 1897, and at the time of his death he was one of the two remaining original members. That Association later developed into the International Society of Leather Trades' Chemists, with sections in many parts of the world (the Society was recently dissolved with the formation of autonomous societies and an international Union). He was the first secretary of the Association, and remained so until 1912, when he was elected president for the years 1912–14. He was awarded the Association's Gold Medal in 1912. After the First World War, he was elected president of the then newly formed International Society for 1920–21, then treasurer for a period, and finally honorary secretary from 1929 until a year or so ago, when ill-health compelled him to forgo many of his activities. He was elected an honorary member of the Society in 1934.

Dr. Vaughan Cornish

Dr. Vaughan Cornish was a son of the vicarage, one of the most valuable groups in our national life, and his father's articles on Nature in south-eastern England in the late nineteenth century are still remembered for their intrinsic value and the beautiful form in which they were given. Dr. Cornish therefore had a good heritage of a kind he was to develop by his own efforts to understand, and to spread the understanding of, natural beauty. He was born in 1862 when his father was vicar of Debenham, Suffolk. After attending St. Paul's School, he studied chemistry at the University of Manchester, ultimately taking the D.Sc. degree and becoming director of technical education under the Hampshire County Council. In 1891 he married Ellen Agnes Provis and, with her, planned travel and research. His earlier researches, continued throughout life, were on waves —of water, snow and sand, on sea beaches, sandbanks, sand-dunes and snowdrifts. The Royal Geographical Society recognized his work by giving him the Gill Memorial Award in 1900. Earthquake waves were also studied in Jamaica in 1907, when both Dr. and Mrs. Cornish were injured; and the results of the inquiries were published in the *Geographical Journal* of 1912. In 1903, Dr. and Mrs. Cornish went around the world, making a special study of Japan, and later on they paid several visits to Panama to study the Canal while it was under construction. In 1911, Mrs. Cornish died and her husband some time afterwards published "The Travels of Ellen Cornish" as a tribute to her memory.

During the First World War, Dr. Cornish did a great deal of lecturing on strategic geographical questions to groups of officers in all branches of the Services, and thereby developed his interest and understanding of many matters of environmental conditioning of social and political life, the political side being more prominent in his mind and work. One of his best known books is "Great Capitals", with its analysis of the situations of capitals in their relations with the country concerned in each case. Dr. Cornish was a well-known and frequent contributor to the work of the British Association for the Advancement of Science, and in 1923 was president of Section E (Geography) of the Association. He was also a faithful friend of the Geographical Association and occupied its presidential chair. One remembers the distinguished figure wandering around at meetings looking for some fine piece of architecture, or some gem of natural scenery to be sketched and studied and discussed from an æsthetic rather than from a historical point of view. He gave much thought to the work of the Council for the Preservation of Rural England and wrote for it "The Scenery of England" (1932); but his most personal interest was in trying to use æsthetics as a channel of approach to truth. "The Poetic Impression of Natural Scenery" (1931) is but the best known of his many efforts in this field. If one cannot point to any very definite doctrine of his concerning æsthetics, we can appreciate, perhaps all the more, the spirit of the searcher after truth who had learned from a scientific training that truth is too great to need propagandist crutches.

Dr. Cornish's second wife was Miss Watson, who was the widow of Mr. E. A. Floyer. In his later years Dr. Cornish derived much pleasure from the inheritance of South Combe farm on which is Salcombe Hill, Devon. He gave this hill-top to the public and supported efforts to protect public amenities in Devon.

We regret to announce the following deaths:

Prof. W. T. David, professor and head of the Engineering Departments of the University of Leeds, on May 22, aged sixty-two.

Mr. G. L. Overton, formerly a member of the staff of the Science Museum, London, on May 22, aged seventy-two.

Dr. G. H. Pethybridge, O.B.E., formerly mycologist to the Ministry of Agriculture and Fisheries and assistant director of the Ministry's Plant Pathology Laboratory, Harpenden, Herts, on May 23, aged seventy-six.

Mr. J. J. Shaw, C.B.E., who maintained his own seismological observatory at West Bromwich, on May 23, aged seventy-four.

NEWS and VIEWS

Royal Botanic Gardens, Kew: Dr. N. L. Bor, C.I.E.

DR. NORMAN LOFTUS BOR, who was recently appointed assistant director of the Royal Botanic Gardens, Kew, had a distinguished career at Trinity College, Dublin, and the University of Edinburgh, and was awarded his doctorate for a thesis on the "Synecology of the Naga Hills". He has had wide experience in forest and general administration in the Indian Forest Service during 1921–46. He was political officer of the Balipara Frontier Tract during 1931–34, deputy commissioner of the Naga Hills in 1935 and acting inspector-general of forests in 1939. During 1942–46 he held a responsible position in relation to evacuation, reconstruction and rehabilitation on the North-East Frontier. He has travelled extensively in India and the Near East. During 1937–42 he was forest botanist at the Forest Research Institute, Dehra Dun, and in recent years has carried out research on the Indian species of the Gramineæ. Dr. Bor's published botanical works deal with the taxonomy of Indian plants and with the ecology of Assam and the Nilgiri Hills. In particular, he has concentrated on the study of grasses and has described new species from various parts of India. Recently, at Kew, he has made a detailed study of the Indian species of *Poa.*

National Museum of Wales: Sir Cyril Fox, F.B.A.

IT is sad to realize that the time has come for Sir Cyril Fox to retire from the post of director of the National Museum of Wales. The old saying may be true, "Le roi est mort, vive le roi", but his successor will find it no light matter to continue Sir Cyril's distinction as a researcher and his efficiency as an administrator. Fox was educated at Christ's Hospital and Cambridge. He was always an ardent archæologist, even in the days of long ago (1912–24) when at Cambridge he occupied the post of superintendent of the University Field Laboratories. Indeed it was at this time that his great work, "The Archæology of the Cambridge Region", which gained him his Ph.D., was written and published, and that he did so much splendid voluntary work for the Cambridge Museum of Archæology and Ethnology, where his beautiful lettering on the labels of things he arranged is still admired. In 1924 he was elected a Kingsley Bye-Fellow of Magdalene College, and later—after his nomination to the directorship of the National Museum in Dublin by the Irish Academy had been refused by the then Irish Civil Service on the grounds that he was an Englishman—he became a keeper and lecturer in the National Museum of Wales, of which he was soon to become the director. Sir Cyril has, not unnaturally, been president of a number of archæological societies, and has published regularly the results of his researches. His most thought-productive work, perhaps, has been "The Personality of Britain", which has passed through no less than four editions. There are other archæologists who can claim a high degree of scholarship and achievement, but few who can inspire and charm as does Sir Cyril Fox; to be with him is indeed an inspiration. The best wishes of all go to him in his retirement at Exeter, where his wife is lecturing and where we may be sure he will have retired only from administration, and will doubtless pursue his researches with continued zest and a freer mind.

Mr. D. Dilwyn John

MR. DAVID DILWYN JOHN, who is succeeding Sir Cyril Fox as director of the National Museum of Wales, is a graduate of the University of Wales. He served as a zoologist on the staff of the *Discovery* Investigations during 1925–35, making three voyages to the Antarctic, and was later awarded the Polar Medal. In the course of one of these commissions, while he was in charge of the scientific work, the first winter circumnavigation of the southern continent was made. His researches into the development and distribution of southern Euphausiidæ, based on material much of which he had himself collected, resulted in a report which is a fundamental contribution to our knowledge of the natural history of these important Antarctic crustaceans. On appointment to the British Museum (Natural History) in 1935, Mr. John was put in charge of the collections of Echinoderms, and his principal publications in recent years have been related to the subject of his specialization. In particular, he has concentrated on collections of Crinoidea made by such expeditions as the *Discovery, Scotia, Belgica* and the British, Australian and New Zealand Antarctic Expedition in high latitudes, and besides the taxonomic results obtained, themselves of great value, he has thrown much interesting light on viviparity in the Crinoidea and the care of the brood by the parent animal. A Territorial Army officer prior to the War, he was on military service until 1946; he became a deputy keeper in the Department of Zoology in February of this year.

World Co-operation in Science

PROF. J. D. BERNAL's recent presidential address to the Association of Scientific Workers contains some points which merit the notice and support of all scientific workers. He directed attention to the danger which retarded capital expenditure involves to industrial development and research, and also to the consequences to scientific effort if the reconstruction plans of the universities and research laboratories should be curtailed or postponed. He emphasized that neglect and waste of resources, both material and human, continue, and quoted Sir Henry Tizard's statement to the Parliamentary and Scientific Committee that on existing knowledge productivity could be raised by fifty per cent. As he very truly remarked, the hope of Great Britain, economically, culturally and scientifically, lies in the extent of its links with all other countries, with the United States no less than with Soviet Russia, with Eastern no less than Western Europe, and with the Colonial peoples. The world requires the flourishing of science as a basic condition of human happiness, even of human life itself; but scientific men by themselves form a weak minority, and can only be effective if they associate themselves with all others who have a common will for reconstruction and peace. Much of Prof. Bernal's address, however, was an attack on the Marshall plan for aid to Europe and the Government's policy of removing communists from key positions in defence research which ignores both the totalitarian threat to the freedom of science in Soviet Russia and the question of loyalties which has compelled Government action in Britain against communists.

Higher Technological Education in Britain

THE University Grants Committee has appointed a sub-committee to advise it on matters affecting technology in the universities of Great Britain, and to consider questions of higher technological education in consultation with the National Advisory Council on Education for Industry and Commerce, appointed by the Ministry of Education. The sub-committee consists of: Dr. A. E. Trueman (chairman), Prof. J. F. Baker, Sir Alan Barlow, H. W. Cremer, Sir Charles Darwin, Sir Peter Innes, Prof. Willis Jackson, Sir Andrew McCance, Prof. Andrew Robertson, Prof. J. B. Speakman, Sir Raymond Streat, Sir Henry Tizard, and Sir Charles Ellis.

B.C.U.R.A. Quarterly Gazette

THE *B.C.U.R.A. Quarterly Gazette*—a new publication of the British Coal Utilization Research Association—is designed to give a more colourful account of the Association's work and to serve a wider range of readers than a rigorously scientific journal. To factual accounts of research and development projects, it will add a running commentary on the Association's staff and their activities. The circulation will not be limited to members only. The first number contains a survey by Sir Charles Ellis, president of the Council, as it finds itself in a nationalized coal industry, covering its members, staff, accommodation, work and prospects. There follow articles on technical achievements in course of development. B.C.U.R.A. Patent No. 1 describes the down jet furnace, which employs a revolutionary system of combustion of solid fuels. Normal combustion on a grate is beset by limitations owing to the presence of ash and volatile matter in the fuel. These are avoided by the new technique, which provides freedom to work at greater intensities and for longer durations. The exploitation of these ideas is only in its infancy. Another item deals with the Association's work on domestic heating by open coal fires, which normally radiate not more than 25 per cent of the heat of combustion. Work in past years has shown the possibility of increasing this by one or other method—especially by supplementing radiation with heat convection. To-day the consumers' progress towards fuel economy is limited by lack of availability of efficient appliances. Sometimes these are too costly or even only to be obtained in a new house. The article describes a new inset fire which can be fitted into an existing grate at a moderate cost. It is designed by Mr. J. S. Hales and Mr. T. W. Grieve and claimed to be capable of high thermal efficiencies. When burning normal house coal, the total output of heat—by radiation and convection combined—reached 37 per cent; with coke, the figure reached 48 per cent of the heat of combustion. In addition, by reducing the flow of heat up the chimney to one change per hour, draughts are minimized and comfort improved.

Medical Group Practice in the United States

THE review of the development and characteristics of Medical Group Practice in the United States which Political and Economic Planning has issued as Broadsheet No. 274 is of special interest in view of the obligations placed on local authorities in Britain under the National Health Service Act to provide, equip and maintain health centres staffed and run by medical practitioners working as a team. The survey shows that American group practice aims at providing a full general and specialist service, including, if possible, in-patient treatment, and in the United States the term is applied to almost any form of organised medical team-work. The main incentives appear to be the inability of individual practitioners to provide a sufficiently complete service, the desire for professional co-operation among medical men and the need to reduce the cost of medical care by decreasing overhead expenditure and bringing specialist and hospital services to undeveloped areas. The main criteria are organised team-work and pooling of income. Day-to-day consultations are supplemented by staff meetings, good record systems, and sometimes also by democratic methods of administration. Groups show much interest in keeping their members up to date and developing their skills, for example, by good libraries, paid annual study leave, and systematic training of junior members. Financial competition within the group not only hinders team-work but also results in friction, and no solution has yet been found for the problem of assessing financially the diverse and constantly changing ability of physicians. The election of group members is of the highest importance and should be done by the medical men themselves. Some are temperamentally unsuited for group work and should be excluded. Good group practice may have a beneficial influence on medical standards over a wide area; but in view of the important differences in social background, in the development of health services and in the organisation of the medical profession in the United States, careful consideration will be necessary before the lessons of American experience can be applied to Britain.

British Trust for Ornithology

THE work of the British Trust for Ornithology (91 Banbury Road, Oxford) is described in the fourteenth annual report which has recently been issued. Much useful information has been collected from the hatching and fledging inquiry and will be included in the new edition of the "Handbook of British Birds". A sample census of heronries showed that large decreases were recorded in every considerable area and in the majority of individual heronries; this was almost certainly due to the extreme severity of the winter. The black redstart inquiry showed that, up to the end of the year, sixteen pairs were reported to have lived in the south of England. Other inquiries have been made into the behaviour of tits with milk-bottles and the nocturnal activities of redwings; but probably the most popular was the watch for swifts on May 11, 1947. Five hundred observers made reports on the movements of about five thousand birds, three out of every four of whom were headed north. Above a line drawn from the Wash to the Severn this northward surge was especially marked, and in south-west Devon several parties of swifts were seen to come in from the sea and to proceed inland.

Megalithic Tombs in Scotland and Ireland

PROF. GORDON CHILDE'S present ideas on the Megalithic tombs in Scotland and Ireland are put on record in a paper read before the Glasgow Archæological Society (*Trans.*, **11**; 1947). Recent discoveries have caused him to modify some details of his exposé made in the same publication for 1931. No longer, for example, is "the priority of Scottish passage graves over against English or Irish" maintained. The chief discoveries made in the last ten years have been those of no less than seventy horned cairns covering segmented cists in Ulster which, allowing for local differences, can be equated with the tombs of the Clyde and Solway coasts. Beacharra ware occurs in both these series of tombs. Further, it would appear that in Megalithic tomb times, south-west Scotland, north-east Ireland and the Isle of Man formed one province, while central and western Ireland and Scotland north of the Great Glen constituted another. Lastly, Prof. Childe uses the new discoveries to suggest an explanation of the anomalous occurrence of long cairns, horned at both ends, which have been found in northern Scotland.

Raffles Museum, Singapore

THE *Bulletin of the Raffles Museum* was suspended in 1941 when the Japanese occupied Singapore. It has now been revived, and the first issue of the new series (No. 18, October 1947) is made up of papers prepared before the occupation and preserved in the Museum. It is devoted almost entirely to the natural history of Christmas Island in the Indian Ocean and based on collections and field notes made on the island by C. A. Gibson-Hill between September 1938 and November 1940. Much of the bulletin describes the birds of the island; but notes are also included on the nature of the coast, climatic conditions from July 1939 to June 1940, echinoderms, Brachyura, terrestrial crabs, Arachnida, Isoptera, heterocerous and rhopalocerous Lepidoptera, terrestrial reptiles and mammals. The *Bulletin* also contains an obituary notice of the late director, F. N. Chasen, who was killed by enemy action in 1941.

Textile Institute: Annual Conference

THE subject of the annual conference of the Textile Institute, to be held at Buxton during June 2–5, will be "The Organisation of the Textile Industry". Among the authors of papers are Sir William Palmer (chairman, British Rayon Federation), Dr. F. C. Toy and Dr. D. W. Hill (British Cotton Industry Research Association) and Prof. A. N. Shimmin and Prof. A. J. Brown (University of Leeds). The Institute will also discuss its own role in the organisation of the industry at the opening session on June 2, when chairmen of its various committees will describe the work of their sections and their plans for the future, dealing in particular with education, standardization, publication, co-ordination, liaison and the status of the textile technologist. Foreign visitors to the conference include B. Hellmann and Dr. Zoltan Szaloki, who are to present a paper on "Textile Planning and Modernization in Czechoslovakia". Mr. Harold Wilson, President of the Board of Trade, has agreed to address the conference on June 2.

Science Service Officers

DR. KARL LARK-HOROVITZ, chairman of the Department of Physics, Purdue University, Lafayette, Indiana, and Charles E. Scripps of Cleveland, Ohio, have been elected trustees of Science Service, of Washington. Mr. Scripps represents the E. W. Scripps Estate, of which he is a trustee, while Dr. Lark-Horovitz represents the American Association for the Advancement of Science, of which he is general secretary. The following officers have been re-elected: *President*, Dr. Harlow Shapley, director of Harvard College Observatory; *Vice-President and Chairman of the Executive Committee*, Dr. Alexander Wetmore, secretary of the Smithsonian Institution; *Treasurer*, O. W. Riegel, director of the Lee School of Journalism, Washington, and Lee University, Lexington, Virginia; *Secretary*, Mr. Watson Davis, director of Science Service, Washington, D.C. Additional members of the Executive Committee are Mr. Frank R. Ford, editor of the Evansville Press, Evansville, Indiana; and Dr. E. G. Conklin, Princeton University, Princeton, New Jersey.

British Medical Association: Annual Scientific Meeting

THE first annual scientific meeting of the British Medical Association since the War will be held at Cambridge during June 25–July 2, under the presidency of Sir Lionel Whitby, regius professor of physic in the University. Among the topics of particular scientific interest announced for discussion are: recent advances in knowledge of the *Rh* factor in blood; plasma and blood derivatives in the treatment of burns; human relations in industry; prophylaxis of virus infections; radioactive isotope therapy; aviation medicine; nutrition; antihistamine substances.

International Summer School in Social Biology

THE British Social Hygiene Council is organising a Summer School on "The International and Cultural Relations of Social Biology", at the University, Lausanne, Switzerland, during August 18–September 1. During the first week of the School, there will be two morning and one evening lecture sessions each day, except Sunday, while the second week will be free for visits, excursions, and personal recreation. The course is intended for students of biology, teachers, social workers, men and women in administrative positions, and all who are interested in problems of human welfare and culture. The estimated cost, including travel, hotel accommodation and tuition, will be about £35. Further information can be obtained from the Secretary, British Social Hygiene Council (Dept. S.J.1), Tavistock House North, Tavistock Square, London, W.C.1.

Summer School in Health Education

THE Central Council for Health Education is holding its annual Summer School in Health Education at 'High Leigh', Hoddesdon, Hertfordshire, during August 11–25. In addition to the basic lectures in physiology (by Prof. Samson Wright), psychology (by Prof. James Drever), the biology of infection (by Dr. Robert Cruickshank), and social factors affecting health (by Prof. J. M. Mackintosh), Dr. H. A. Wilson, the Bishop of Chelmsford, will speak on "The Spiritual Needs of Man", and Sir Alexander Fleming on "Penicillin". An interesting new development is that of a course of nature study, with rambles and evening discussions, illustrated by films, strips and bird-song records. The School will appeal especially to educational and medical administrators, doctors, teachers, youth leaders, public health nurses, industrial nurses, industrial welfare workers, training organisers and students. Further information can be obtained from the Medical Adviser and Secretary, the Central Council for Health Education, Tavistock House, Tavistock Square, London, W.C.1. The inclusive cost of the course per person will be £16 16*s*.

Conference on Individual Freedom and Social Responsibility

THE tension between society and the individual was emphasized by more than one speaker at the Ethics and Science Conference organised by the British Social Hygiene Council in March this year. This conflict, recurrent in every age, but particularly acute in our own, was felt to be one meriting closer examination than was possible at the time, and for this reason another Ethics and Science Conference has been arranged for Thursday, June 10, when the subject will be "Where does Freedom End ?" On one hand, the individual is faced with certain obligations towards the community—obligations which seem to increase in number with the growth of the welfare State. On the other hand, there is the urge to self-expression, which only too often appears to conflict with man's social responsibilities. The need for reconciling these two principles is present in every department of life, but is nowhere more clamant than in the spheres of home and work. The Conference will therefore concentrate on these two aspects of the problem, Canon V. A. Demant, of St. Paul's Cathedral, dealing with the first, and Prof. T. S. Simey, professor of social science in the University of Liverpool, with the second. The Conference will take place in the Livingstone Hall, London, from 2 p.m. until 5.30 p.m., and ample time will be allowed for discussion. Tickets (price 2*s.* 6*d.*) and further information may be obtained from the Secretary, British Social Hygiene Council (Dept. S.J.1), Tavistock House North, London, W.C.1.

Conference on the Overseas Territories of Western Europe

A STUDY Conference on the Overseas Territories of Western Europe is to be held in the Indisch Institut, Amsterdam, under the joint auspices of the Allied Circle, Amsterdam, and the British Society for International Understanding, during June 9–12. The purpose of the Conference is to study in their widest aspects the implications for the Overseas Territories of the union which is in process of formation between the countries of Western Europe ; to promote mutual understanding of the actual conditions, needs and possibilities of the countries for whose well-being the British, French, Belgian, Netherlands and Portuguese Governments are responsible outside Europe ; to learn what steps have been taken or could be taken to develop collaboration between them in the spheres of economics, social welfare and security, and to consider the education of public opinion upon this important subject. Further information can be obtained from the Secretary, British Society for International Understanding, Benjamin Franklin House, 36 Craven Street, London, W.C.2.

The Night Sky in June

NEW moon occurs on June 7d. 12h. 55m., U.T., and full moon on June 21d. 12h. 54m. The following conjunctions with the moon take place : June 8d. 23h., Mercury 4° S. ; June 9d. 04h., Venus 3° S. ; June 11d. 17h., Saturn 4° S. ; June 13d. 08h., Mars 4° S. ; June 21d. 01h., Jupiter 4° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Venus on June 30d. 19h., Mercury being 1·0° S. Mercury is an evening star at the beginning of the month, but towards the middle of the month is too close to the sun for favourable observation, and is in inferior conjunction on June 24. Venus is conspicuous in the western sky, setting at 22h. 35m. and 21h. 10m. on June 1 and 15 respectively, and is in inferior conjunction on June 24. Mars is still visible as an evening star, setting at 0h. 48m. and 23h. 15m. at the beginning and end of the month respectively, and Saturn, which is fairly close to Mars, sets on the corresponding dates shortly after midnight and 22h. 22m. respectively. Jupiter, in opposition on June 15, is visible throughout the night, but is rather low for good observation in northern latitudes. No occultations of stars brighter than magnitude 6 occur in June. Summer solstice occurs on June 21d. 12h.

Announcements

THE RIGHT HON. SIR STAFFORD CRIPPS has been elected a fellow of the Royal Society under Statute 12 of the Society, which provides for the recommendation by the Council of persons who "have rendered conspicuous service to the cause of science, or are such that their election would be of signal benefit to the Society".

PROF. E. O. LAWRENCE, professor of physics and director of the Radiation Laboratory, University of California, Berkeley, has been elected an honorary fellow of the Physical Society.

THE following have been elected officers of the Royal Aeronautical Society for the year 1948–49 : *President*, Dr. H. Roxbee Cox ; *Past Presidents*, Sir Frederick Handley Page, Sir A. H. Roy Fedden ; *Vice-Presidents*, Sir John Buchanan, Mr. W. G. A. Perring, Mr. N. E. Rowe ; *Hon. Librarian*, Mr. J. E. Hodgson ; *Hon. Treasurer*, Captain C. F. Uwins ; *Secretary*, Captain J. Laurence Pritchard

IN connexion with the next General Assembly of the Union Radio Scientifique Internationale, to be held at Stockholm in July (*Nature*, May 1, p. 695), Unesco is contributing 3,000 dollars to the travelling expenses of the official members of the Union who will attend the meeting, and another 3,000 dollars to the publication of the report of the General Assembly.

A SYMPOSIUM on "The Genetics of Cancer", organised by the Genetical Society of Great Britain and the British Empire Cancer Campaign, is being held during June 24–25 in London. Among the topics to be discussed are inheritance of cancer in animals ; virus- and carcinogen-induced mutations ; inheritance of cancer in man. A number of American, Continental and British scientific workers will read papers. The meetings will be open to all interested in the subject. Further particulars can be obtained from Dr. R. R. Race, Lister Institute, Chelsea Bridge Road, S.W.1.

THE Committee of the Challenger Society has received a grant from the Development Fund to assist in paying the expenses of certain oceanographers attending joint meetings arranged by the Society. It is not available for members of State-aided institutions, nor can it be used for undergraduates. It may be used for others than members of the Challenger Society. Grants from the fund will consist of third-class travelling fare and a daily subsistence allowance. The awarding of grants rests with the Committee of the Challenger Society. The number for one meeting is likely to be limited to five or six. Applications for grants for a meeting to be held at the Fisheries Laboratory, Lowestoft, on July 8 and 9 should be submitted to the Honorary Secretary, Challenger Society, British Museum (Natural History), Cromwell Road, S.W.7, before June 15.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Anomalous Distribution of Nuclear Disintegration in Photographic Emulsions Exposed to Cosmic Rays: Double Stars

IN making systematic exploration of 640 cm.^{2} of Ilford plates of 100 μ thickness exposed vertically to cosmic rays for three to six weeks at a height of 3,600 m., we have observed 2,250 nuclear disintegrations and have noticed an anomaly in their distribution.

The accompanying table indicates the number p of observed pairs of stars for which the distance between the centres is less than R microns, the probable number P of the stars which would be observed with random distribution, and number of standard deviations r separating the observed value from the mean value.

R	50	100	150	200	250
P	0·15	1·2	5·0	10·3	17·3
p	4	10	17	24	33
r	10	8	5	4	4

For example, chance would lead one to expect 1·2 pairs with a centre distance less than 100 μ, yet we have observed 10 pairs; in this case the number of standard deviations from the mean value is 8.

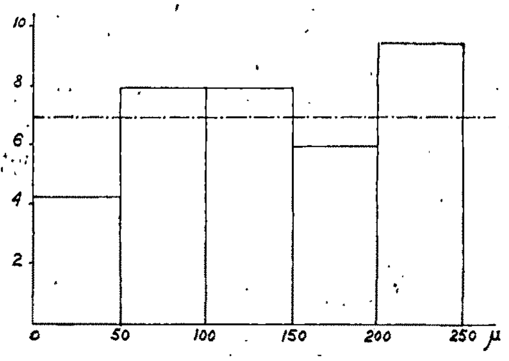
The simplest explanation of the anomaly is to suppose that one of the stars of the pair has produced the other through the medium of a particle which is invisible in the emulsion (neutron, neutral meson, photon, electron, fast proton, or fast charged meson). It is not possible to evaluate the energies and momenta carried by such intermediate particles from our present data, for we are unable to distinguish *a priori* a fortuitous pair from a real one; neither could we distinguish the primary star from the secondary (except three cases in which one of the stars is due to a σ-meson). Furthermore, the measurements with photographic emulsion involve many uncertainties, such as the nature of the disintegrated nucleus, nature of short tracks, distribution of emitted neutrons.

However, it is possible to get an idea of the order of magnitude of the cross-section of this intermediate particle by the following reasoning. The probable number of random pairs with their centre distance between R and $R + dR$ is

$$A.2R^2/h.dR, \text{ if } R \ll h; \quad A.3h/8.dR, \text{ if } R = h/2; \quad A.RdR, \text{ if } R \gg h;$$

where h is the thickness of the emulsion.

$A = \pi \Sigma N_i^2/S_i$, where N_i is the number of stars in the ith plate, S_i its surface, $i = 1 \ldots . 30$.



If we subtract from the observed number of pairs those due to chance as calculated above, and if we take into account the pairs which are not observed since the thickness of the emulsion is very small (by multiplying the result by $k(R) = 1$ if $R \ll h$; or $2 \log 2$ if $R = h/2$; or $2R/h$ if $R \gg h$) we shall get the number of non-fortuitous double stars in an emulsion, which is now presumed to be very thick, as a function of the distance separating the centres, say, from 50 μ to 250 μ.

If we assume that each star emits on the average b particles able to produce a secondary star, we get for the order of magnitude of the cross-section

$$\sigma = \frac{1}{nM}\frac{dn}{dx} = \frac{7 \cdot 5}{b} \times 10^{-24} \text{ cm.}^2,$$

where $M = 8 \cdot 5 \times 10^{22}$ is the number of nuclei per cm.^{3} of emulsion; $n = 2{,}250$, b is the total number of 'asterogen' particles issuing from the stars of our plates; and $dn = 35 \cdot 75$ is the number of double stars deduced from the curve by setting $dx = 250\,\mu$.

This value of σ, for example, would be in accord with that of neutrons, for the stars emit on the average four to six protons; therefore the order of b can be assumed to be 5–10.

During the course of the present work, we have been in close touch with D. H. Perkins, whose results are given in the following letter. We thank G. P. S. Occhialini, C. F. Powell, and C. M. G. Lattes for their friendly advice concerning the method; we are indebted to T. F. Hoang, L. Jauneau, J. Stroumsa and D. Morellet of the Laboratory of the Ecole Polytechnique for their assistance in the experiments.

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J. HEIDMANN

Laboratoire de Physique
de l'Ecole Polytechnique,
Paris.

MEASUREMENTS have been made on the surface distribution of 1,230 stars on 54 sq. in. of 100 μ C2 plates loaded with boron, exposed for 40 days at 3,650 m. elevation. Observations on the star frequency in 1 in. × ½ in. rectangles of plate area show that, by comparison with the appropriate Poisson distribution, the stars are randomly distributed over areas of these dimensions.

The distances between forty-seven close pairs of stars have been obtained; the projection, r_p, of the separation between the star centres, in the plane of the emulsion, is $r_p^2 = x^2 + y^2$, where x and y are the differences between the surface co-ordinates of each pair. If the distribution were random, the probable number of stars, out of the total observed, within distances r_p of other stars, should be $\pi r_p^2 N . N/A$, where A is the area of plate from which the total of N stars are taken. The probable number of pairs, separated by distance r_p or less, is therefore

$$Q = \tfrac{1}{2}\pi r_p^2 \frac{N^2}{A},$$

provided $Q \ll N$.

As can be seen from the accompanying table, the observed number of pairs P is considerably greater than the expected number Q, and the ratio $(P - Q)/\sqrt{Q}$ of the observed to the expected deviations is always greater than one.

Assuming the volume distribution of stars to be uniform, the actual mean separation r between the centres of pairs can be calculated in terms of the projected separation r_p, and values of r are given in the second row of the table.

r_p (1/100 in.) r (μ)	0·25 67	0·50 131	0·75 191	1·0 254	1·5 381	2·0 508	2·5 635	3·0 762
P	2	4	6	8	16	28	40	47
Q	0·27	1·10	2·48	4·4	9·9	17·6	27·5	39·6
$(P - Q)$	1·7	2·9	3·5	3·6	6·1	10·4	12·5	7·4
$(P - Q)/\sqrt{Q}$	3·3	2·8	2·2	1·7	1·9	2·5	2·4	1·2
$B = R/q\sigma \times 10^{24}$	0·38	0·60	0·73	0·83	0·97	1·05	1·14	1·21
$(P-Q)/B = q\sigma \times 10^{24}$	4·5	4·8	4·8	4·3	6·3	9·9	11·0	6·1

If we consider the surplus of double stars to be produced by infinitely penetrating radiation from the primary stars producing secondary stars, we can easily calculate the variation of the double stars with distance r. Let q be the number of particles from each star, σ the cross-section of each for producing a further star. Then, assuming the particles to be emitted isotropically, the number of 'doubles' with separation less than r is

$$R = Nq\sigma L \,.\, \left[\frac{3d}{4} + \frac{d}{2}\log r/d\right] \text{ for } r > d$$

$$R = Nq\sigma L \,.\, [r - r^2/4d] \text{ for } r < d,$$

where d is the emulsion thickness and L is the number of nuclei per c.c. of emulsion. The most accurate analysis at present available gives $L = 5{\cdot}61 \times 10^{22}$ for the boron-loaded Ilford emulsions (neglecting the hydrogen content).

Hence we obtain for a mean value

$$q\sigma \times 10^{24} = 6{\cdot}5 \pm 2{\cdot}4.$$

If the invisible secondaries are assumed to be fast neutrons, $\sigma \sim 10^{-24}$ cm.^{2} and hence $q \sim 6{\cdot}5$. This requires every star to emit about six neutrons, each with sufficient energy to produce a second disintegration. The average number of protons emitted in stars in our plates is slightly more than three, with an average energy of 10 MeV. each. Since the disintegrations must liberate roughly equal numbers of neutrons and protons, and the energy required to produce a second disintegration must be at least 30 MeV., our conclusion is that only a fraction of the secondary stars are, in fact, produced by neutrons from the primaries. In the batch of plates from which these measurements were taken, we observed only one definite case in which a disintegration liberated a charged (σ) meson giving rise to a second disintegration. Hence the number of neutral mesons emitted in the disintegrations may be quite small, and if these are responsible for the regenerative processes, we should have to postulate very large nuclear capture cross-sections.

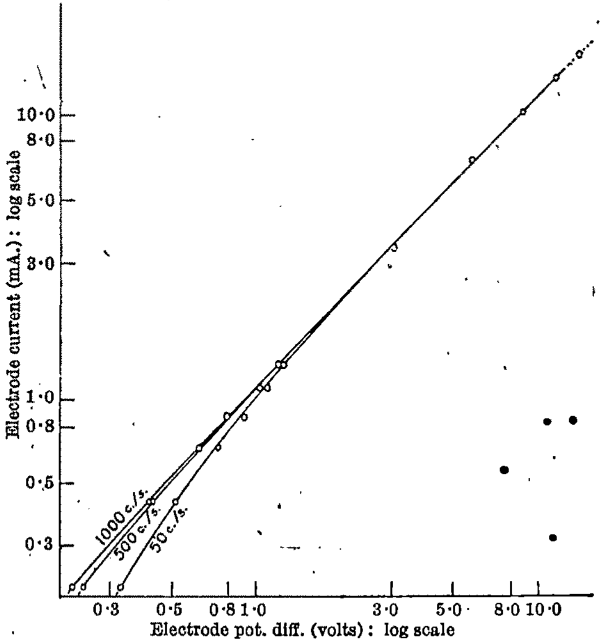
It is possible, however, that the pairs are produced by single penetrating particles, or by collimated showers of particles of unknown type. The variables in such a process could easily be chosen so as to give the observed variation of pair frequency with r.

The value of $q\sigma$ we have obtained agrees very well with that of Leprince-Ringuet and Heidmann in the previous communication. We are indebted to Prof. Leprince-Ringuet for so kindly exposing our plates in his laboratory at Chamonix, and for communicating to us his results prior to publication. Our thanks are also due to Sir George Thomson for valuable discussions and advice.

T. T. Li
D. H. Perkins
Imperial College of Science and Technology,
London, S.W.7. March 16.

An Electrolytic Tank for Exploring Potential Field Distributions

Two difficulties have commonly been experienced in the exploration of potential distributions in electrolytic tanks, when alternating current is used: (*a*) non-linear conduction due to polarization at the electrode surfaces[1], which becomes serious at very low potential differences or currents, and (*b*) corrosion of the electrodes causing the conducting path to assume a leading power factor[2], which increases with increasing current density. Both effects are greatly reduced by raising the working frequency; but they are incompatible with one another if very fine probe electrodes are used. The effect of frequency on the non-linear conduction is illustrated in the accompanying diagram.



In a series of studies using solutions of copper sulphate in distilled water of concentration varied between 0·5 and 8·0 gm./litre and copper electrodes of various diameters, we have found that very accurate results are obtained with a measuring frequency of 1,000 c./s. and electrodes 0·5 mm. diameter, provided that the current per electrode is not less than 5 mA. or the current density does not exceed 0·3 mA./sq. mm. (by adjusting electrode depth). These results apply throughout the range of concentration quoted.

For such fine electrodes, steel sewing needles which have previously been plated by the copper cyanide process, being rigid, are particularly suitable. The current density used during the plating process has been 0·3 mA./sq. mm. for the first 5 min. and 0·015 mA./sq. mm. for a further 20 hours. This affords a polished copper surface 0·04 mm. thick. The plated needles have then been immersed in boiling acidified copper sulphate solution for a few minutes to coarsen and stabilize the copper crystals.

Alongside these studies, attention has been given to removal of errors due to the finite tank boundary, which can limit seriously the usable fraction of the electrolyte surface. A circular shallow tank, 18 in.

diameter, has been used, divided into two equal layers ½ in. deep, by a glass disk held at half the depth of the electrolyte. The top liquid layer, in which the potential field to be explored is set up, is thus contiguous with the lower layer around the periphery and may be shown to be electrically 'matched', such that it simulates an infinite sheet of electrolyte. The measured error in potential at the extreme edge is less than ½ per cent.

Thanks are due to the Electro-Chemistry and Chemical Engineering Departments of this College for assistance and advice.

R. Makar
A. R. Boothroyd
E. C. Cherry
Electrical Engineering Department,
Imperial College, London, S.W.7.,
Feb. 16.

[1] Rollet, A. P., *C.R. Acad. Sci., Paris*, 185, 457 (1927).

[2] Shipley and Goodeve, *Trans. Amer. Electro-Chem. Soc.*, 52, 377 (1927).

Electron Emission from Oxide-coated Cathodes under Electron Bombardment

The electron emission from thermionic cathodes of the alkaline-earth oxide-coated type when under electron bombardment has been investigated recently by Johnson[1] and by Pomerantz[2]. Johnson concluded that the secondary-electron emission produced by the bombardment changed little with the cathode temperature, that at 850° C. the maximum value, δ_m, of the secondary to primary ratio was about 5, and that the bombardment produced a temporary improvement in the thermionic activity of the cathode, which gave an 'enhanced thermionic emission'. Pomerantz, on the other hand, concluded that the secondary-electron emission increased exponentially with the cathode temperature, and deduced from extrapolation of the results obtained at lower temperatures that, at 850° C., δ_m exceeded 100. The effect which Johnson interpreted as "enhanced thermionic emission" was also observed; but that interpretation was not accepted. It has been suggested[3] that "enhanced thermionic emission" rather than secondary-electron emission enables the anode current in a magnetron to exceed the thermionic emission provided by the unbombarded cathode. The experiments the results of which are indicated below were designed to throw light on the disagreement in the conclusions of the above investigators regarding the temperature dependence of the secondary-electron emission, and on the nature of the "enhanced thermionic emission" effect.

The target cathodes used in the experiments were coated with various thicknesses of a standard barium–strontium carbonate coating mixture. The measurements were made in electron-gun type tubes, the primary electrons being focused on the target through a hole in the collector surrounding the target. The secondary-electron yield of each target was measured as a function of the energy of the bombarding electrons, of the thermionic activity of the target, of coating thickness, and of target temperature in the range 20°–850° C. At temperatures at which thermionic emission was appreciable, both the thermionic emission and the emission caused by the bombardment were collected by pulsed collector voltages, pulses of 5–100 microsec. duration being used. In respect of the pulsed collection of the thermionic emission, and in the use of high collecting voltages (up to 5 kV.), the measurements differed from those made by other investigators.

The experiments showed that the secondary-electron yield of the various targets when at room temperature increased with the energy V_P of the primary electrons, reached unity at V_P 35 ± 5 eV. and a maximum value δ_m at V_P 1,100 ± 100 eV. δ_m varied from target to target, and values as low as 4 and as high as 14 were observed. When the targets were heated, δ_m usually changed to some extent in the lower temperature range, but in the temperature range, up to 850° C., in which the thermionic emission was appreciable, all the targets gave values of δ_m between 5 and 10 independent of the temperature. Incidentally, targets coated by evaporation in vacuum, and on which the coatings were so thin that they appeared merely as tarnishings of the nickel bases, gave δ_m values of about 4 or 5 which were completely independent of target temperature in the range investigated, 20°–850° C.

The results obtained with target coatings of various thicknesses and of varying degrees of activation supported the view that the variation of δ_m with temperature in the lower temperature range was not of a fundamental nature but was due to disturbing effects resulting from the appreciable resistance of the coating at those temperatures. On this view it would appear that Pomerantz was not justified in extrapolating from the yield values he obtained at the lower temperatures in order to deduce yield values at temperatures about 850° C., for the cause of the variation at the lower temperatures would have had negligible effect at the higher temperatures.

No evidence was obtained of the effect which Johnson interpreted as "enhanced thermionic emission". The electron current released from each target by a given pulsed bombardment rose immediately (in less than a microsecond) to a value which remained constant during the bombardment and dropped to zero immediately after the bombardment, and the magnitude of this current changed little with the target temperature. It is possible that the effect observed by both Johnson and Pomerantz followed from the continuous collection of the thermionic emission from the targets in their experiments. Continuous collection of thermionic emission from an oxide cathode is known to lower its thermionic activity, partly through increasing the concentration of 'foreign' atoms on the surface. Reduction of this concentration by the bombardment could then cause enhancement of the thermionic emission. Another reason for the absence of the effect in the present experiments might have been the adequate elimination of disturbing space-charges by the high collecting voltages that were used.

Thanks are due to Mr. A. Sczaniecki for his help in one of the experiments. A fuller account of the investigations will be published elsewhere. The work was done at the Admiralty Signal and Radar Establishment, and permission to publish this communication is gratefully acknowledged.

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Total Emission Damping

IN recent letters in *Nature*, C. N. Smyth[1], A. van der Ziel[2] and A. van der Ziel and A. Versnel[3] have reported measurements on the damping produced by a diode in the non-conducting state placed across a resonant circuit.

To investigate this subject mathematically, the following idealization has been employed. It is assumed that the thermionic electrons are all emitted with speed v_0 at right angles to the cathode surface, and that they are then acted upon by a constant retarding field E_R superimposed upon the small alternating field $E_S \sin(\omega t + \varphi)$. The time of flight of these electrons in the absence of the alternating field is then $2v_0/E_R\frac{e}{m} = T$, and the transit angle is $\theta = \omega T$. If E_S is small compared with E_R, it can then be shown that the damping conductance $1/R$ is given by

$$\frac{1}{R} = \frac{8V_0I}{V_R^2}f(\theta). \qquad (1)$$

In this equation V_0I is total power emitted by the cathode, that is, the product of the number of electrons emitted per second and the kinetic energy of each electron. V_R is E_RD, where D is the effective distance across which the constant fields E_R and E_S are assumed to act.

The interesting part of equation (1) is $f(\theta)$, which is

$$f(\theta) = \frac{1}{\theta^2}\Big[\Big(1 - \frac{1}{\theta^2}\Big) \{4(1 - \cos\theta) - 4\theta\sin\theta + \theta^2(1 + \cos\theta)\} + \{2(1 - \cos\theta) - \theta\sin\theta)\}\Big]. \qquad (2)$$

This may be compared with the corresponding function for the conducting diode, $F(\theta)$, where

$$F(\theta) = \frac{1}{\theta^2}[2(1 - \cos\theta) - \theta\sin\theta]. \qquad (3)$$

Graphs of $f(\theta)$ and $F(\theta)$ are shown in Fig. 1.

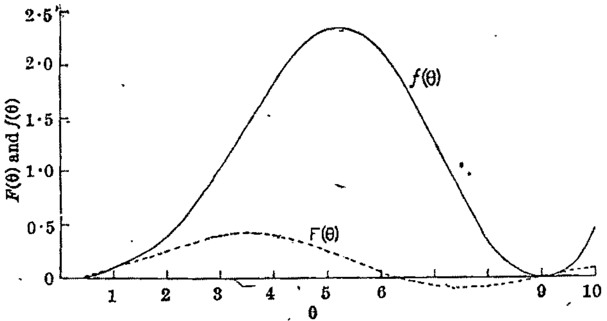

Fig. 1

That the absolute magnitude of the damping in equation (1) can be of the correct order of magnitude may be shown as follows. In Smyth's case[1], assume the values $V_R = 1$, $V_0 = 1/16$, both in volts, and $I = 1/10$ amp. per cm.^{2}. Then equation (1) gives $R = 20$ ohms per cm.^{2}. In van der Ziel's case[2], the damping is so small and the cathode-anode spacing is so large that it would be unwise to guess the value of V_R.

An interesting point emerges if equation (1) is written in the correct form to exhibit the variation of the damping with V_R, where V_R is assumed to be proportional to $1/\theta$. Then

$$\frac{1}{R} = \frac{I}{(\omega D)^2}\theta^2 f(\theta) = \frac{I}{(\omega D)^2}\frac{\theta^4}{9}$$

for small values of θ. The function $\theta^2 f(\theta)$ is shown in Fig. 2.

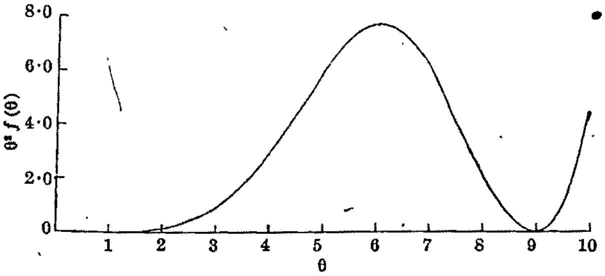

Fig. 2

It is not suggested that the idealization which has led to the results reported above is adequate to explain all the phenomena of total emission damping; but it points to a mode of attack on the problem which is hopeful. The method by which equations (1) and (2) are derived will be published elsewhere in due course.

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Theory of the Streaming Potential

BOOTH[1] has recently pointed out the unsatisfactory nature of the existing theory of electrokinetics, and suggested modifications to the commonly used equations of Helmholtz[2] and Smoluchowski[3], with particular reference to the phenomenon of electrophoresis. I have devoted some attention to the theory of the streaming potential difference set up in the plane of flow when an electrical double layer, existing at an immobile interface in an ionic liquid, is sheared. This potential difference will tend to resist the flow of the liquid owing to the electrical retarding force acting on the ions of the double layer. It has been shown[4,5] that in narrow channels this electrical resistance to flow, or 'electroviscous resistance', can assume considerable importance, with the result that the apparent viscosity of a liquid in such channels may be increased several fold, depending on the values of the electrokinetic potential of the double layer, the specific conductivity of the liquid in the channel, and the dielectric constant. Various workers[6-8] have reported the qualitative observation of such an effect, and a quantitative experimental examination of the subject has been commenced in this laboratory.

In view of this apparent increase in viscosity in narrow channels, it is to be expected that zeta-potentials calculated from measurements made in diaphragms of very small particle size will lead to anomalously low results if the usual Helmholtz–Smoluchowski equation is used. The results of Bull and Gortner[9] and others[10-12] have been explained on this basis[4,5].

The results of this analysis are of importance when applied to the theories of surface conductivity and of lyophobic colloid stability, and offer an explanation of certain anomalous results obtained by workers[13-15] who attempted to measure equilibrium distances of separation between surfaces immersed in ionic liquids.

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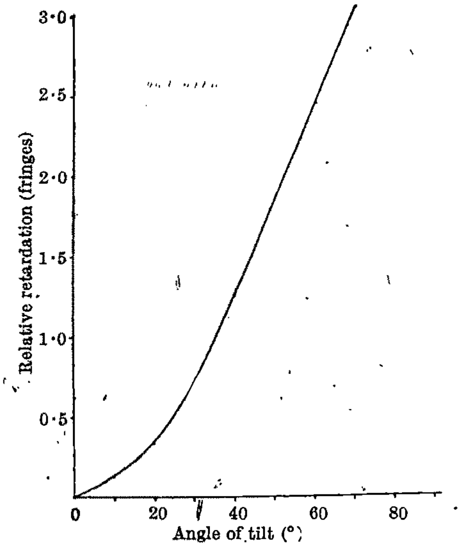
A Large Field Compensator of the Berek Type

P. E. Jellyman and A. J. Milne have described in *Nature* of March 27, p. 477, a form of photo-elastic compensator using a plate of *C.R.*39 resin in which a uniform stress variation (produced by pure bending) is frozen. A more sensitive compensator (which also depends on the frozen stress in *C.R.*39 resin) has been in use for more than a year at the Royal Aircraft Establishment. This instrument works on the same principle as the Berek compensator, in which a thin crystal slice (calcite or quartz), cut normal to the optic axis, can be tilted at various angles to the light path, giving a relative retardation increasing with the angle of tilt.

The Berek instrument is used in conjunction with a polarizing microscope. For covering fields of several inches diameter, natural crystals sufficiently large are not to be had. Instead, I have employed a plate of *C.R.*39, $\frac{3}{8}$ in. thick by about 4 in. by $2\frac{1}{2}$ in.

In the process of manufacture, the applied lateral pressure produces a frozen stress in a direction normal to the plate. This stress is not always uniform, but the piece selected had a variation of less than 3 per cent over its whole area. The *C.R.*39 sheet, which has uniform thickness, high polish and excellent light transmission, is lightly held between two frames mounted symmetrically on co-axial spindles which can rotate in a circular frame. The angle of rotation is shown by a pointer and scale. The whole frame is a sliding rotational fit in a split outer ring which is provided with an angular scale. Thus the axis of tilt can be adjusted to lie in the direction of either of the principal stresses. The inner ring is then fixed by the clamping screw. The instrument is set for compensation, and the plate is then tilted by means of a knurled knob; it can be clamped in any position. Owing to the large area of the plate it is rarely necessary to adjust the position of the instrument in the light field (except perhaps when the angle of tilt is high and the projected area is reduced).



Calibration curve for white light

One advantage of this type of instrument is that its sensitivity becomes greater for very small retardations, as is shown by the accompanying calibration curve. For a crystal slice, the slope of the curve would increase continuously. In the *C.R.*39 instrument, the slope appears to become constant. This may be due to the fact that the birefringence is not completely constant through the thickness of the material. The instrument may be calibrated directly in Angström units if desired. The calibration has stayed constant for more than a year, and is not noticeably affected by slow temperature variations in the laboratory. It is necessary, of course, to avoid stresses due to clamping.

The range of the instrument is from 0 to 3 fringes (at about 69° angle of tilt), and its sensitivity 1/20 fringe or better. The calibration can be readily checked at any time.

When used, the instrument is mounted on the photo-elastic bench between the polarizer and the model, so as to avoid displacement of the image as a result of tilting.

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Isolation of a New Androstenol-3(α)-on-17 from the Urine of a Patient with Adrenal Cancer

In a previous paper (Dingemanse, Huis in 't Veld and De Laat[1]), we reported that we had detected, by means of a chromatographic-colorimetric method, a new 17-ketosteroid in the urine of patients suffering from a dysfunction of the adrenal cortex. This 17-ketosteroid, to which we refer in this paper as 17-ketosteroid II, occurs in the urine of normal individuals, as a rule, in small quantities only, and may be completely absent. Considerable amounts, however, have been found in the urine of persons with 'virilizing' tumours and with hyperplasias of the adrenal cortex.

This substance has now been isolated from the urine, and obtained in pure condition. We used for this purpose 2 litres of urine of a female child aged two, who showed symptoms of virilism, and from whom afterwards an adrenal tumour was extirpated.

The urine was neutralized and extracted according to the method of Dingemanse and Laqueur[2], and the extract was purified by means of chromatographic analysis and high-vacuum sublimation. After repeated crystallization from a watery methanol solution and from petroleum ether, a product with a melting point of 140·5–141° C. was obtained. In ethanol its specific rotation was found to be +121 ± 3°.

The quantitative analysis led to the empirical formula $C_{19}H_{28}O_2$ (H, 9·68; C, 79·06 per cent). In 80 per cent ethanol it gave no precipitate with digitonin. Titration, by the method of Rosenmund – Kuhnhenn, revealed the presence of one double bond (1·89 and 2·14 equivalents of bromine were taken up). With hydroxylamine it was found to form a monooxime with a melting point of 109–113° C. (N, 4·40 per cent). An acetate could not be isolated in the pure condition. The α-ketosteroids are, as is well known, more difficult to esterize than the β-ketosteroids.

The new ketosteroid proved to be unstable in the presence of mineral acids. When treated at room temperature with hydrochloric acid, it formed two transformation products that could be separated by chromatographic analysis. The first proved to have a melting point of 151–152° C., and the quantitative analysis led to the empirical formula $C_{19}H_{27}OCl$ (C, 74·44; H, 8·83; Cl, 11·53 per cent).

The second transformation product had a melting point of 140–141° C., and gave a precipitate with digitonin. When this substance was mixed with dehydro-*iso*-androsterone, the melting point underwent no change. Its acetate proved to have a melting point of 171–172° C.; mixing with dehydro-*iso*-androsterone acetate did not lower the melting point. We must assume, therefore, that it is identical with Δ5-androstenol-3(β)-on-17 (that is, dehydro-*iso*-androsterone).

Our idea of the reaction with hydrochloric acid is that it takes place as follows:

$$\text{17-ketosteroid II} \xrightarrow{\text{HCl}} \text{chloro-ketone} \xrightarrow{\text{HCl}} \text{dehydro-}\textit{iso}\text{-androsterone.}$$

Dehydro-*iso*-androsterone is *not* appreciably transformed in a chloroketone when it is treated at room temperature with hydrochloric acid. Butenandt[3,4] has already pointed out in a paper on the chloroketone of male urine that the precursor of this compound may be different from dehydro-*iso*-androsterone.

The configuration of 17-ketosteroid II must therefore be very similar to that of dehydro-*iso*-androsterone. For this reason it seems to us that the atom C_3 will bear an α-hydroxyl group. For a keto group at C_{17} the Zimmermann reaction is characteristic. The Pincus reaction of 17-ketosteroid II is qualitatively as well as quantitatively the same as that of dehydro-*iso*-androsterone.

On account of the fact that 17-ketosteroid II is transformed by the action of hydrochloric acid in dehydro-*iso*-androsterone, there are apparently three positions in which the double-bond might, theoretically, be present; namely, Δ4.5, Δ5.6 and Δ6.7. Ruzicka and Goldberg[5] have synthesized the Δ5.6-androstenol-3(α)-on-17, which proved to have a melting point of 221° C., and $[\alpha]_D \sim 0°$. Our new ketosteroid, therefore, cannot be identical with this substance.

As the formula Δ4.5-androstenol-3(α)-on-17 accounts better than the other ones for the instability of our substance in the presence of acids (Wolfe, Fieser and Friedgood[6]), this configuration seems to be the most plausible. Wolfe *et al.* have already pointed out that this ketosteroid might be found in urine extracts.

We have tried to ascertain the configuration of 17-ketosteroid II by oxidation, using Oppenauer's method, of the hydroxyl group attached to C_3. If the formula suggested above be correct, this ought to give Δ4.5-androstenedione. The melting point of our oxidation product proved, however, to be 185° C., and is therefore different from the melting points that have been reported for Δ4.5-androstenedione. Mixed with Δ4.5-androstenedione it showed, moreover, a sharp fall in its melting point.

The possibility that our 17-ketosteroid II might be an *i*-steroid was also considered. *I*-steroids are so far known only as synthetic products (Wallis, Fernholz and Gephart[7]). When a surplus of bromine is added, such substances ought to give tribromides (Beyon, Heilbron and Spring[8]; Wallis *et al.*[7]), whereas our product absorbed in the Rosenmund – Kuhnhenn titration but two equivalents of bromine

The investigation is being continued.

The quantitative analyses were carried out by Mr. P. Hubers in the Laboratory for Organic Chemistry of the Amsterdam Municipal University. A grant was received for this study from Organon, Ltd., Oss.

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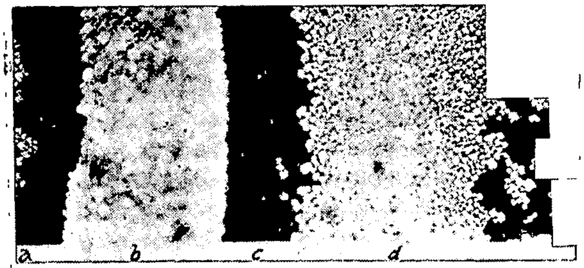
Evidence for an Electrostatic Field on Penicillin Assay Plates

ONE of the effects of penicillin on susceptible bacteria is to cause a change in electrostatic charge which may be measured in terms of ζ potentials, and which it has been suggested may be used quantitatively for assaying solutions of penicillin[1,2,3]. So early as 1938, Loiseleur[4] studied changes that occur in electrostatic charge during proteolysis, such as would be expected during lysis of bacterial cells. Similar changes in charge resulting in development of an electrostatic field can be shown on penicillin assay plates by treatment with electronegative or electropositive colloids suspended in buffers at *p*H levels above or below the isoelectric range of the nucleoproteins.

The accompanying reproduction is of a photomicrograph of a segment of an inhibition zone on a standard assay plate that was flooded for a few minutes with a suspension of starch in phosphate



SEGMENT OF AN INHIBITION ZONE SHOWING FLOCCULATION OF STARCH WITHIN ZONE buffer (pH 6·8) and from which the excess suspension was afterwards decanted. It shows (*a*) a few scattered starch grains at the site of the buffered penicillin solution inside the 'penicylinder'; (*b*) starch grains sedimented in the trough, where the 'penicylinder' had rested (out of focus because in a different plane from the surface of the agar); (*c*) a narrow ring devoid of starch around the trough; and (*d*) the circumjacent wide band of starch grains covering most of the width of the inhibition zone and extending up to the 'ring of enhanced growth' where a few scattered grains appear on the right.

Conversely, the 'ring of enhanced growth', where starch fails to flocculate, is the site of heaviest deposition of silver following flooding of the plates with an aqueous solution of silver nitrate[5,6], or of the red triphenyl formazan following treatment with solutions of triphenyl tetrazolium chloride such as have been used as indicators of seed viability[7,8].

These observations may be taken as evidence of electro-negativity in the regions of enhanced growth and of positive charges in the zones of inhibition. No such responses are seen on unseeded plates exposed to penicillin. Thus the effects cannot be attributed to reactions of the reagents with penicillin diffusing from the cylinders.

The pH effect postulated by Carr[9] to account for the mechanism of the Feulgen reaction may be demonstrated by comparing plates stained with basic fuchsin at pH values above 6·2 or below 4·8. The more acid solutions stain the colonies in the background intensely red, thus sharply outlining the unstained inhibition zones, from which the desoxyribose nucleic compounds have been dispersed. There is relatively poor definition of the zones on plates stained with the less acid solutions.

Grateful acknowledgment is made to the Cutter Laboratories, Berkeley, California, for partial support of these experiments.

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Fœtal Hæmoglobin and Erythroblastosis

THE hæmoglobin of the fœtus and the new-born child and the hæmoglobin of older children and adult people can be distinguished by their different resistance against 0·1 N sodium hydroxide. At pH 12 normal hæmoglobin is denatured very rapidly, whereas fœtal hæmoglobin is denatured only slowly. By using this difference in denaturating-rate, it is possible to calculate the amounts of fœtal and later hæmoglobin present in small samples of blood[1]. A normal new-born child has only fœtal hæmoglobin. During the early months after birth, this hæmoglobin is gradually replaced by later hæmoglobin, at a rate of a little less than 1 per cent a day, so that after 120 days normally all fœtal hæmoglobin has disappeared. In prematurely born babies, later hæmoglobin appears only at the time that the child ought to have been born[2].

In new-born children suffering from erythroblastosis fœtalis caused by the *Rh* antagonism there is a marked difference in behaviour of the two hæmoglobins. The fœtal hæmoglobin is broken down very rapidly, so that in severe cases it has practically disappeared from the blood within about five days. In less severe cases the breakdown stops after about six days and a certain amount of the fœtal hæmoglobin remains. This remaining fœtal hæmoglobin disappears during succeeding months as it does in normal children. On the other hand, later hæmoglobin normally not found in the blood shortly after birth is already present in these patients at the moment of delivery. It is present in an amount up to 4 gm. per 100 c.c. of blood. This later hæmoglobin is not broken down, or only very slowly, during the serious hæmolysis, the fœtal hæmoglobin being broken down rapidly. When the child survives, its amount rises slowly later on. The *Rh* antibodies which are the cause of the destruction of the red blood corpuscles and of the hæmoglobin have not the same action on the cells containing fœtal and later hæmoglobin respectively. Only those which contain fœtal hæmoglobin are hæmolysed.

The presence in the blood at the moment of birth of later hæmoglobin, which is not broken down in children suffering from erythroblastosis, must be the result of a reaction of the child before birth against the *Rh* antibodies of the mother.

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Action of Sulphuryl Chloride on Wool

ONE of several general methods of making wool unshrinkable depends for its success on disulphide-bond breakdown in the surface of the fibres. A solution of sulphuryl chloride in white spirit is sometimes used for this purpose[1]; but it has now been found that treatment which is effective with commercial fabric is relatively ineffective when the latter is freed from adsorbed soap and residual oil by extraction with alcohol and ether.

Samples of extracted and unextracted flannel (2·5 gm.) were conditioned at 65 per cent relative humidity and 22·2° C. before being immersed in 100 c.c. of a 2·5 per cent (v./v.) solution of sulphuryl chloride in carbon tetrachloride for one hour at room temperature. After treatment, the samples were neutralized with sodium bicarbonate solution, washed in running water, and then milled by hand for fifteen minutes in 5 per cent soap solution. The resulting shrinkages are given in Table 1, which includes data for an extracted sample to which 0·5 per cent by weight of oleic acid (I.V. 83·7) had been added before treatment with sulphuryl chloride.

TABLE 1

Fabric	Treatment	Percentage shrinkage in area
Extracted	None	42·7
Unextracted	Sulphuryl chloride	3·2
Extracted	,, ,,	25·0
Extracted + oleic acid	,, ,,	−7·3

Similar results were obtained with white spirit as the solvent, and the effect of oleic acid in promoting the reaction between wool and sulphuryl chloride is remarkable. When, however, oleic acid is added to the solution of sulphuryl chloride in carbon tetrachloride, instead of to the wool, no beneficial effect is obtained, as is shown by the data of Table 2.

TABLE 2

Fabric	Treatment	Percentage shrinkage in area
Extracted	None	43·7
Extracted	Sulphuryl chloride	24·0
Extracted + oleic acid*	,, ,,	–5·0
Extracted	Oleic acid* + sulphuryl chloride	24·6

* 1 per cent on the weight of the wool.

Further, the action of oleic acid in assisting the reaction is not entirely lost when the fabric to which 1 per cent of oleic acid has been added is left in carbon tetrachloride for periods up to two hours, or is washed in three changes of carbon tetrachloride over a period of one hour, before adding sulphuryl chloride.

The most probable explanation of these results is one based on the work of Kharasch and Brown[2]. If peroxides in the oleic acid are adsorbed by the wool, they will promote the formation of free chlorine atoms at the wool-solution interface :

$$R\cdot + SO_2Cl_2 \rightarrow RCl + SO_2 + Cl\cdot.$$

The chlorine atom may then react with the disulphide bond of wool :

$$R{-}S{-}S{-}R + Cl\cdot \rightarrow R{-}SCl + R{-}S\cdot.$$

$$R{-}S\cdot + SO_2Cl_2 \rightarrow R{-}SCl + SO_2 + \cdot Cl,$$

and so on, thus causing unshrinkability. When, however, oleic acid is dissolved in carbon tetrachloride, instead of being applied to the wool, free chlorine atoms are more easily lost by reaction with the oleic acid itself. In support of this explanation, it should be added that stearic acid (I.V. 5·2) has little catalytic effect on the reaction between sulphuryl chloride and wool.

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Demonstration and Separation of Noradrenaline, Adrenaline and Methyladrenaline

A SIMPLE and reliable means of recognizing noradrenaline, adrenaline and methyladrenaline, singly or in mixtures, has been obtained by combining two methods : one enzymatic and the other chromatographic.

Enzymatic. An insoluble polyphenolase is prepared from shoots or roots of *Atropa belladonna* by blending twice with acetone and discarding the fluid. The solid residue is extracted three times with water, and further washings should give no colour reaction with ninhydrin. The residue is dried at room temperature and ground to a 60-mesh powder. It can be stored in a stoppered bottle without loss of activity for several months. Dried belladonna leaf is obtainable from manufacturing chemists, and, if retaining a green colour, contains active enzyme.

For the test, a few drops of solution containing not less than about 20 μgm. of the adrenaline are diluted in a test-tube with 2 ml. phosphate buffer, *p*H 7·8. About 50 mgm. enzyme (the exact amount is immaterial) is added and shaken into a suspension. The tube is kept at 30° C. for ten minutes and the colour is then observed. If adrenaline was present it will be bright orange-red (adrenochrome) and, if noradrenaline was present, pale brown. The adrenochrome is stable in solution for several hours and then slowly fades. The brown coloration is due to condensation products of noradrenochrome which are precipitated in a dark layer at the bottom of the tube. Under the conditions described, the bright red colour of noradrenochrome is never visible, and no confusion can occur. If inorganic oxidizers are used, this colour appears strongly at first and no easy distinction from adrenachrome is possible. Methyladrenaline gives no colour reaction.

The reactions of several related polyphenols have been observed ; the primary amines tend to resemble noradrenaline and the secondary amines resemble adrenaline. Thus, 3,4-dihydroxytyramine gives no detectable red stage; 'Dopa' gives a transient pink stage which passes rapidly to brown and then to a black precipitate easily distinguished from the noradrenaline brown. Corbasil gives a temporary red colour which passes over to brown ; it is distinguished from noradrenaline by the red phase and from adrenaline by the brown. Among the secondary amines, epinine and N-methylcorbasil give a red that is much less stable than adrenochrome and fades within the hour. There is no difficulty after one trial with known solutions in distinguishing any of these changes from those due to noradrenaline and adrenaline. In a mixture of noradrenaline and adrenaline, a pale brown colour develops first and is followed by a stable red colour, a sequence that is not obtained with any one substance.

Chromatographic. A good separation of the adrenalines is obtained on a Whatman No. 1 paper chromatogram, using the one-way method of Consden, Gordon and Martin[1] with phenol as solvent. The amines are applied as hydrochlorides from neutral or slightly acid solution. In this state they are stable in air and not destroyed by heating to about 100° C. when driving off the phenol. Potassium ferricyanide, made up to 0·44 per cent in phosphate buffer *p*H 7·8, is used as indicator. Oxidation of the adrenalines is immediate and leads to a brownish-red spot with noradrenaline and a bright red spot with adrenaline. Methyladrenaline does not give a colour when oxidized, since no indole ring-closure is possible ; but the ferricyanide is bleached by reduction so that a white spot is left on the paper that does not turn yellow until a considerable excess of ferricyanide is applied. As soon as the white spot is defined, the presence of methyladrenaline may be confirmed by adding one drop of very dilute copper sulphate. A red colour (due to ferrocyanide) is given, whereas the surrounding ferricyanide, in the absence of a reducer, gives a brown. The highly sensitive arsenophosphotungstate blue, sometimes used for detecting the adrenalines, is not suitable as an indicator, since it is produced by reduction of the reagent on the surface of the paper itself. Ninhydrin gives a strong coloration with noradrenaline, but a very weak one with adrenaline. It sometimes affords useful confirmation for the former if interfering amino-acids are not present.

So far, no second solvent has been found in addition to phenol that will separate the adrenalines. Very little movement occurred in *n*-butanol and none in collidine, amylacetate or butyric acid. All runs have been for approximately twenty hours at room temperature, and the R_F values observed were as follows:

Noradrenaline	$(HO)_2\ \varphi\ CHOH.CH_2.NH_2$	0·216
'Dopa'	$(HO)_2\ \varphi\ CH_2.CH.COOH.NH_2$	0·230
3,4-Dihydroxytyramine	$(HO)_2\ \varphi\ CH_2.CH_2.NH_2$	0·320
Corbasil	$(HO)_2\ \varphi\ CHOH.CH.Me.NH_2$	0·408
Adrenaline	$(HO)_2\ \varphi\ CHOH.CH_2NH.Me$	0·441
N-methylcorbasil	$(HO)_2\ \varphi\ CHOH.CH.Me.NH.Me$	0·706
Epinine	$(HO)_2\ \varphi\ CH_2.CH_2.NH.Me$	0·760
Methyladrenaline	$(HO)_2\ \varphi\ CHOH.CH_2.NMe_2$	0·796

It will be seen that the movement of these substances in phenol is determined mainly by the terminal amine group and that the R_F increases as this is methylated. An ideal separation is consequently achieved between the three adrenalines. Taking the list as a whole, satisfactory separation in a mixture cannot be guaranteed if the difference of R_F values falls much below 0·1. The confusion most likely to matter in tissue extracts is that between noradrenaline and 'Dopa'. This is easily resolved by the enzyme test, because of the black colour given by 'Dopa'. Adrenaline can be distinguished from corbasil with a similar R_F by the much greater stability of adrenochrome over the corresponding corbasil derivative in the enzyme tests.

These methods have been successfully applied to the demonstration of noradrenaline and adrenaline in tissue extracts. I am indebted to Dr. H. Blaschko for samples of most of the compounds used.

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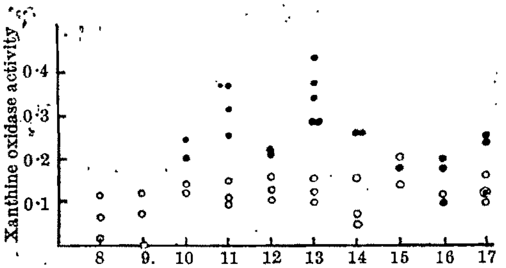
Association of Xanthine Oxidase with Virus Multiplication

It has previously been reported that the xanthine oxidase content of mouse brain is markedly increased during infection with yellow fever and other viruses[1,2], and evidence was adduced which suggested that this rise of enzyme activity was not fortuitous but was causally related to the growth of virus in the tissue. The possibility of the virus particles themselves having xanthine oxidase activity was excluded by the demonstrable lack of parallelism between enzyme activity and the amount of virus in the brain. Recent work reported here shows that the extra enzyme is not obtained from other parts of the body, and demonstrates that synthesis of xanthine oxidase takes place during virus infection.



○, NORMAL EMBRYOS; ●, EMBRYOS INFECTED WITH 17 *D* STRAIN OF YELLOW FEVER VIRUS

Fertile eggs at the ninth day of incubation were inoculated with the 17 *D* strain of yellow fever virus by the allantoic route, and were then incubated for a further period. In a preliminary survey of the enzyme activity of the various tissues of both normal and virus-infected eggs, it was found that xanthine oxidase was present only in the chorioallantois and the embryo. In all subsequent experiments the embryo and membrane were ground up together with twice the weight of water and centrifuged, and the supernatant fluid was tested for xanthine oxidase activity by the Thunberg technique. The enzyme activity of the combined tissue extract was expressed in arbitrary figures per unit weight of tissue. The results are shown in the accompanying graph. The values for normal embryos remain fairly constant throughout the period of incubation investigated; since the weight of the embryo increases from 1 to 20 gm. over this period, a continual synthesis of xanthine oxidase must be taking place of sufficient extent to maintain a uniform value per unit weight of tissue. The values for embryos infected with virus are in nearly all cases considerably higher than normal, the increase being particularly noticeable on the thirteenth day; between the thirteenth and eighteenth days the activity falls towards the normal level. Since these determinations were all made upon the embryo plus the chorioallantoic membrane, which together represent the only available source of xanthine oxidase, it is evident that the enzyme content of the whole egg is increased in response to the virus infection, and that the possibility of enzyme accumulating in infected tissues from depots elsewhere can be excluded. In addition to the synthesis of xanthine oxidase which is taking place in the normal embryo, there is thus an additional synthesis brought about by the presence of the virus, and it is suggested that this extra amount of enzyme is required for virus metabolism.

There are certain points to be noted in comparing these results with those already reported for mouse encephalitis. (1) In the chick embryo there is very little cellular response to the presence of the virus, so that the rise of enzyme activity is not likely to be due to the presence of a round-cell infiltration. (2) The maximum enzyme activity (0·44) is lower than that found in mouse brain (1·6), which may be related to the lower virus titre (10^5 in the embryo and 10^7 in the mouse brain). (3) The virus titre and enzyme activity both fall from the thirteenth day onwards, and a similar fall of enzyme activity is seen in mouse encephalitis after the onset of symptoms and attainment of maximum virus titre; these facts suggest that enzyme synthesis is connected with the active proliferation of virus and occurs only during this phase.

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[1] Bauer, D. J., *Nature*, 159, 438 (1947).

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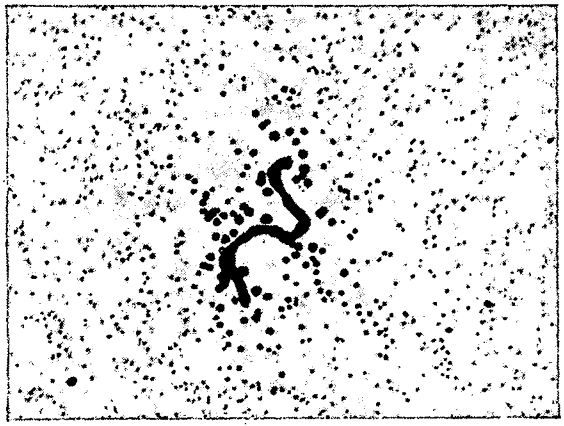
Unsaturated Fatty Acids in Cotton Wool Plugs

During a study of a diphtheroid bacterium (not yet identified, but temporarily labelled *Q*) it has been found that the slight growth on nutrient agar can be abolished by adding 0·2 per cent charcoal to the agar. Growth on charcoal-agar could be restored by adding excess of oleic, linoleic or linolenic acids. Experiments in synthetic media showed that the organism requires these unsaturated fatty acids as growth factors.

It was noted that 'satellitism' of colonies of *Q* occurred on charcoal-agar plates around a fibre of cotton wool accidentally dropped on the surface (see accompanying illustration). It appeared that the cotton fibre was supplying the necessary fatty acid growth-factor. 20 gm. of the ordinary non-absorbent cotton wool used in the laboratory for plugging all sterile glassware were therefore extracted for 3 hr. in a soxhlet with methanol, yielding 24·7 mgm. (more than 0·12 per cent) of petrol-soluble lipoid.



GROWTH STIMULATION, BY A COTTON FIBRE, OF MICRO-COLONIES OF A BACTERIUM (Q) REQUIRING OLEIC ACID; MEDIUM NUTRIENT AGAR CONTAINING 0·2 PER CENT CHARCOAL. × 25

This phenomenon was at once linked with the observation that a greasy film developed on the inside of flasks and tubes, previously acid-cleaned, plugged with cotton wool and sterilized by treatment for 1½ hr. in the oven at 180°. This greasy film, which was itself invisible, was only detected because it rendered the surface of the glass completely hydrophobic. It did not appear when plugs made of the extracted cotton wool were used. The bacteriostatic properties of the fatty distillate from cotton wool plugs has previously been reported by Wright[1] for pneumococci and by Drea[2] for tubercle bacilli, but the importance of their observations has not perhaps been fully appreciated.

When the fat-extracted cotton wool was used for plugging flasks in experiments with *Q*, the organism completely failed to grow in the absence of oleate; whereas previously, with ordinary plugs, quite considerable, though variable, growth had occurred in the basal synthetic medium alone.

It was thus possible, using *Q* as the test organism, to make a rough assay of the growth-promoting activity of the fatty extract from cotton wool, which was found to be 25–50 per cent that of oleic acid. (It should be mentioned here that pure linoleic and linolenic acids have exactly the same growth-promoting activity for *Q* as oleic acid, while the two saturated acids, palmitic and stearic, are quite inactive.) It was calculated that each cotton wool plug contained 0·5–1·0 mgm. of oleate-equivalent lipoid. Further, by measuring the average growth of *Q* in 5 ml. of basal medium without oleate in 50 ml. flasks plugged with ordinary cotton wool and sterilized in the usual way by hot air at 180° for 1½ hr., the oleate-equivalent quantity of lipoid distilled off the plugs and afterwards dissolved in the medium amounted to about 10 μgm. per flask. The same figure was arrived at by assaying the activity of petroleum-ether washings from samples of dry flasks, similarly plugged and sterilized. This amount was quite enough to give considerable growth of *Q*, which responds visibly to a concentration of 0·5 μgm. oleic acid per ml., and also to cause marked inhibition of organisms, such as *H. pertussis*, which are highly sensitive to unsaturated fatty acids. A strain of *H. pertussis* was found to grow heavily in broth with 0·01 per cent albumen in flasks with extracted cotton wool plugs, but failed completely to grow in the same medium in flasks with ordinary plugs.

Long-chain unsaturated fatty acids such as oleic, linoleic or linolenic (which may be derived from cotton wool in its natural state or after washing with soap solutions) have remarkable activity both as growth-promoters[3-7] and growth-inhibitors[2,3,8,9] of a wide variety of micro-organisms, down to a concentration of 1 μgm./ml. or less. These substances may thus be responsible for erratic results in growth experiments on sensitive micro-organisms where cotton wool is used for plugging tubes afterwards sterilized in an oven at high temperatures. To avoid this difficulty, Wright[1] suggested using a particular grade of absorbent cotton wool, and sterilizing by autoclave followed by drying at 120°. The fatty acid content of absorbent cotton wool, however, depends largely upon its method of preparation and may be higher than that of the non-absorbent variety. It is clearly preferable to attempt to get rid of the easily liberated fat by extraction with an organic solvent such as methanol (as described) or, even better, to use some substitute such as glass, 'Cellophane' or aluminium caps as recommended by Drea[2]. A more promising substitute which is being tested here at the moment is a very fine glass wool (Fibreglass, Ltd.). This is unfortunately treated with a mixture containing oleic acid in the process of manufacture, but can easily be subjected to fat-extraction and/or treated with concentrated acid and so obtained as chemically clean as the flasks themselves.

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Feb. 16.

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Regulation of Oviposition in Social Hymenoptera

The rate of increase of population in societies of social insects obviously depends upon the numbers of adults which can be produced per head of the adult population. Ideally, the numbers of eggs laid should be just appropriate to this situation, so that the prevailing food supply may be efficiently transformed.

In a study of *Bombus agrorum* Fab. kept in observation nests with free access to the open, and not fed in any way, it has been noticed that eggs excepting the first were only laid on pupal cells, and by far the majority on cells up to three days after formation.

NUMBERS OF EGGS LAID ON PUPAL CELLS 1, 2, 3, . . ., ETC., DAYS AFTER FORMATION IN A COLONY OF *B. agrorum* ssp. *septenzionalis* VOGT.

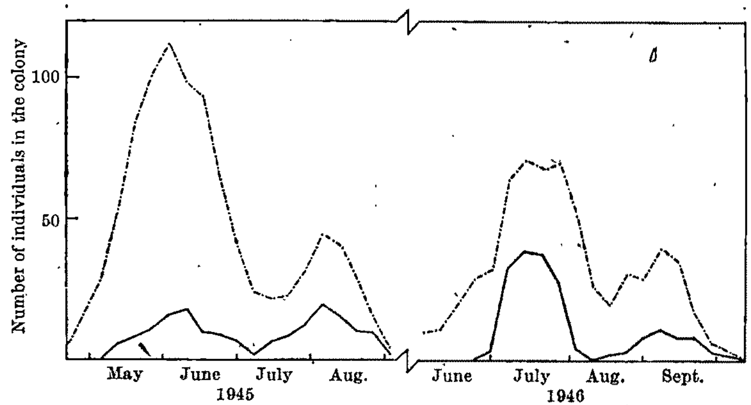
Age of pupal cell (days)	1	2	3	4	5	6	7	8	9	10	11	12
Numbers of eggs laid	18	50	38	18	15	9	7	0	0	8	0	0

This association of eggs with metamorphosis may have been the result of a reduced 'demand' on the part of larvæ for attention—more particularly, food; but that a direct response to the presence of pupæ was involved is perhaps suggested by the fact that the numbers of eggs laid (X) was proportional to the size of the pupal mass, that is, to the numbers of pupæ in each batch (Y). The equation relating these was

$$X = 2{\cdot}84\,Y + 0{\cdot}16$$

(standard error of regression coefficient, 0·53 eggs per pupa), which means that about three eggs were laid per pupa. By thus replacing each fully grown and metamorphosed larva with three eggs, a reasonably continuous regulation of larval numbers was achieved, as the eggs took only six days to hatch. Since several groups of brood ran concurrently, but out of phase, all ontogenetic classes were present in the nest at any time, and it seems likely that in the bumble-bee a fairly sensitive method of regulating the time of appearance and quantity of brood to the capacity of workers to tend it has been evolved.

In colonies of the ants *Myrmica lævinodis* Nyl. and *M. ruginodis* Nyl. kept in observation nests under normal climatic conditions, as well as at constant temperatures, and subjected to weekly censuses, a marked temporal association of eggs and pupæ has also been observed (see graph); and it has been noticed that oviposition tended to increase soon after metamorphosis had started. The result, in spite of the fact that the over-wintering larvæ—all in third instar—ranged in weight from 0·24 mgm. to 3·10 mgm., was not an immediate replacement, and a consequent approximately constant larval population; since the eggs took more than a month to hatch. In fact, over-wintering larvæ had usually all metamorphosed before many new larvæ appeared. Moreover, since the period of oviposition was approximately equal to the period of metamorphosis, the appearance of young larvæ coincided with the amplification of the worker force. Thus, instead of a continuous replacement of larvæ and a steady flow of material through the ontogenetic classes, there was in these species of ant, in contrast to the bumble-bee, a phasic alternation of egg and pupal increase with larval and worker increase. Two such maxima, the first larger than the second, have occurred each year in *M. lævinodis*. But although a regulation of the time of oviposition has been observed, there has been no indication so far of a quantitative relation between the numbers of pupæ formed and the number of eggs laid as in *Bombus*.



FLUCTUATIONS IN NUMBERS OF EGGS AND PUPÆ IN A COLONY OF *Myrmica lævinodis*, 1945 AND 1946

—.—.—., eggs ———, pupæ

A clear understanding of the factors involved in this situation cannot be obtained until much more is known about the mode of organisation of activities in these colonies, of the times and energies necessary for performing the various actions, and of the complex effect of variations in ontogenetic class composition which a never static worker force has to cope with. If larvæ receive prime attention, then it is plausible to suggest that egg-laying is proportional to the spare worker-power up to a point where the queen's constitution becomes the limiting factor. But it is equally plausible to suggest that in ants, as in bumble-bees, the queen responds directly to the arrival of pupæ, an action which is facilitated by the increasing attention the workers can give her. It is not inconceivable that some hormone affecting both processes—egg formation and metamorphosis—may be transmitted or absorbed through the medium of the 'social stomach'.

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Ciliate Protozoan Fauna of Soil and Inland Waters

A YEAR's study of the bacteria in the current core of a chalk stream has shown that there is a natural water bacterial flora (*Pseudomonas* sp., *Flavobacteria*, *Micrococci* sp.), which was supplanted by a bacterial flora of soil types (*Bs. mycoides*, *Bs. subtilis*, *Actinomyces* sp., *Bt. coli* irregulars) after heavy rain, floods or prolonged periods of hot dry weather when presumably a continuous rain of earth crumbled into the stream.

It was also observed that bacteria-eating ciliates in the current core were most numerous and most varied when a soil bacterial flora predominated. Further, many of these bacteria-eating ciliates (for example, *Colpoda*, *Halteria*, *Holophyra*) appeared in numbers after heavy rain, floods or periods of hot dry weather, that is, after the same physical conditions which had ushered a soil bacterial flora into the stream.

It was assumed that soil ciliate protozoa might have been washed into the stream, and examination of the soil on its banks, and of the soil 200 yards away on the banks of gullies emptying into the stream, showed the presence of ciliates many of which were indistinguishable from forms found in the stream (*Colpoda, Holophyra, Oxytricha, Halteria*). Ciliate protozoa indistinguishable from forms found in the stream were also obtained from within dried mud originally excavated from the bottom of the stream and cast on adjoining fields (*Oxytricha, Halteria*).

Singh[1] observes that "the satisfactory edible bacteria in estimating protozoal numbers [in the soil] belong to strains of small cocci or non-sporing rods". Following this suggestion, it was found that soil ciliate protozoa from the above situations developed only slowly in artificial culture—in one to two weeks—if the sole food supply was the natural soil bacteria. If, however, the culture was inoculated with micrococci isolated from the stream, a massive development occurred within three to five days.

From these observations it is suggested that there is a free exchange between soil ciliate protozoa and those of inland waters, and that any distinction drawn between them is apparent and not real; in short, that water ciliates are identical with those of the soil, one habitat being the source of the other.

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Jan. 28.

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Separation of Polar from Non-Polar Molecules

AFTER an interruption due to the War, I have re-commenced experiments aiming at the separation of molecules having a permanent dipole moment from non-polar molecules in liquid mixtures by the aid of a non-uniform electric field.

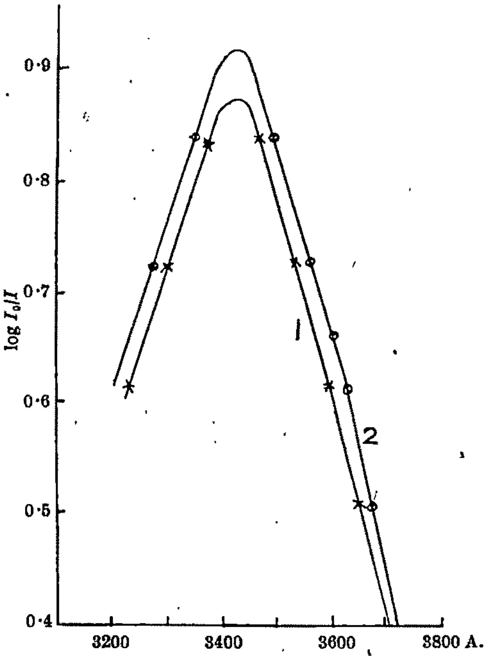
The ratio of the polar and non-polar molecules (N_p/N_n) will undergo a change to the value $(N_p/N_n)_r$ at a point r with the electric field strength E_r given by the expression:

$$\left(\frac{N_p}{N_n}\right)_r = \left(\frac{N_p}{N_n}\right)_0 \exp\frac{\mu E_r \cos\theta + \frac{1}{2} E_r^2 (\alpha_p - \alpha_n)}{kT},$$

where μ is the permanent dipole moment, E_r the intensity of the electric field at the point concerned, $\cos\theta$ the mean cosine of the orientation angle, α_p and α_n the polarizabilities of the polar and non-polar molecules respectively, and k the Boltzmann constant.

In evaluating this formula, which does not take into account a possible interaction between polar and non-polar molecules, the complete Langevin function for the calculation of the values of $\cos\theta$ has been used. Plotting the ratio $(N_p/N_n)_r$ against the logarithm of the field intensity and making $(N_p/N_n)_0 = 1$ shows that up to 10^5 volt./cm. no appreciable deviation from the value 1 is to be expected. But from that value on a very rapid increase occurs, reaching several per cent at 10^6 volt./cm. At still higher fields, which of course cannot be reached due to the sparking potential, the ratio would increase rapidly to very great values.

In the apparatus used the liquid mixture is placed in a radial field produced in a metallic cylinder of 2 cm. diameter coaxial with a thin tungsten wire of 0·020 mm. diameter, which passes through a glass capillary of 0·1 mm. diameter. The tungsten wire protrudes 1–2 mm. beyond the end of the capillary. On applying potentials up to 10,000 volts, which are below the sparking potential of the cell, an electric field of the magnitude of 10^6 volts./cm. is established close to the thin wire. The liquid around it up to a distance of 0·1 mm. is continuously collected at a very slow rate and its refractive index is compared with that of the original solution by means of a liquid-interferometer.



Using benzene–nitrobenzene mixtures, and plotting the observed interferometric deviation against the potential applied, it is found that an enrichment of nitrobenzene up to 0·7 per cent takes place in the solution for 6,000 volts applied. With *p*-nitroaniline solution in benzene and potentials up to 10,000 volts, a change of the concentration up to 12 per cent has been observed. The accompanying graph shows the ultra-violet absorption of the *p*-nitroaniline solution collected from the vicinity of the tungsten wire (Curve 2) and the absorption curve of the original solution (Curve 1). The position of the maximum is not altered, but the extinction is increased, showing an enrichment of the solution for the polar molecules of *p*-nitroaniline.

In a second apparatus the mixture was allowed to pass through a metallic net, with the horizontal wires forming the negative pole and the vertical ones the positive. They were insulated from each other so that potentials of up to 1,000 volts could be safely used. The net was wound about a glass rod and then placed in a glass tube. The dimensions were such that there were 42,000 intersection points, forming the non-uniform field, in a volume of 100 ml. After passing through the net, the liquid proves to be poorer in polar molecules compared with the liquid remaining in the tube. This shows that the net acted as a dipole filter.

At present work is in progress to amplify the changes in concentration by application of the method of counter-streams. A fuller report of this work is being prepared.

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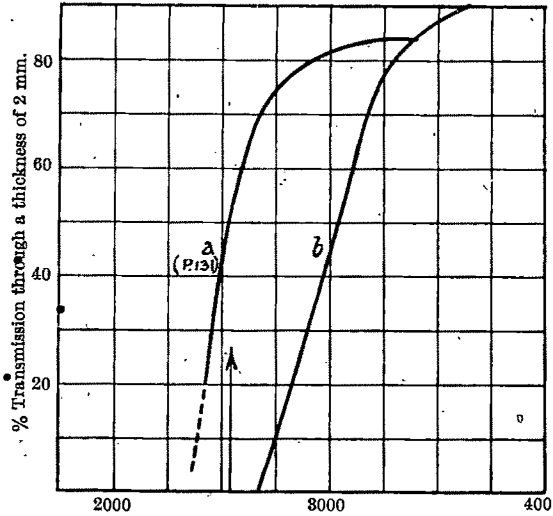
Transmission of Bactericidal Radiation through Glass

It is well known that iron, present in glasses as an impurity, has a most important effect in reducing their transmission of ultra-violet radiation. Of both theoretical and practical importance is the exact quantitative effect, at various wave-lengths, of iron in both the ferrous and ferric condition and in glasses of various compositions. On this question the most authoritative work known to me is that of D. Starkie and W. E. S. Turner[1] who, unlike other authors, quoted precise chemical compositions, including ferrous and ferric iron contents, together with complete transmission data. Curve *P*.131 in the graph is taken from their work and shows that a soft soda glass containing 0·01 per cent of iron oxide cut off completely at ~ 2650 A., the iron in the glass being practically all in the ferrous condition. With the same percentage iron content, but practically all in the ferric condition, the same glass cut off at even longer wave-lengths (~ 2675 A.). Starkie and Turner studied a glass containing so little as 0·005 per cent iron oxide, and concluded by extrapolation that a glass completely without iron would cut off at ~ 2230 A.



PERCENTAGE TRANSMISSION CURVES FOR (*a*) *P*.131 GLASS CONTAINING 0·010 PER CENT IRON OXIDE; (*b*) ONE OF THE NEW GLASSES CONTAINING 0·010 PER CENT IRON OXIDE, THE CURVE IN THE LATTER CASE *not* BEING CORRECTED FOR REFLEXION LOSSES. THE VERTICAL ARROW INDICATES THE 2537 A. LINE

Small melts made in this Laboratory during 1939, using platinum–rhodium crucibles and pure materials, showed that it was possible to make a silicate glass containing about 15 per cent of alkali oxides and having a transmission at 2537 A. of ~ 70 per cent for a thickness of 1 mm. This work was interrupted by the War; but the subject is now under investigation again.

In large-scale melting it is very difficult to keep the iron oxide very much below 0·01 per cent, and an important question, therefore, is the possibility of obtaining good transmission at 2537 A. with about this percentage of iron oxide. We have established that a soft soda glass of linear expansion coefficient ~ 9·5 × 10^{-6} per ° C., and containing 0·01 per cent of iron oxide, may have the transmission curve shown in the graph, when made on a scale of several hundredweights at a time.

Two main conclusions may be drawn from the work, as follows:

(*a*) Soft glasses, even when containing as much as 0·01 per cent iron oxide, may be made with remarkably good ultra-violet transmission at 2537 A., and much remains to be done before one can say precisely where the absorption edges occur for glasses completely free from iron. It may be remarked in this connexion that even the new glass referred to is distinctly coloured when viewed in thicknesses of a few inches. It follows that one cannot yet estimate exactly the specific effect the main constituent oxides of glasses have on the position of the absorption bands, and this should be remembered when studying the work of previous experimenters.

(*b*) Hitherto, in the manufacture of bactericidal lamps, it has been assumed that hard borosilicate glasses must be used. The above work shows that glasses of expansion coefficient ~ 9·5 × 10^{-6} may have good transmission at 2537 A., and this has the practical advantage that seals may be made to relatively easily available alloys and soft glasses.

The whole subject is under active investigation in this Laboratory, and it is hoped to publish detailed results at a later date. I would thank Mr. L. J. Davies, director of research, for permission to publish this communication.

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Stimulation of Growth in Pigs by Iodinated Casein and Stilbœstrol

THE earlier attempts to stimulate the growth-rate of pigs by administration of thyroid-active substances[1] and of synthetic œstrogens[2] have been followed by tests in which both treatments were given simultaneously.

	Average initial weight	Average final weight after 19 weeks	Average gain	Average amount of food required for 1 lb. live-weight gain
Trial 1				
Control animals (6)	41·0	201·5	160·5	3·79
Treated animals (6)	41·8	219·3	177·5	3·63
Trial 2				
Control animals (6)	43·5	218·8	175·3	3·76
Treated animals (6)	42·7	235·0	192·3	3·44
Both trials combined				
Control animals (12)	42·3	210·2	167·9	3·78
Treated animals (12)	42·3	227·2	184·9	3·54

Young growing castrated male pigs, ten to twelve weeks old at the beginning of the trials, received daily additions of iodinated casein and stilbœstrol to the food throughout the fattening period. The results for the first twelve pairs are now available. The treated pigs showed a substantially greater rate of growth than their control litter-mates, and more efficient food utilization. No untoward effects due to treatment have been observed. The accompanying table gives the relevant information. Further tests are in progress to confirm these preliminary findings and will be reported later.

The help of Miss E. Henriques is gratefully acknowledged.

R. BRAUDE

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University of Reading.

Feb. 12.

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[1] Braude, R., *J. Agric. Sci.*, **37**, 46 (1947).

[2] Braude, R., *Brit. J. Nutrit.*, **1**, iii (1947).

A Radioactive Local Anæsthetic

THE method of production of the local anæsthetic, dibromo procaine, described below, is of wide application, permitting the rapid formation of a saturated solution of radioactive hydrobromic acid from a small mass of active bromide. The hydrobromic acid serves as a basis for many brominations.

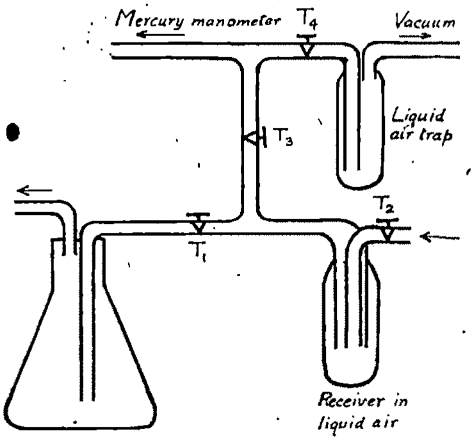
A solution of active bromide is converted to silver bromide by addition of excess silver nitrate. The precipitated silver bromide is dried, and reduced in a silica tube furnace at 800° C. by a stream of dry hydrogen. The furnace outflow, consisting of hydrogen and hydrobromic acid gas, is led through a receiver standing in liquid air and containing the calculated volume of distilled water. A manometer at the hydrogen inlet gives warning by showing a rise of pressure should the receiver become 'iced up'; this should not occur if the bore of the receiver tube is adequate for the mass of silver bromide to be reduced.

The hydrogen escaping from the receiver is led through a solution of silver nitrate (left of diagram), thence out to the air. Clouding of this solution indicates that hydrobromic acid is being carried through, and the rate of hydrogen flow is appropriately adjusted. Forty-five minutes is more than adequate for total reduction of 0·5 gm. silver bromide.

The furnace is disconnected, taps T_1 and T_2 closed, T_3 and T_4 opened and the receiver exhausted with a suitable pump. Tap T_4 is now closed and the receiver, connected only with the manometer in the vacuum circuit, is removed from the liquid air and its base slowly immersed in water at room temperature; the ice melts before the hydrobromic acid higher in the trap. The acid then resumes the gaseous state and dissolves in the water. Should the manometer show a significant rise of pressure above atmospheric, it is only necessary to re-immerse the flask in liquid air for a moment and recommence. In about five minutes, the fuming radioactive hydrobromic acid is ready for use.

Bromination is achieved according to the method of Morel and Leulier[1], who, in 1929, produced a dibromo procaine and investigated it pharmacologically and chemically, ascribing to it the formula $C_{13}H_{18}Br_2N_2O_2HBr$.

The calculated quantity of procaine is added to the hydrobromic acid in the receiver and about 0·5 c.c. of 100-volume hydrogen peroxide introduced. There is a brisk reaction and rapid precipitation of dibromo procaine. If the reaction becomes too violent, further peroxide is added to slow it down. The time taken for this reaction may vary from minutes to hours, depending on the concentration of reagents and, since the half-life of Br^{82} is only 34 hours, the need for a concentrated acid is obvious. In my series of experiments, the dibromo procaine was recrystallized. The conversion of potassium bromide to dibromo procaine can be completed comfortably in one and a half hours. An account of my radio-autographic studies will be given later.



Discussion. The method described has advantages over the simpler techniques for bromide-acid conversion. It is almost quantitative and commends itself when a bromide of small mass and low activity is to be dealt with. It involves no intermediate stages with loss of active substance. Radioactive bromine is usually provided as a simple bromide, so the method has a wide field of application; it is also satisfactory with highly active bromide, in that the system is a closed one and in no stage is a radioactive gas, with its attendant hazards, liberated in the laboratory.

Morel *et al.* have produced several brominated natural alkaloids, and have studied their properties, thus paving the way for experiments with the active bromine isotope.

As yet the synthesis of a complex molecule incorporating one or more radioactive C^{14} atoms presents considerable difficulty and involves losses of C^{14}, in spite of the most careful technique, while many compounds of great pharmacological interest cannot yet be synthesized; it is to bridge this gap that some simple method of labelling is required, and a halogen seems to be the 'label' of greatest general utility at present.

I wish to thank the staff of the Liverpool and Cambridge cyclotrons, and also Prof. A. D. Macdonald, for facilities in his laboratory.

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Victoria University of Manchester.

Feb. 13.

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[1] Morel, A., Leulier, A., and Denoyel, P., *Bull. Soc. Chim.*, 45, 435, 457 (1929).

"Plant Geography"

BOOK reviews are of value not only to readers but also to writers, and I am therefore sorry that Sir Edward Salisbury did not, in his notice of my book "The Geography of the Flowering Plants" in *Nature* of May 8, give us his views on any of the more profound modern problems of phytogeography with which it tries to deal.

With regard to the point which he particularly stresses, namely, the question of the value of specialized dispersal mechanisms, I remain unrepentant and see no reason to modify my belief that a broad acquaintance with the Angiosperms and their distribution allows of no other conclusion than that which the reviewer criticizes.

It is also only proper to point out that the incomplete sentence which Sir Edward quotes from my book in the second paragraph of his notice is not, as the context might imply, from the chapter on the dispersal of plants but from an earlier chapter, and from the very pages of it in which the "critical consideration" he desires is, in fact, given at some length.

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FRACTIONAL DISTILLATION AND ITS APPLICATION IN THE CONCENTRATION OF THE HEAVY ISOTOPES OF OXYGEN AND HYDROGEN

By DR. I. DOSTROVSKY, PROF. E. D. HUGHES
AND
DR. D. R. LLEWELLYN
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IN a previous communication[1] we described a convenient type of fractionating column suitable for the concentration of the heavy isotopes of oxygen and hydrogen in water. The glass assembly was efficient for comparatively slow distillations and was capable of producing valuable enrichments of O^{18} in sufficient quantities of water to be useful for tracer studies. A column 12 ft. in length and ¾ in. in diameter had efficiency equivalent to about 450 theoretical plates for a boil-up rate of 500 ml. per hour, and, to give an illustration of its performance, in twenty-four days of continuous distillation at atmospheric pressure it produced 500 ml. of water with nearly a three-fold enrichment of O^{18}. As expected, the production of the desired isotopes is increased by operating the column under reduced pressure. Thus, a five-fold enrichment of O^{18} is obtained after six weeks of continuous distillation at 150 mm. pressure. A further increase results by periodically replacing the reservoir water (which becomes lighter during the course of an experiment) by fresh water. It is more convenient, however, to use the same stock throughout a run, and this has generally been our practice with this column.

The successful use of the apparatus prompted us to attempt the construction of a larger column, our aim being to maintain approximately the platage of our first design while increasing the throughput by about ten-fold. Our general intention was to demonstrate the possibilities of such columns in isotopic work and other investigations involving the close fractionation of mixtures. The unsuitability of the radioactive isotopes of oxygen for tracer studies, and the lack of success hitherto experienced in devising other convenient methods for the separation of the stable isotopes of this element in substantial quantities, gave added interest to the application in this instance of the distillation method, which, on the basis of the results of previous investigators[2] and our experience with the smaller column, promised to be especially useful in the case of oxygen. Our immediate target then was to obtain good enrichments of O^{18}, and, in particular, to obtain a rapid supply of sufficient quantities of enriched material for a second-stage concentration in the glass column previously described. An ultimate objective, using various columns in conjunction, is to obtain isotopically pure O_2^{18} and H_2O^{18} for studies of their properties, and to have ample quantities of highly enriched samples suitable for all types of tracer experiments. Accordingly, we have constructed a 30-ft. metal column of 3 in. diameter, suitable for continuous fractionation, and we now wish to place on record its chief characteristics.

The still is designed to operate at reduced pressures with either ordinary distilled water or enriched water as feed stock. The main section consists of a 31-ft. length of 3-in., 16-gauge copper pipe, and contains a 30-ft. portion filled with 100-mesh phosphor-bronze packing, as in the column previously described[1]. The remaining length accommodates the inlet from a feed pipe, the outlet to an overflow pipe and a short reflux condenser, the last two items being used only in connexion with the flooding process. The top of the column is connected to a pipe leading to the main condensers, from which another pipe carries the condensate to a reservoir situated on the level of the base of the column. In the first mode of operation, the condensate displaces from the reservoir (containing enriched material in this case) an equal volume of water, which is conveyed through the feed pipe to the top of the column. In the second method, the displaced water is run into distilled water containers (and may be used for ordinary laboratory purposes), while fresh distilled water is fed to the top of the column through a flowmeter[3] which records and automatically controls the rate of flow. With this column, which is especially useful for the first stage of concentration, we generally employ the latter method.

The water flowing down the column is led through a glass tube to the bottom of the boiler, which consists of a 'Pyrex' tube, 18 in. in length and 2¾ in. in diameter, containing four one-kilowatt tubular heaters. The boiler has a working volume of 200 ml. of water, and a level-controlling device is incorporated which keeps this volume sensibly constant. The vapour is returned to the bottom of the column through a copper tube (diameter 1 in.). A connexion is taken from this tube to a manometer and to one side of a differential manometer, the other side of which is connected to the top of the condenser, to a manostat and to the vacuum line. Samples of water can be removed from the boiler through a side tube and valve.

Thermal insulation of the column is provided by 'Fibreglass' pipe lagging (2½ in. thick) built in two layers with a compensating electric heater wound on the inner layer. The input of this electric heater is controlled by a 'Simmerstat' and adjusted to compensate for the residual heat loss. A number of thermocouples and differential thermocouples are incorporated throughout the length of the jacket as an aid to the correct adjustment of the jacket heater.

The centre section of the column is fixed to the wall of a laboratory, the upper portion extending to the top of a ventilator on the roof, while the lower section passes through a hole in the floor of the laboratory to a basement below, where it is supported by a brick structure.

Since it is necessary to operate the column for long periods without attention, it is essential to safeguard the equipment from damage and the enriched water from loss consequent upon failure of water or electricity supply or breakdown in parts of the apparatus; accordingly, appropriate safety devices and automatic controls are incorporated.

The following details indicate the achievements of the column in preliminary runs on the first-stage fractionation of water. The distilled water feed-rate was 3,850 ml./hr. and the pressures in the boiler and at the top of the column were 460 mm. and 290 mm of mercury respectively. We give two illustrations of the performance of the still in production experiments. After sixteen days of continuous distillation the boiler contained approximately 1 per cent H_2O^1 (excess density (H_2O^{18}) = 755 p.p.m.; enrichment nearly five-fold) and, thereafter, 115 ml. of water of this quality could be withdrawn daily for further concentration. (Using the column previously described[1], a second-stage fractionation of water obtained in this manner is expected to yield 5 per cent H_2O^{18}.) The operating conditions, which were intended to be suitable for O^{18} enrichment, were not particularly appropriate for the production of deuterium, but it is of interest to record that after the same period (16 days) the boiler water in the first stage of distillation contained 3 per cent of HDO. The daily withdrawal of 115 ml. of water afterwards reduced this figure to a steady value of 1·1 per cent (excess density (HDO^{16}) = 560 p.p.m.; enrichment factor = *c.* 32). After thirty-two days of continuous distillation, a six-fold enrichment of O^{18} was obtained in the boiler water, while the deuterium concentration was about 180 times the normal value. At this point, 30 ml. of water of approximately the same quality in O^{18} (excess density (H_2O^{18}) = 1,073 p.p.m.) could be withdrawn daily from the still, but this rate of removal lowered the deuterium enrichment to about 140 times the normal value (excess density (HDO^{16}) = 2,530 p.p.m.; HDO = 5 per cent). If applied appropriately in conjunction with the electrolytic process, the use of the distillation method, employing suitable modifications and enlargements of the type of still described, may be of value in the production of pure deuterium oxide. This and similar applications are being further explored.

When no water is withdrawn from the boiler the enrichment (q') of O^{18} is represented approximately (except for small t values) by the equation

$$q' = 6{\cdot}80 - 5{\cdot}45\exp(-t/16) - 0{\cdot}18\exp(-t/0{\cdot}77) - \ldots,$$

q' being the ratio of the concentrations of O^{18} in the boiler water and in the feed-stock and t the time in days from the commencement of the run. Except for small values of t, the first two terms of the expression provide a useful approximation formula for q'. The enrichment of deuterium (q'') over the range examined approximately follows the linear relationship $q'' - 1 = 5{\cdot}64\ t$, q'' representing the ratio of concentrations of deuterium in the boiler water and in the feed-stock and t being measured in days as before. Assuming a value of α, the ratio of the vapour pressures of H_2O^{18} and H_2O^{16}, deduced from the data of Wahl and Urey[4], namely, 1·0044, the efficiency of the column under the conditions described is equivalent to about 435 theoretical plates. An analysis of our results, however, indicates a considerably higher value of α than that deduced from the data of previous workers[5]. Discussion of this point is postponed pending the results of further investigations.

A detailed description of the construction and characteristics of the column will be published elsewhere.

We wish to thank Imperial Chemical Industries, Ltd., Billingham Division, for advance information concerning the operation of their metal-gauze-packed fractionation columns[6].

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[1] Dostrovsky and Hughes, *Nature*, **158**, 164 (1946).

[2] Urey, Pegram and Huffman, *J. Chem. Phys.*, **4**, 623 (1936). Huffman and Urey, *Ind. Eng. Chem.*, **29**, 531 (1937). Datta, Day and Ingold, *J. Chem. Soc.*, 1968 (1937). Brodski, Alexandrovitsch and Skarre, *Acta Physicochem. U.R.S.S.*, **7**, 469 (1937); *J. Phys. Chem. Russ.*, **10**, 538 (1937) and subsequent papers. Winter, Carlton and Briscoe, *J. Chem. Soc.*, 131 (1940). Thode, Smith and Walkling, *Canadian J. Res.*, **22**, 127 (1944).

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Cf. Riesenfeld and Chang, *Z. phys. Chem.*, **33**, B, 127 (1936).

Cf. B.P. 578,309.

REVERSAL OF VERNALIZATION BY HIGH TEMPERATURE

By Prof. F. G. GREGORY, F.R.S.,
AND
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IN a previous letter[1], evidence was presented showing that 'Petkus' winter rye vernalized for six weeks and then exposed for a short period (1–4 days) to a temperature of 35° C. showed a retardation of flowering, thus indicating a partial reversal of the vernalized condition. The complete devernalization reported by Efeikin[2] and Tetjurev[3] using winter wheat was not obtained in this experiment with winter rye. After a period of vernalization of twelve weeks, however, high temperature completely failed to cause retardation in flowering. The conclusion was therefore drawn that as the period of low temperature treatment is extended the vernalized condition induced becomes less and less easily reversible and finally is completely stable. This suggestion has been completely substantiated by an experiment carried out in 1947. Winter rye was vernalized for varying periods, using the 'restricted moisture' method, and at the end of treatment was exposed for three days to a temperature of 35° C. The grain was then sown, both in the field and in pots, and the flowering behaviour assessed by the 'scoring method' of Gregory and Purvis[4], which gives a quantitative measure of 'earliness' of flowering. The results for plants grown in the field are presented in Table 1.

TABLE 1. RETARDATION OF WINTER RYE VERNALIZED FOR DIFFERENT PERIODS AND THEN HEATED TO 35° C. FOR 3 DAYS. FIELD CULTURE. NUMBER OF REPLICATES IN BRACKETS

Duration of vernalization	'Scores' Unheated	'Scores' Heated	Difference	Degree of vernalization	% reduction by heat
0 (Control)	24±1·4 (42)	24±0·9 (43)	—	—	—
2 weeks	28±2·6 (40)	24±1·3 (34)	3·2±3·1	4	100
3	62±4·4 (59)	41±3·9 (45)	22·2±6·1	38	58
4	79±4·6 (56)	48±5·3 (44)	30·5±7·0	55	55
5	108±1·1 (42)	87±5·5 (38)	21·2±5·4	84	25
6	112±0·8 (48)	98±3·0 (49)	13·8±3·1	88	16
8 (5 days heat)	121±0·5 (53)	118±1·0 (45)	3·0±1·1	97	3

High temperature following on all periods of vernalization, except the shortest (two weeks), led to a retardation in flowering which was statistically significant; two weeks of vernalization failed to give a significant acceleration of flowering and therefore no subsequent reversal by heat could be expected. The figures entered in column 2 of the table show the usual effect of increasing duration of vernalization upon the acceleration of flowering; those in column 3 the 'scores' for plants grown from the grain heated after vernalization; by difference the effect of the subsequent heat treatment on the 'score' is obtained and entered in column 4. The degree of vernalization of the unheated grains is shown in column 5, and the reversal of vernalization by heat is entered in column 6. The progressive reduction in the effect of the heat

TABLE 2. RETARDATION OF WINTER RYE VERNALIZED FOR DIFFERENT PERIODS AND HEATED AT 35° C. FOR 3 DAYS. POT CULTURE. NUMBER OF REPLICATES IN BRACKETS

Duration of vernalization	'Scores' Unheated	'Scores' Heated	Difference	Degree of vernalization	% reduction by heat
0 (Control)	26±3·0 (5)	34±4·0 (6)	−8·2±5·2	—	—
2 weeks	58±10·9 (7)	31±4·1 (10)	27·0±10·3	32	84
3	89±6·2 (8)	69±9·5 (9)	20·4±11·6	63	32
4	113±2·5 (11)	96±5·0 (7)	17·1±4·4	87	20
6	118±1·5 (8)	114±4·7 (10)	4·3±5·4	92	4

treatment as vernalization is prolonged is very apparent. Similar results obtained with plants grown in pot culture are given in Table 2.

Replication in this experiment was much reduced by attacks of frit fly; but the numbers surviving were adequate to establish the significant devernalization by heat and the progressive decline in effect of heat with prolongation of vernalization treatment. The higher 'scores' usually found with plants in pot culture[5] have made possible a demonstration of devernalization after two weeks low-temperature treatment.

The leaf numbers for the pot culture plants are entered in Table 3.

TABLE 3. INCREASE IN LEAF NUMBER IN PLANTS VERNALIZED FOR DIFFERENT PERIODS AND THEN HEATED TO 35° C. FOR 3 DAYS. POT CULTURE. NUMBER OF REPLICATES IN BRACKETS

Duration of vernalization	'Scores' Unheated	Heated	Difference
0 (Control)	21·8±0·34 (5)	21·2±0·56 (6)	−0·6±0·98
2 weeks	19·2±1·61 (7)	22·3±0·47 (10)	3·1±1·34
3	16·2±0·38 (8)	19·8±0·73 (9)	3·6±1·09
4	12·7±0·26 (11)	18·0±2·57 (7)	5·3±0·41
6	10·8±0·45 (8)	11·8±0·53 (10)	1·0±0·91

After two, three and four weeks vernalization, subsequent heat treatment has significantly increased the leaf number, which affords conclusive evidence that retardation in flowering results from a true reversal of vernalization rather than from a mere retardation of growth-rate of the plants. A similar increase in leaf number following devernalization by heat has been noted in wheat by Efeikin[6].

Experiments on devernalization have been carried out in four successive years and have given variable results; in 1946 the reversal was insignificant despite the fact that the response to vernalization was quite normal and similar to the values for 1947 presented above. The cause of this variation is still being investigated, and there is evidence to show that the stability of the vernalized condition increases with the degree of development taking place during the low-temperature treatment, since far more reversal occurs when the grains are prevented from growing by restricting the moisture supply during vernalization than when vernalized in moist sand with unlimited water supply. Thus two lots of vernalized grain may be alike in flowering response but differ in stability of the vernalized condition. On the other hand, it is possible that the differences noted were due to revernalization by low temperature encountered after planting out the grain; for Efeikin[6] has pointed out that, in wheat, revernalization after a partial devernalization by high temperature takes place more rapidly than the original vernalization, and a similar result with Petkus rye has been obtained by us, which thus would greatly augment the effect of such low temperatures after planting out.

It is clear that any attempt to formulate the reactions resulting in vernalization must take into account this gradual establishment of an irreversible condition of vernalization; its practical importance in relation to effects of sowing date upon time of flowering of vernalized grain has been indicated elsewhere[5].

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[1] Gregory, F. G., and Purvis, O. N., *Nature*, **155**, 113 (1945).

[2] Efeikin, A. K., *C.R.* (*Doklady*) *Acad. Sci. U.R.S.S.*, **25**, 308 (1939). **30**, 661 (1941).

[3] Tetjurev, V. A., *C.R.* (*Doklady*) *Acad. Sci. U.R.S.S.*, **30**, 189 (1941).

[4] Gregory, F. G., and Purvis, O. N., *Ann. Bot.*, (N.S.), ii, 237 (1938).

[5] Purvis, O. N. (1948, in the press).

[6] Efeikin, A. K., *C.R.* (*Doklady*) *Acad. Sci. U.R.S.S.*, **56**, 95 (1938).

U.S. NATIONAL ACADEMY OF SCIENCES

Election of Officers and Members

AT the annual meeting of the U.S. National Academy of Sciences held in Washington during April 26–28, the following officers, members and foreign associates were elected:

Treasurer (July 1, 1948–June 30, 1952): William J. Robbins, director of the New York Botanical Garden. (The other officers of the Academy are: *President:* Alfred N. Richards; *Vice-President:* L. P. Eisenhart; *Foreign Secretary:* Detlev W. Bronk; *Home Secretary:* Fred. E. Wright.)

Members of the Council of the Academy (for a three-year term ending June 30, 1951): Carl R. Moore, professor of zoology, University of Chicago; and J. Robert Oppenheimer, director of the Institute for Advanced Study, Princeton, New Jersey. (Other members of the Council are: Alfred N. Richards, L. P. Eisenhart, Detlev W. Bronk, Fred. E. Wright, William J. Robbins, W. R. Miles, W. Albert Noyes, jun., I. I. Rabi, and Donald D. Van Slyke.)

Members: Eric G. Ball, professor of biological chemistry, Harvard Medical School; Lloyd V. Berkner, chairman of the Section of Exploratory Geophysics of the Atmosphere, Carnegie Institution of Washington; Felix Bloch, professor of physics, Stanford University; Gerty T. Cori, fellow and research associate in pharmacology and biochemistry, Washington University School of Medicine; Hallowell Davis, director of research, Central Institute for the Deaf, research professor of otolaryngology, Washington University; John R. Dunning, professor of physics, Columbia University; W. Maurice Ewing, head of the Department of Geophysics, Columbia University; Karl Folkers, assistant director of research, Merck and Co., Rahway, New Jersey; Thomas Francis, jun., professor of epidemiology and chairman of the department, School of Public Health, University of Michigan; Edwin R. Gilliland, professor of chemical engineering, Massachusetts Institute of Technology; Haldan K. Hartline, associate professor of biophysics, Hospital of the University of Pennsylvania; Ernest R. Hilgard, chairman of the Department of Psychology, Stanford University; Frank L. Horsfall, jun., member, Rockefeller Institute for Medical Research, New York; John R. Johnson, professor of chemistry, Cornell University, New York; Raymond A. Kelser, dean of the School of Veterinary Medicine and professor of bacteriology, University of Pennsylvania; Cyril N. H. Long, chairman of the Department of Physiological Chemistry, Yale University School of Medicine; Edward J. McShane, professor of mathematics, University of Virginia; Donald H. Menzel, chairman of the Department of Astronomy, Harvard University, and associate director for solar research, Harvard College Observatory; C. W. Metz, chairman of the Department of Zoology, University of Pennsylvania; Curt P. Richter, associate professor of psychobiology Johns Hopkins University; Hermann I. Schlesinger professor of chemistry, University of Chicago Francis O. Schmitt, head of the Department of Biology and Biological Engineering, Massachusetts Institute of Technology; Glenn T. Seaborg, professor of chemistry, University of California, Berkeley Gilbert M. Smith, professor of botany, Stanford University; Curt Stern, professor of zoology, Univer sity of California, Berkeley; Chester Stock, professor of palæontology, California Institute of Technology; James B. Sumner, professor of biochemistry, Cornell University; Edward Teller, professor of physics, University of Chicago; Kenneth V. Thimann, associate professor of botany, Harvard University; Charles A. Thomas, executive vice-president, Monsanto Chemical Co., Dayton, Ohio.

Foreign Associates: Ronald Aylmer Fisher, Arthur Balfour-professor of genetics in the University of Cambridge; Prince Louis de Broglie, professor of theoretical physics, University of Paris (Sorbonne).

Medal Awards

Henry Draper Medal. The Henry Draper Medal for 1947 was conferred on Hans Albrecht Bethe, professor of physics at Cornell University, in recognition of his contributions to astronomical physics, more especially his researches on the generation of energy in the sun and stars. Since the first development of the concept of energy, one of the outstanding problems of the physical sciences has been that of the source of the tremendous flow of energy from the sun and stars. Dr. Bethe gave a brilliant, quantitative solution to this problem in terms of the nuclear transformation of hydrogen into helium, with carbon and nitrogen serving as catalysts. Dr. Bethe has furthermore used this solution to extend our knowledge of stellar interiors.

The Henry Draper Fund was established in 1883 for the purpose of striking a gold medal to be "awarded and presented from time to time by the said National Academy of Sciences to any person in the United States of America or elsewhere who shall make an original investigation in astronomical physics of sufficient importance and benefit to science to merit such recognition".

Agassiz Medal. The Agassiz Gold Medal and Honorarium for 1947 were conferred on Felix Andries Vening Meinesz, professor of geodesy and geophysics in the University of Utrecht, and president of the Netherlands Geodetic Commission, for his contributions to oceanography (see *Nature*, **160**, 169; 1947).

The Sir John Murray Fund was established in 1911 "for the purpose of founding an Alexander Agassiz gold medal, to be awarded for original contribution in the science of oceanography to scientific men in any part of the world, whenever and as often as the President and the Council may deem desirable".

Walcott Medal. The Charles Doolittle Walcott Bronze Medal and Award for 1947 were conferred on Dr. Alexander G. Vologdin, of the Palæontological Institute in Moscow. Dr. Vologdin was chosen because of his studies of Pre-Cambrian and Cambrian algæ, and particularly because of his researches on that most distinctive and enigmatic group of Cambrian organisms, the Archæocyatha. When Dr. Vologdin began his studies these early organisms were supposed to be rare and unimportant in the U.S.S.R., but he soon saw in collections brought back from central Siberia and from the southern Urals a rich field for investigation. His early results stimulated interest, and new discoveries of Cambrian formations were made in rapid succession from the Urals to the Altai and from Mongolia to Arctic Siberia. Dr. Vologdin personally made large collections of algæ and Archæocyatha from certain of these deposits, but his collections grew also by the additions from other field parties. Meanwhile, his first large monograph, "The Archæocyathinæ of Siberia", in 1931 almost doubled the known fauna of these organisms for the world. So early as 1937, when the known Archæocyatha of the world totalled approximately 400 species, some 250 were due to Dr. Vologdin. As a result of his brilliant achievements the Government of the U.S.S.R. in 1943 established a special laboratory at Moscow expressly for research in the Archæocyatha and the Pre-Cambrian and early Palæozoic algæ.

The Charles Doolittle Walcott Fund was established "to encourage and reward individual achievement in advancing our knowledge of Pre-Cambrian and Cambrian life in any part of the world". The deed of gift provides that nomination be made by a board of five, one of whom shall be appointed by the Royal Society of London, one by the Institut de France, two by the president and council of the U.S. National Academy of Sciences, and the secretary of the Smithsonian Institution.

NORMAN LOCKYER OBSERVATORY OF THE UNIVERSITY COLLEGE OF THE SOUTH WEST OF ENGLAND, EXETER

THE arrangements for transferring control of the Norman Lockyer Observatory to the University College of the South West (see *Nature* of January 3, p. 15) came to fruition on May 1, when the transfer was formally completed at a joint meeting of the two institutions. Sir Richard Gregory (chairman of the Observatory Corporation) gave possession, control and management of the Observatory to the College, and this was accepted on behalf of the College by Sir William Munday, deputy president. A new stage has thus been reached in the history of a unique attempt to develop, by private enterprise, an institution for pure research with no industrial applications.

The Observatory was founded in 1912 through the energy and foresight of Sir Norman Lockyer who, with Lady Lockyer and a small band of enthusiasts, presented land, money, instruments and practical services to the new enterprise. These early benefactors included, among others, Sir Francis McClean and his brother, Capt. W. N. McClean, who has acted as honorary secretary since the foundation. They were later joined by others and formed a Corporation under the Companies (Consolidation) Act, 1908, with articles of association approved by the Board of Trade. In spite of severe setbacks occasioned by the two world wars, the Observatory has not only survived but even developed to a considerable extent with the help of occasional short-term grants and the generosity of additional donors. Among the latter may be mentioned Sir Robert Mond, who made considerable gifts of money and equipment; also Lady Lockyer, who bequeathed the whole of her residuary estate to the Observatory, finally bringing the capital funds of the Observatory to about £40,000 in addition to about 44 acres of freehold land and much valuable equipment.

The astronomical equipment includes two twin equatorial refractors, each with a visual telescope of 10 in. aperture and an objective prism telescope (apertures 12 and 9 in. respectively) for photographing stellar spectra; also an astrographic instrument with four Zeiss lenses for direct photography, several smaller telescopes and two 12-in. siderostats. A 30-in. reflector, by Common, and a 6-in. Cooke refractor have not yet been erected. In the laboratory is a fine recording microphotometer by Casella, a 3-prism Littrow spectrograph, various measuring micrometers and much miscellaneous apparatus. There is an excellent library, containing most of the astronomical literature published since 1912, as well as a large proportion of earlier publications from the libraries of Sir Norman Lockyer and Dr. Frank McClean.

The scientific work has been carried out by a staff which, though enthusiastic, has always been very small, consisting of a director and usually either one or two assistant astronomers. At some periods no assistants were available. The first director, Sir Norman Lockyer, was succeeded by his son, the late Dr. W. J. S. Lockyer, and Mr. D. L. Edwards (the present director). These, with their small band of colleagues, have developed the Observatory until, in the words of the Astronomer Royal, "it has earned for itself an important place in British astronomy" —an importance which is recognized throughout the world in scientific circles.

A measure of the vitality of such an institution is afforded by the number of original communications from it accepted and published by scientific societies. About forty such papers were published under the directorship of Dr. Lockyer during 1920–36, and this rate of output has been maintained, as about thirty papers have been published since that period. The amount of night-work involved may be judged from the fact that more than 10,000 photographs (mostly of stellar spectra) are now available for reference and further study—a collection which is possibly unequalled in Great Britain. All this has been built up and maintained through the generosity of private persons; but in the present world conditions further development in this way is unlikely, so that the transfer to the University College will not only place the Observatory on a permanent responsible foundation but also give the best possible chance of future expansion.

The method of achieving the transfer, however, namely, by keeping the Corporation in existence but allowing a decisive majority on its Council to Exeter representatives, retains a pleasing link with the past and leaves a convenient channel available to any further flow of benefactions from private enterprise, great or small, should that arise in the future. It also retains the possibility of enlisting the interest and active assistance of leading British astronomers in the Observatory. Many of the most eminent of these have given valuable help from the beginning, by serving on the Council or Research Committee or in other ways, and the Council of the new Corporation still includes a number of well-known astronomers who are prepared to give active support in a similar way.

The University College authorities, on their side, are to be congratulated on acquiring such a well-established institution for astronomical research, with considerable endowments—a possession which is unequalled in any but the older universities. This was fully recognized by Sir William Munday, who regarded the union as an important milestone in the progress of the College and as helping it to obtain the full university charter which is desired. The responsibilities attached to the gift are also fully realized, and it is the intention of the College to do everything possible not only to maintain but also to develop the Observatory in the future. The event is thus of mutual benefit to the institutions concerned and also, it is to be expected, to astronomical research in Britain. The considerable advancements in this direction made in the past should receive additional impetus and it will always be remembered (in the words of a vote of thanks proposed by the Astronomer Royal) "that these achievements constitute a lasting memorial of gratitude to the spirit of the donors".

LONG ASHTON RESEARCH STATION

THE annual report for 1946 of the Agricultural and Horticultural Research Station, Long Ashton, Bristol, marks a year of change, when members of the advisory staff were transferred to the National Agricultural Advisory Service at Bracken Hill, Leigh Woods, close to the Station. This proximity should allow continued close liaison.

Several studies deal with nutrition of fruit and vegetable crops. An interesting result of work by E. J. Hewitt is that symptoms of acid damage are largely those of excess manganese and low calcium. T. Wallace, W. Morley Davies, D. J. D. Nicholas and E. J. Hewitt show that liming will correct this trouble; but residual deficiencies of magnesium, potash, phosphorus and nitrogen will still require treatment. Inorganic fertilizers are compared with organic manures such as sewage sludge, town refuse, and straw composted with sewage sludge, by C. Bould and E. Catlow. This is part of a long-term experiment on cultural systems for apples and black currants.

L. C. Luckwill has found that the methyl ester of alpha-naphthalene acetic acid will delay sprouting of stored potatoes. Spring treatment is effective at the rate of ½ oz. per ton, and its use would seem economically feasible for certain purposes. An important feature about winter wash emulsions is their resistance to rain, and S. H. Bennett, H. G. H. Kearns and H. Martin find, *inter alia*, that dinitrocresol washes are more rain-proof than tar-oil emulsions.

A detailed study of hop diseases and pests in the west Midlands is being made by E. H. Wilkinson, who is investigating virus diseases and the condition known as split leaf blotch, and J. F. Southey, who surveys the insects associated with this crop. J. A. H Tolhurst has surveyed the incidence of the virus disease nettlehead in relation to soil conditions and nutritional status of the plant. Preliminary results suggest that there may be a correlation with soil types, but none between the amounts of nitrate nitrogen, phosphate, potassium, calcium and magnesium in the host plant. Serious losses of field beans have been caused by chocolate spot disease, and L Ogilvie and M. Munro suggest manuring with phosphate and potash, and the avoidance of close, sheltered sites, as measures against the trouble. M. Miles discusses the importance of the bean seed fly in England and A. Stringer makes the interesting point that mature *Solanum polyadenium* plants are immune from aphid attack largely because a gummy secretion from the plant clogs the legs of the aphids.

An important aspect of the Station's work is its investigation of factors affecting quality of fresh and preserved fruit and vegetables. M. E. Kieser and A Pollard find that from one half to two thirds of the vitamin C in apples is retained on cooking, and the largest amounts of this vitamin occur in cider varieties. J. D. Bryan reports that the organic acid in plums and apples is almost all malic, in black currants chiefly citric, whereas gooseberries and tomato have a mixture of the two. Some potato varieties blacken on cooking, and have unsuitable texture; A. Pollard, M. E. Kieser and B. A. Crang show that cooking quality is mainly dependent on site, and the correction of manurial deficiencies improves the quality if its initial level was sufficiently high.

It seems appropriate that the report should close with a historical account, by R. W. Marsh, of the advisory agricultural services of the University of Bristol, which have been in operation since 1912; they have gradually gained the increasing confidence of farmer and grower, and should proceed to an even more useful future under the National Agricultural Service.

INTERNATIONAL ASPECTS OF THE RADIO-FREQUENCY SPECTRUM

During the summer of 1947, a series of International Telecommunication and Radio Conferences were held at Atlantic City, U.S.A., and the proceedings and conclusions of these have recently been published from the headquarters of the International Telecommunications Union at Berne, Switzerland. The object of these conferences was to revise the radio-communication regulations and the convention last formulated at Cairo in 1938 (see *Nature*, **141**, 195; 1938), and to re-plan the allocation of radio frequencies for the many and varied applications in use at the present time. A summary of the findings of the Atlantic City Conferences, which were attended by nearly thirty British delegates under the leadership of Sir Stanley Angwin, is given in the April issue of the *Wireless World*.

Since the drafting of the Cairo regulations, the radio-frequency spectrum has been extended very considerably at the high-frequency end, while many fresh applications have arisen for which it is necessary to find frequencies either for exclusive use or for sharing with other services in the same or other parts of the world. Under the new regulations, specific provision is made for radio navigation systems, for radio aids to meteorology and for the transmission of standard frequencies of very high accuracy. In addition, certain limited bands have been designated for industrial, scientific and medical equipment: for Great Britain, and in some cases elsewhere, the frequencies assigned for these purposes are 13·56, 27·12, 40·68, 2450 and 5850 Mc./s. Within these bands, any emission from apparatus used for industrial, scientific and medical purposes enjoys priority over other services operated within the bands. Elsewhere in the spectrum, all such apparatus must presumably be screened or operated in such a manner as to avoid any interference with other radio services.

For the purpose of frequency allocations for the many types of communication, broadcasting, radar and navigational aids, the world was divided at Atlantic City into three regions. Region 1 comprises Europe, the U.S.S.R. territory outside Europe, the Mongolian Republic and Asia Minor and Africa; Region 2 covers the whole of the western hemisphere from Greenland to Hawaii; while Region 3 comprises Australia, New Zealand, Oceania and that part of Asia not included in Region 1. It has also been found necessary to re-define and extend the zone in which certain frequencies are allocated for Tropical Zone broadcasting.

A most useful guide to the radio frequency allocations made at Atlantic City has been issued by the Radio Corporation of America in the form of a coloured chart. This chart covers the spectrum between 10 kc./s. (wave-length 30 km.) and more than 30,000 Mc./s. (wave-length 1 cm.); and it shows for each of the three regions described above the bands of frequencies proposed for twenty-three different services. It is to be noted that no specific allocations are yet proposed above 10,500 Mc./s., such higher frequencies being still regarded as for experimental purposes. While some of the allocations are already in being, it is recommended that the provisions become effective during 1949. One of the most important outcomes, however, of the Atlantic City conferences was the decision to set up an International Frequency Registration Board, which has already begun its task of examining all notifications of the proposed use of frequencies with the view of including those approved in the Master International Frequency Register. In addition to dealing with the allocation of frequencies, the new regulations contain a number of new definitions of the terms now used in radio engineering and scientific work, and also a revised classification of the various portions of the radio spectrum, and of the types of transmission and the systems of modulation now in common use.

Bearing in mind the extent and complexity of modern telecommunications technique, it must be a source of satisfaction to all those who participated in the conferences that such a large measure of agreement has been obtained on the methods of conducting world-wide radio communications.

FORTHCOMING EVENTS

Monday, May 31

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5.30 p.m.—"Photo-Canada" (Kodachrome Film with Sound Commentary).

Wednesday, June 2—Saturday, June 5

Textile Institute (at Buxton).—Conference on "The Organisation of the Textile Industry and Textile Production".

Thursday, June 3

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Messrs. E. R. Andrew, M. Desirant and D. Shoenberg: "The Intermediate State of Superconductors".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 5.15 p.m.—Annual General Meeting.

Chemical Society (at the Royal Institution, 21 Albemarle Street, London, W.1), at 7.30 p.m.—Prof. L. C. Pauling, For.Mem.R.S.: "The Modern Theory of Valency" (Liversidge Lecture).

Friday, June 4

Physical Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Sir George Thomson, F.R.S.: "The Growth of Crystals" (32nd Guthrie Lecture).

Geologists' Association (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. F. J. North: "A Cave near Aberdare, Glamorgan; Geological Notes and Queries".

Institution of Electronics, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Mr. L. C. Jesty: "Television".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Secretary and Registrar—The Secretary and Registrar, University College of North Wales, Bangor (June 5).

LECTURER (Grade I) IN ZOOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (June 7).

RESEARCH ASSISTANT to work under the direction of the Professor of Surveying and Photogrammetry on a programme of research into Altimetry in its relation to Photogrammetry—The Secretary, University College, Gower Street, London, W.C.1 (June 10).

ASSISTANT TECHNICAL EXAMINING OFFICER (male) IN THE VICTUALLING DEPARTMENT of the Admiralty—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2166 (June 10).

UNIVERSITY LECTURER and a UNIVERSITY DEMONSTRATOR IN PHYSICAL CHEMISTRY—The Secretary of the Appointments Committee, Faculty of Physics and Chemistry, Chemical Laboratory, Cambridge (June 12).

ASSISTANT LECTURER (grade III) IN THE DEPARTMENT OF PSYCHOLOGY—The Registrar, The University, Liverpool (June 12).

ASSISTANT PRESS OFFICER (unestablished) at Headquarters of the Department of Scientific and Industrial Research, London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.159/48 A (June 14).

SENIOR PRINCIPAL SCIENTIFIC OFFICER in the Royal Naval Scientific Service to undertake theoretical and experimental research in hydrodynamic problems—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2167 (June 14).

LECTURER IN MATHEMATICS in University College, Dundee—The Secretary, The University, St. Andrews (June 15).

SENIOR EXAMINERS (temporary) at the Ministry of Supply A.I.D. Test House, Harefield, Middx.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.344/48A (June 15).

SENIOR ENTOMOLOGIST-IN-CHARGE, an ENTOMOLOGIST, and a CHEMIST, in a Research Unit proceeding to Mauritius to undertake a large-scale mosquito eradication experiment using D.D.T. and B.H.C. insecticides—The Under-Secretary of State, Colonial Office (Research Department), Palace Chambers, Bridge Street, London, S.W.1 (June 21).

SENIOR SCIENTIFIC OFFICER IN THE DEPARTMENT OF PARASITOLOGY AND CHEMOTHERAPY, and a SCIENTIFIC OFFICER IN THE DEPARTMENT OF PHYSIOLOGY, CHEMISTRY, ANIMAL HUSBANDRY AND ANIMAL BREEDING, East African Veterinary Research Organisation, Kenya—The Under-Secretary of State, Colonial Office (Research Department), Palace Chambers, Bridge Street, London, S.W.1 (June 21).

LECTURER IN THE DEPARTMENT OF BOTANY—The Secretary, The University, Aberdeen (June 25).

CHAIR OF MINING—The Secretary, The University, Edmund Street, Birmingham 3 (July 1).

ASSISTANT and ASSOCIATE PROFESSORSHIPS IN THE DEPARTMENT OF PHYSICS—The Head, Department of Physics, University of British Columbia, Vancouver, B.C., Canada.

LECTURER, and a DEMONSTRATOR, IN THE DEPARTMENT OF BACTERIOLOGY AND IMMUNOLOGY—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

METEOROLOGICAL FORECASTERS in the West African Meteorological Service—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

CHIEF OFFICER OF THE OFFICIAL SEED TESTING STATION for England and Wales, and a SECOND ASSISTANT to the Chief Officer—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

PHOTOMICROGRAPHER (male) for senior appointment in technical grade—The Administrative Officer, National Institute for Medical Research, Hampstead, London, N.W.3.

ANALYTICAL CHEMISTS—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

ASSISTANT LECTURER IN AGRICULTURE, a DEMONSTRATOR IN POULTRY HUSBANDRY, an ASSISTANT LECTURER, and a SENIOR LABORATORY ASSISTANT, IN THE DEPARTMENT OF BOTANY—The Registrar, University College, Nottingham.

SOIL CHEMIST AND HEAD OF THE CHEMISTRY DEPARTMENT—The Bursar, Royal Agricultural College, Cirencester.

ASSISTANT ELECTRICAL ENGINEER IN THE PLANT ENGINEERING DIVISION—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Plant Engineering Division'.

INDUSTRIAL CHEMIST, and a CIVIL ENGINEER—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Foreign Office. Tuberculosis in the British Zone of Germany, with a Section on Berlin. Report of an Inquiry made in September–October 1947. By Dr. M. Daniels. Pp. 32. (London: H.M. Stationery Office, 1948.) 6*d*. net. [83

Astronomical Navigation Tables. Vol. A: Latitudes 0°–4° North and South. (Air Publication 1618.) Prepared by H.M. Nautical Almanac Office on behalf of the Air Ministry. Pp. 233. (London: H.M. Stationery Office, n.d.) 7*s*. 6*d*. net. [113

British Standards Institution. Yearbook 1947. Pp. 324. (London: British Standards Institution, 1948.) 3*s*. 6*d*. [243

The Commandant's House at Margidunum. By Dr. Felix Oswald. Pp. 41 (17 plates). (Nottingham: University College, 1948.) 7*s*. 6*d*. [243

Notes on Descarte's Règles pour la direction de l'esprit. By S. M. Jacob. Pp. 36. (London: International Book Club, 1948.) 4*s*. 6*d*. [303

Colonial Office. Colonial Primary Products Committee Interim Report, January 1948. (Colonial No. 217.) Pp. 24. (London: H.M. Stationery Office, 1948.) 6*d*. net. [64

Electricity Supply: Directory of B.E.A., Boards and Officials. Pp. 52. (London: Electrical Review, Ltd., 1948.) 2*s*. net. [84

National Institute of Economic and Social Research. Occasional Papers, 12: The Measurement of Colonial National Incomes. By Phyllis Deane. Pp. xvi+173. (Cambridge: At the University Press, 1948.) 12*s*. 6*d*. net. [84

Department of Scientific and Industrial Research. The Fundamental Research Problems of Telecommunications. Reports of the Working Parties of the Telecommunications Research Committee. Pp. iv + 80. (London: H.M. Stationery Office, 1948.) 1*s*. 6*d*. net. [124

Memoirs of the Geological Survey of Great Britain: England and Wales. Dudley and Bridgnorth (one-inch Geological Sheet 167, New Series.) By T. H. Whitehead and Dr. R. W. Pocock. Pp. xi + 226 + 10 plates. (London: H.M. Stationery Office, 1947.) 7*s*. 6*d*. net. [124

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board, with the Report of the Director of Water Pollution Research, for the Year 1946. Pp. iv + 39. (London: H.M. Stationery Office, 1948.) 1*s*. net. [134

The Social Medicine of Old Age: Report of an Inquiry in Wolverhampton. By Dr. J. H. Sheldon. (Survey Committee on the Problems of Ageing and the Care of Old People: Medical Sub-Committee on the Causes and Results of Ageing.) (Published for the Trustees of the Nuffield Foundation.) Pp. x + 240. (London: Oxford University Press, 1948.) 5*s*. net. [144

The Case for the Full Development of Agriculture. By Jorian Jenks. Pp. 39. (Farnham: Rural Reconstruction Association, The Lime House, Tilford, 1948.) 1*s*. 6*d*. [144

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Factors Regulating Blood Pressure. Transactions of the First Conference, April 24–25, 1947, New York. Edited by B. W. Zweifach and Ephraim Shorr. Pp. 175. (New York: Josiah Macy Jr. Foundation, 1947.) 1.90 dollars. [33

Conference on Liver Injury. Transactions of the Fifth Meeting, September 26–27, 1946, New York. Pp. 128. (New York: Josiah Macy Jr. Foundation, 1947.) 2.25 dollars. [33

Liver Injury. Transactions of the Sixth Conference, May 1 and 2, 1947, New York. Edited by F. W. Hoffbauer. Pp. 74. (New York: Josiah Macy Jr. Foundation, 1947.) 2 dollars. [33

Somaliland Protectorate. Report on General Survey of British Somaliland, 1946. (Colonial Development and Welfare Act, Economic Survey and Reconnaissance.) Pp. 20+12 plates. (Burao: Published under authority of British Military Administration, 1947.) 6*s*. [103

Science and Technology in China. (Published bi-monthly.) Vol. 1, No. 1, February. Pp. 16. (Nanking: Natural Science Society of China, National Central University, 1948.) [243

Communications on Applied Mathematics. (Issued quarterly by the Institute for Mathematics and Mechanics, New York University.) Vol. 1, No. 1, January. Pp. 100. (New York and London: Interscience Publishers, Inc., 1948.) 2.50 dollars; 8 dollars per year. [303

Los grupos sanguineos de los Indios del Ecuador: comunicacion definitiva. Por Prof. Dr. Antonio Santiana. Pp. 48+8 plates. (Quito: The Author, Facultad de Filosofia y Letras, Universidad, 1947.) [303

Memoirs of the Section of Studies on Alcohol, Laboratory of Applied Physiology, Yale University, No. 6: A Rorschach Study on the Psychological Characteristics of Alcoholics. By Dr. Charlotte Buhler and Prof. D. Welty Lefever. Pp. viii+64. (New Haven, Conn.: Hillhouse Press, 1948.) 75 cents. [303

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NATURE

No. 4101 SATURDAY, JUNE 5, 1948 Vol. 161

CONTENTS

Page

Science and History 865
Development of Radar. By Sir Robert Watson-Watt, C.B., F.R.S. . 867
Landscape Architecture. By Prof. L. Dudley Stamp . . . 868
Research on Management. By E. F. L. Brech 869
Humour and Humanism in Chemistry. By Denis I. Duveen . . 869
Biochemistry in Progress 870
Local Government and the Citizen. By Lieut.-Col. Eric Lowe . 870
Significance of Nuclear Change in Differentiation. By Dr. K. Mather 872
Biological Aspects of Water Pollution 874
The Royal Academy, 1948. By Dr. A. Tindell Hopwood . . . 876
Obituaries :
  Dr. H. W. Richmond, F.R.S. By Prof. E. A. Milne, M.B.E., F.R.S. 877
  Prof. P. A. C. Dangeard. By Dr. B. Barnes 878
News and Views 879
Letters to the Editors :
  Meson Scattering with Nuclear Excitation.—Dr. H. J. Bhabha, F.R.S., and R. R. Daniel 883
  Investigation of the Radioactivity of Rocks by the Photographic Method.—Dr. J. H. J. Poole and J. W. Bremner . . . 884
  Lightning Arrester Discharge Currents.—Robert C. Cuffe . 885
  Effect of Lattice Distortions on the Mean Rate of Propagation of Large Barkhausen Discontinuities.—Dr. L. J. Dijkstra and Dr. J. L. Snoek 886
  Metastable States of Nickel Characterized by a High Initial Permeability.—Dr. J. L. Snoek and J. F. Fast 887
  Audio-Frequency Magnetic Fluctuations.—H. F. Willis . . 887
  Structure of Plasteins.—Prof. Artturi I. Virtanen and Heikki K. Kerkkonen 888
  A Synthesis of Fluoranthene Derivatives.—Dr. E. Bergmann . 889
  Chemical Mechanism of Permanent Set.—A. J. Farnworth and Prof. J. B. Speakman 890
  Energy of the Central C—C Bond in Diphenyl.—Dr. M. Szwarc 890
  Stress Corrosion.—J. C. Chaston 891
  Podocarpic Acid as a Source of an Œstrogenic Hormone.—C. W. Brandt and D. J. Ross 892
  Isomerization of Dienœstrol.—W. Hausmann and Dr. A. E. Wilder Smith 892
  Glycerol Dichlorhydrin and Vitamin A.—D. D. Penketh . . 893
  Pressor Effect of Renin on Pulmonary Artery Pressure.—E. G. Brewin, R. A. Kenney and D. H. Miller 893
  A Culture Method for *Lymnaea truncatula*.—E. L. Taylor and Alan Mozley 894
  Resistance to 'Inanition' in Grass Seedlings.—J. P. Cooper . . 894
  Occurrence of Volcanic Bomb in the Agglomeratic Slates of Kashmir.—Dr. R. C. Misra 895
  Proposed Central Publication of Scientific Papers.—Watson Davis 896
Mesons and Nucleons. By Prof. O. Klein 897
Excitation Curves for the γ-Radiation from Light Elements Bombarded with α-Particles from Polonium. By Prof. Hilding Slätis . 899
Reactivity and Structure of Molecules. By Prof. F. A. Paneth, F.R.S. 901
Fauna and Flora of Palestine 902
Afforestation as a World Problem 902
South African Council for Scientific and Industrial Research . . 903

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SCIENCE AND HISTORY

THE plea for a historical approach in teaching science which Dr. J. B. Conant advanced in his Terry Lectures at Yale University, which have now been published under the title "On Understanding Science"*, raises questions of interest to many besides those who are concerned with teaching itself. Dr. Conant is indeed urging the use of case-histories in teaching science, and illustrates his proposal by the specific example of seventeenth-century experiments on the 'spring of the air' with barometers, air pumps and vacua to show the influence of new techniques, the evolution of new concepts from experiment, the difficulties of experimentation and the significance of the controlled experiment, and the development of science as an organised social activity. These points are further emphasized by a study of the discovery of the electric battery and of the chemical revolution which placed our knowledge of combustion on a sound basis, in which he shows further how an accidental discovery may lead by a series of well-planned experiments to a new technique or a new concept, or both. In exploring a new phenomenon, the experiments may be well planned without any working hypothesis as to the nature of the phenomenon ; furthermore, a useful concept may even be a barrier to the acceptance of a better one if it be long entrenched in the minds of scientific men. Experimental discoveries, he believes, must fit the times ; facts may be at hand for years without their significance being realized ; the total scientific situation must be favourable for the acceptance of new views.

These principles in the tactics and strategy of science are of great importance in the education of the scientific worker himself, and it might be urged that they should be considered with special care by those responsible for the training of the social scientist. They are equally important for the education of the layman, and in conveying to him a clear understanding of what science can and cannot accomplish, and how it works ; for on such understanding the smooth functioning of a democracy largely depends. Dr. Conant argues cogently that, in this way, by clarifying popular thinking about the methods of science, as well as by assisting those in positions of authority and responsibility and those who shape opinion to gain some understanding of science, we should go far to lay the basis for a fruitful discussion of the ways in which rational methods may be applied to the study and solution of human problems.

Even if that is claiming too much, there can be no doubt as to the value of the historical approach in assisting a better understanding of natural science among laymen, or of the importance of such an understanding for the promotion of national welfare. A greater knowledge of the genesis of certain habits of mind should, as Dr. Conant suggests, reinforce slowly but persistently those habits of mind and those rational elements in our civic life which make for the adventurous yet orderly development of our free society. Dr. Conant makes no extreme claims for the widespread application of the scientific method to the problems of society at every level: he recognizes its limitations, and questions, indeed, the validity of Karl Pearson's assertion that "modern science, as training the mind to an exact and impartial analysis of facts, is an education specially fitted to promote sound citizenship"; indeed, he holds that those who have little or no direct experience with scientific investigations might be completely misled as to the nature of the scientific method by studying "The Grammar of Science".

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* On Understanding Science. By Dr. J. B. Conant. Pp. 162. (London : Oxford University Press, 1947.) 10s. 6d. net.

What Dr. Conant is concerned to promote is just that understanding of the way science works, its difficulties and limitations, which will prevent the distortions which arise when the man of science is put on a pedestal and his activities are regarded as something mysterious or even magical and apart from the ordinary activities of mankind. Incidentally, these few pages are much more suggestive and stimulating in their brief reference to professional tradition and discipline and the rôle of the learned societies in science, as well as in society as a whole, than some of the lengthy but subjective volumes which other authors have devoted to these matters.

Dr. Conant goes right to the heart of the problem of the relation of knowledge to power. He sees clearly that if science is to be used wisely and to take its place among the ordinary activities of mankind, the idea of mystery or magic must be cleared away from the minds of the people. Indeed, so long as any such idea lingers in the popular imagination, the danger of a violent reaction against science and of the social throttling of research, of which Glenn Frank and others have warned us, will persist, and that danger is as great among the Western nations as it is among the more backward peoples.

It is a great merit of the historical approach that it facilitates apprehension of the social implications of science, and there is a passage in the recently issued report on Education for Citizenship in Africa prepared by the Colonial Office Advisory Committee on Education in the Colonies which is strikingly in line with Dr. Conant's thesis. It is not merely among the Colonial peoples that the lesson needs to be learned that man's power over Nature is obtained only by studying and using the facts, and that facts will not consent to adapt themselves to fit a man-made theory; or again, that we should consider the problem of the relationship between the intellectual and the spiritual sides of man's life, between the science of acquiring knowledge and the art of using it.

Burke once reminded us that we do not draw the moral lessons we might from history; and those who realize most fully the extent to which man's material advance has outstripped his spiritual progress have asked with reason whether anything could do more to help to recapture moral control than the universal recognition that physical science belongs in essence to the humanities, is a part, and may become the most important part, of that body of teaching which, though once narrowly confined, was always destined to expand and in unity to embrace the obligations of the good life. In that suggestion, Mr. J. B. Atkin in a recent book, "Incidents and Reflections"*, goes beyond Dr. Conant's arguments; but he is much more convincing than those who, like Dr. G. M. Trevelyan, reject entirely the idea of history as science and contend that history is more a matter of rough guessing from all available facts, dealing with intellectual and spiritual forces which cannot be subjected to scientific analysis, while at the same time they claim that the study of history instils the habit of surveying broadmindedly and calmly the pageant and process of human affairs. It is true, as Dr. G. G. Coulton once remarked, that the more we divorce history from the common life of man, the more we strangle its own vigorous life; but it is equally true that the historian can give no real guidance unless he proceeds from the assembling of facts to generalizations and from generalizations back to facts.

In the simplest and most fundamental way, historical method and scientific method are one and the same, as Mr. A. L. Rowse points out, and the scientific worker concerned to use the historical approach to science or interested in the relations of science and history might do worse than study the two chapters in Mr. Rowse's little book "The Use of History"†, where he brings out the ultimate reason why the study of history and of science is so vital at the present time.

Mr. Rowse suggests tentatively that in spite of all sorts of disillusionments and setbacks, there is an irresistible impulse towards self-government in human society, and he draws the general conclusion from European history that no one power is strong enough to rule all the rest. The sense of history therefore, he suggests, indicates some federal system that may enable us to work together in co-operation. Events in Europe since Mr. Rowse wrote those words in 1945 seem to support the brave assumption that on the basis of a knowledge of history we can look into the nearer future and see something of the shape of things that is emerging, and that such knowledge is the best aid to knowing what we can usefully achieve in our turn.

Mr. Rowse makes that assumption a little too readily, but if the project for a Western Union in Europe is to take concrete shape, the combination of the historian and the man of science, of the historical and the experimental method, may be indispensable. From one must come some guidance as to the behaviour of human groups and the working of human institutions; from the other, and especially the social scientist, must come the closer study of such groups and of individuals in the context of modern society. But both alike will require that the scientific approach be accompanied by the imaginative insight and understanding that marks the great historian no less than the great scientist, if they are to yield their full contribution to the shaping of the new institutions which the world needs to establish order and safeguard its great heritage of freedom and culture from the danger of destruction in war. The historian's work, like that of the man of science, must be sensitive to those human undertones and values which give life its dignity and purpose, and without which the human spirit droops and loses its creative power.

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* Incidents and Reflections. By J. B. Atkin. Pp. 258. (London: Christophers, 1947.) 12*s.* 6*d.* net.

† The Use of History. By A. L. Rowse. Pp. xi+247. (London: Hodder and Stoughton, Ltd., 1946.) 4*s.* 6*d.* net.

We need to remember that history is a matter of sense as well as of science, and of feeling as well as of fact; and that both will be required no less in the exercise of citizenship than in the practice of management and administration. We cannot understand why men acted in a certain manner unless we know how they felt; and in discovering where men failed in sympathy and understanding because of such ignorance, we come to the realities of history and indeed of politics, in the widest sense, upon which not merely good citizenship but also good management and administration, and indeed the organisation to serve a new world order, must be based. The historical approach to science helps us to see science in its true perspective in relation to those problems; just as the study of history inculcates that discipline and insight through which alone man can acquire the wisdom and self-command to evolve the forms of organisation which will serve his needs to-day, in industry, in the relations of one nation with another, and in society as a whole.

DEVELOPMENT OF RADAR

Radar System Engineering

Edited by Prof. Louis N. Ridenour. (Massachusetts Institute of Technology, Radiation Laboratory Series.) Pp. xviii+748. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 37*s.* 6*d.*

THOSE who had the privilege of participating in "the tremendous research and development effort that went into the development of radar and related techniques during World War II" are often asked about the effects of that effort in peace-time applications. The effects are of two kinds. The direct use of radar in increasing the safety, speed and economy of transport by air, sea and (perhaps) land is generally appreciated, widely understood and, not infrequently, too optimistically appraised. The indirect effects of radar development or more general radio development are less fully recognized outside specialist circles. Yet it is almost certainly true that these indirect effects will be more important than the direct peace-time applications; they may indeed be comparable in importance to the contribution of radar to victory in the War.

The full benefits of the imaginative skill and initiative, and the 'expertise' which produced, *inter alia*, "the basic microwave and electronic theory and techniques that had been so thoroughly developed during the war-time work on radar" could not be reaped without the further efforts of a distinguished group of the physicists and engineers concerned. The great Radiation Laboratory at the Massachusetts Institute of Technology was itself a monument of scientific co-operation in a great cause. It leaves, as its written memorial to the comparatively few whose names have been quoted in accounts of radar development, and to "the unnamed hundreds and thousands of other scientists, engineers and others who actually carried on the research development and engineering work", a new 'Five-Foot Shelf' not unworthy of a place below the original five-foot shelf of the 'Hundred Best Books'. The generous co-operation of an editorial-cum-author group of about sixty members, which remained at the Massachusetts Institute for more than six months after they might reasonably have chosen to return to their normal peace-time pursuits, and which was supported by a still larger body of contributing authors, has given us a twenty-eight volume series of which Prof. Louis Ridenour's "Radar System Engineering" is, appropriately, the first volume. Appropriately, because the five books dealing with radar and allied systems, and the twenty-two books dealing with special techniques, circuits and circuit elements, which with a twenty-eighth index volume fill the five-foot shelf, all spring from the parent stem of "Radar System Engineering", and are all contributing to the synthesis of radar engineering. The author's preface remarks that this volume serves to specialize to radar the techniques which are described in other volumes of the series.

Ridenour's book will continue to be the best book on the subject when the present and still too thin first crop of books on radar and allied topics has greatly increased. It is an admirably full and balanced survey, at once a general treatise substantially complete in itself, a reference book on design and a guide to the use of the more detailed but more closely canalized papers which are now being added to the tool-kit of the radio worker.

No comparable work has been published, or appears to be contemplated, in Great Britain. The only substantial body of published work on radar yet published in the United Kingdom is contained in the proceedings of the highly successful and stimulating Radiolocation Convention of the Institution of Electrical Engineers, supplemented by a few isolated volumes on special subjects. The British *ensemble* still falls short of being a balanced and comprehensive whole. The American *ensemble* has the enormous advantage of having been carefully planned, before execution, to ensure balance and completeness. It has the major merits, as well as the minor blemishes, of an enterprise in which the whole series is the work of a co-operative team, and in which the typical volume, like the volume under review, is itself the product of a team of authors, each an authority on the subject of which he writes. In the planning, the editing and the writing, the Radiation Laboratory team had the cordial co-operation of their British colleagues, and the author-writer of this volume acknowledges in particular the help of Dr. B. V. Bowden.

If the team method has produced some unevenness in standard, the lowest standard is still high and the average remarkably high. The section on the "Properties of Radar Targets" has no adequate counterpart in British published papers, and that on the "Minimum Detectable Signal" may be cited as an exceptionally searching synthesis of fundamental considerations in design.

The book is extremely well illustrated, and the wealth of photographs of P.P.I. (Plan Position Indicator) displays illustrating a great variety of technical and operational points of importance make a fascinating and excellent album of modern radar.

The book contains much the best, and indeed the only reasonably comprehensive account of the technique developed, in the latter stages of the War, for discriminating between the usually desired responses from moving targets and the usually, but not invariably, undesired responses from substantially fixed targets. This technique of 'moving target indication' will be of great importance in peace-time radar, as, for example, in maintaining continuous observation on civil air traffic by elimination of the 'ground clutter' of 'permanent echoes' which obscure or overlay aircraft echoes.

There is another 'clutter' phenomenon which imposes grave limitations on the general use of radar. The return of radar echoes from rainstorms is a well-known and quantitatively understood cause of impairment of radar search and surveillance. The general problem is well treated in a brief section which ends with a tantalizingly brief indication of results obtained by utilizing, as a discriminant between rain echoes and the echoes from ground targets, the fidelity with which the polarization of the incident radiation is retained in returns from spherical drops, as opposed to the changes in polarization produced by the ground targets. A fuller quantitative account of observations in adequately diverse conditions especially with echoes from aircraft would be welcomed by all radar workers.

This problem of rain-clutter is one, but only one, of a variety of considerations which lead to the only major criticism that can be levelled against the content of a volume entitled "Radar System Engineering". The editor-author says in his preface, "This book is intended to serve as a general treatise and reference book on the design of radar systems. No apology seems to be needed for the fact that it deals primarily—though by no means altogether—with microwave pulse radar. Thousands of times as much work has gone into pulse radar as into any other kind, and the overwhelming majority of this work has been concerned with microwave pulse radar. The superiority of microwaves for almost all radar purposes is now clear." What he means by "microwave" is clear; he means wave-lengths less than ten centimetres. What he means by "almost all radar purposes", if we are to agree with his conclusion, is much less clear. The variety of considerations referred to a moment ago may be journalistically summarized as ranging "from raindrops to V2". Nor was it merely the accidents of time and place that made a large majority of the radar equipment used in the final liberation assault on Europe work on wave-lengths greater than 10 cm.

The truth is that microwave radar is of extreme importance in a majority of all radar operations, but that radar equipments working on wave-lengths from 30 centimetres to about 10 metres are indispensable for operations of crucial importance which cannot be assured even by microwave radar.

There is, throughout the book, a generous and cordial appreciation of the British contributions to the development and application of radar in war. That generous cordiality has always characterized opinion at the Massachusetts Institute of Technology through all the variations of emphasis found elsewhere in discussions on radar history. It may be suggested that the Radiation Laboratory view is most happily enshrined in the emblem adorning the cover and the title-page of each volume in this impressive and satisfying series. The emblem shows the picture of a characteristic and cherished part of New England, the Cape Cod area, displayed on what even a Scottish reviewer may allow himself to describe as one product of Old England, the Plan Position Indicator, all surrounded, enshrined and defended by another product which its Australian-born inspirer would also gladly admit as a product of Old England, the anode of a resonant cavity magnetron. And integrally knit into this symbol of American-British interdependence in progress is the name of the great institution of which all British radar workers are as justly proud as are the American, the "Radiation Laboratory M.I.T., Cambridge, Mass., 1940–1945".

The book has few—remarkably few—errors; they will not mislead, and they will be corrected in the second edition which will certainly be demanded; they are negligible brush marks on a brilliantly successful piece of co-operative authorship. We join with the distinguished leader and inspirer of the Radiation Laboratory, Dr. L. A. Du Bridge, in the sense of his foreword: "to all those who contributed in any way to this great cooperative development enterprise, both in this country and in England, these volumes are dedicated". The monument is worthy of those to whom it is dedicated—and they were a great army of great men.

ROBERT WATSON-WATT

LANDSCAPE ARCHITECTURE

Land and Landscape

By Brenda Colvin. Pp. xii+266+106 plates. (London: John Murray, 1948.) 21*s*. net.

THE scenery of a long-settled country such as Britain is the result of the action and interaction of several factors. The background is provided by the relief and drainage of the land, the natural and semi-natural vegetation; the broad aspect is the result of economic use in the production of food and raw materials; but in detail the scenery is the result of man's conscious activities in the lay-out of his homes and their surroundings.

The term 'landscape architecture' is now commonly applied to work which is at once a science and an art. In planning a garden, small or large, still more in planning such an extensive area as an estate, the landscape architect requires to know and understand the scientific laws which have determined the surface form of the site and its vegetation cover before he can introduce those elements of design in which he uses living plants in order to obtain the desired effect. While it may be true that the formal garden never obtained quite the vogue in Britain which it had on the Continent, Britain abounds in mature examples of the work of landscape architects, especially those who laid out the great estates with their avenues of trees and their vistas, and which we associate particularly with the mansions built in the later part of the eighteenth century. Many of these carefully planned estates are to-day jealously guarded as part of our national heritage. Among the examples included in the album of photographs of Miss Colvin's volume we notice Blenheim and Chatsworth, but she does not forget to remind us that beech clumps on the chalk, such as Wittenham, or the informal landscape setting of Dinton House are also examples of landscape architecture, and she further reminds us that in detail the rock garden or the peculiarly English art of topiary must also be included.

Miss Colvin's book treats of a subject which it is extraordinarily difficult to expound, since it needs the clear understanding of the scientific principles involved on one hand and a balanced assessment of the æsthetic results on the other. Fashions change as much in landscape architecture as in architecture itself. Yet without attempting to decide between one style and another, there is at least a partial agreement on what constitutes 'good manners' in the treatment of landscape as there is in architecture.

In reading Miss Colvin's book one feels that behind a welter of words she is attempting to convey to the reader a philosophy which should underly any work of execution. One can learn much from having one's thoughts directed to some of the many examples she illustrates and describes; but the scientific reader will feel that she has failed to appreciate the meaning and influence of the natural laws which must govern the work of the landscape architect, and he is likely to show only impatience at what he may call a sentimental and subjective approach.

The book deserves the credit of being a pioneer in a difficult field. One would like to see a future development along the lines of a more adequate treatment of the scientific principles involved.

L. Dudley Stamp

RESEARCH ON MANAGEMENT

The Board of Directors and Business Management

By Melvin T. Copeland and Asst. Prof. Andrew R. Towl. Pp. xiii + 202. (Boston, Mass.: Harvard University, Division of Research, Graduate School of Business Administration, 1947.) 3.25 dollars.

In view of the widespread official and public interest in management as an important contributor to the solution of contemporary economic problems, it is to be regretted that so little has hitherto been done to ensure that the practice of management should be adequately supported by research. The controversy whether 'management' is a science or an art is largely academic and many people find it idle. Whatever its character, knowledge of the principles and methods of management, and improvements in its practice, can be obtained only from the collation and interpretation of experience, supplemented by systematic research. This is the approach customarily pursued in the natural sciences, and its value to the social sciences in general and to management in particular is more readily recognized in the United States than in Great Britain.

Copeland and Towl's book is evidence of the readiness of American universities and business corporations to collaborate in the conduct of research. It is a report on a research project; not one that has been carried out in an academic setting in terms of pure theory, but a practical investigation of certain aspects of higher management conducted in the setting of real life. The study starts from recognition of the fact that "a business corporation is inherently a social undertaking, in which several groups and divers personalities are assembled to work together to their mutual economic advantage". Among such groups is the board of directors, the group charged with responsibility for the formulation of policy and for the overall direction of the activities of the enterprise.

The different legal framework of American and British industry necessarily entails certain differences in the position and outlook of directors, but in the main the study resulting from this research is as pertinent and as valuable to British conditions as to those on the other side of the Atlantic. It can be briefly described as a review of most aspects of the functions of the board of directors, and of their attitude to their duties. It brings out clearly their primary responsibility for the formulation of policy, and stresses the corporate character of the board. The difference between a director as such and an executive in the organisation is also well brought out, and special attention is paid in later chapters to correcting misconceptions, as well as unfolding the 'unpleasant' tasks within the director's domain. So far as British conditions are concerned, the two common misconceptions of a director holding executive functions, and of a board being the gathering point for big names, are clearly diagnosed.

The authors round off their study by a chapter entitled "Some Questions which a Director may well ask himself". This is a factual list revealing the extent to which the research project was bedded in the actual practice of directors at work in a variety of industrial organisations.

The book can be safely recommended as a valuable contribution to literature, of value to the practising director, to the younger senior executive who has aspirations to the board, and even to those who are studying management as a matter of interest rather than preparing themselves at the moment for its higher levels. Perhaps the reviewer's only regret is that this particular study has come from American sources rather than British.

E. F. L. Brech

HUMOUR AND HUMANISM IN CHEMISTRY

Humour and Humanism in Chemistry

By Prof. John Read. Pp. xxiii+388+47 plates. (London: G. Bell and Sons, Ltd., 1947.) 21*s.* net.

As the author points out in his preface, "Humour and Humanism in Chemistry" is divided into three sections, the first two being approximately equal in length and dealing with alchemy and "chymistry", which the author defines as the transition from alchemy to chemistry, respectively. The last section deals with the chemistry of the late eighteenth and nineteenth centuries.

The first five chapters, which are concerned with alchemy, may be considered as an appendix to Prof. Read's "Prelude to Chemistry"; and they contain further interesting details and some expansion of matters already touched upon in the earlier work. There has been a tendency to ridicule alchemy and the alchemists; but however misguided some of them may have been, there is no doubt that important empirical discoveries were made by them, and they form a vital link in the chain of development by which chemistry graduated from an art to a science. The author shows understanding and sensitivity when dealing with these early workers.

The next two chapters (6 and 7) deal with such seventeenth- and eighteenth-century chemists as Jean Beguin, William Davisson, Johan Glauber, Nicolas Le Febure, Christopher Glaser, Nicolas Lemery and Herman Boerhaave. Prof. Read gives an account of the life and personality of each of these "chymical artists" and then details their main contributions to the literature of chemistry, with an analysis of the contents and relative importance of the works in question. This section of the book is particularly interesting, and is valuable because it stresses an important period in the development from alchemy to chemistry and shows how this development can be traced in the text-books written by these men.

The third and largest section of the book contains a wealth of interesting information but suffers somewhat from being disjointed. It opens with an account of Joseph Black's contribution to chemistry, and passing by way of Madame Marcet and her oft-reprinted text-book, leads up to a description of nineteenth century student life in the laboratories of the great masters Liebig, Bayer and Werner at Giessen, Munich and Zurich. A sympathetic evaluation of Sir William Pope's work and a good account of the man himself is followed by a chapter on Australia, dealing largely with the various eucalyptus trees indigenous to that country and the chemistry of the essential oils obtained from them. Finally comes an entertaining flight of fancy in the form of a "Chemic Drama in One Act".

The book, written in Prof. Read's customary charming style, is well produced and lavishly illustrated. DENIS I. DUVEEN

BIOCHEMISTRY IN PROGRESS

Annual Review of Biochemistry

J. Murray Luck, Editor; Hubert S. Loring, Associate Editor; Gordon Mackinney, Associate Editor. Vol. 16. Pp. xi+740. (Stanford University P.O.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) n.p.

THIS series of volumes continues to need no stimulus to its sales; all biochemists buy it or see it, or ought to. For the most part, as in previous years, the review for 1947 proceeds along familiar lines, with articles on biological oxidations, the chemistry and metabolism of the major foodstuffs, mineral metabolism, vitamins, hormones, and so on. But the editors always take care to vary the staple diet with something uncommon, and this year the 'bakemeats' include choline, anti-oxidants, animal biochromes (pigments to most of us, and why not ?), folic acid, anti-malarial drugs, and marine bacteriology. There is thus no lack of variety in subject-matter, which is treated throughout in the critical manner that reviewing of this kind demands, but does not always get.

Limitation of space does not allow the majority of the reviewers to go beyond their set task, that of discussing all the published work which has appeared since the last "Review"; all the more welcome, therefore, is an article on the use of isotopes in biochemical research, in which the snags of some methods, and the advantages of others, are freely and frankly canvassed on a platform of recent experiment, to the great profit of any reader who does not happen to be an expert in this field. It is to be hoped that this article is not the last of its kind.

The standard of the "Review", both in reporting and editing, is now so high that considerable suggestions for improvement are scarcely possible. But perhaps the editors might care to consider one small item. The bibliography attached to each article is so very useful to anybody wanting a quick conspectus of the subject that alphabetical arrangement of the authors would be an advantage. For the "Review" is not ephemeral, to be laid aside when the novelty of the contents has worn off; the back numbers are consulted by writers of books, papers and lectures, and much time can be consumed in searching through two hundred names for a single reference. It is true that some may prefer a bibliography to be arranged in the order of appearance of the references in the text, and for any but works of reference this system has much to commend it. But the "Review" is a work of reference. Already some of the articles have bibliographies alphabetically arranged; if some, why not all ? Doubtless the point has been made before, and anyhow it must not be allowed to stand between editors and reviewers and our thanks.

LOCAL GOVERNMENT AND THE CITIZEN

Local Government

By Sir A. S. MacNalty. (Home Study Books.) Pp. x+222. (London: Methuen and Co., Ltd., 1948.) 4*s*. 6*d*. net.

IN the new series of Home Study Books designed, under the general editorship of Dr. B. Ifor Evans, to cover "the most significant aspects of modern thought and investigation", two major considerations may be held to justify the inclusion of "Local Government" among the first seven titles: the close relationship between local government activity and the daily life of the citizen, and the negative attitude of a large proportion of the community towards the management of local affairs. Written with the view of assisting "men and women who are interested in the subject and who may be inclined, either as members or officials of local authorities, to devote their gifts to this important branch of national work for the common weal", this volume carries the insistent message that the effective co-operation of the private citizen is vital to progressive administration at local government level.

Since the book was written, developments have already taken place in the system of local government, and far-reaching changes are, of course, impending, such as those foreshadowed in the recently published second annual report of the Local Government Boundary Commission. The trend of such developments is discussed in a short final section on the future of local government, but the author's major purpose is to provide a historical background against which change may be seen in true perspective. The treatment, though authoritative, is not intended to be exhaustive, and since the book is "neither a textbook nor a legal treatise" the author delivers his own views on a number of live issues. He can fairly claim to have provided a comprehensive survey of the growth, structure and functions of local government, and the serious student will certainly want to add this book to his collection. It will perhaps be particularly valued for the special interest of the section on public health, in which the author's own experience speaks most clearly.

One curious omission may limit the book's appeal. Not a single chart, diagram or other form of graphic representation is used, although the subject so obviously lends itself to treatment of this kind. The average man or woman has grown to expect such aids, and the author who neglects to employ them when addressing the general reader places himself at an initial disadvantage. ERIC LOWE

The Atom

By Sir George Thomson. (Home University Library of Modern Knowledge, 145.) Third edition. Pp. viii + 196. (London: Oxford University Press, 1947.) 5*s*. net.

THIS is neither a text-book nor a 'popular' work, but a book of genuine educational value, in which present knowledge of atomic and nuclear physics is simply but clearly set forth, backed by the historical perspective of earlier ideas, and looking forward to the resolution of present difficulties by further experimental and theoretical development of the subject.

The writing of such a book demands nice judgment and strong determination to hold the balance between facts and theories, and to give no more than proper prominence to those parts of the subject that catch the imagination of the amateur. Sir George Thomson, as in previous editions of the book, has done this admirably and has given, in eighteen short chapters, a remarkably complete outline of modern knowledge of atoms and the electrons and nuclei that are their constituent parts. He never forgets that atoms are fundamental to chemistry as well as to physics, and the chapters on crystal structure, "The Atom in Chemistry" and "The Electron in Chemistry", are among the best in the book.

"The Atom", though quite an elementary book, deserves and indeed demands careful reading. Like the others in this series, it is meant for those who are prepared to think as well as to read. The thoughtful reader will not be satisfied with all the explanations of atomic phenomena that are offered; that is as it should be, for there are plenty of unsatisfying features in current theories. Sir George himself does not hesitate, on occasion, to envisage the overthrow of the views he is expounding; for example, he ends his discussion of the inherent limitations of physical measurement by speculating on "a probe more delicate than an electron", immune from its wave-like properties that he himself has done so much to establish and to use.

P. B. M.

Radio Data Charts

A Series of Forty-four Abacs providing most of the Essential Data required in Receiver Design. By Dr. R. T. Beatty. Revised by J. McG. Sowerby. Fourth edition, second impression. Pp. 93. (London: Iliffe and Sons, Ltd., 1947.) 7*s*. 6*d*. net.

THESE charts present in nomogram form the solution to many of the problems met with in the design of radio receivers and similar apparatus. The explanatory text accompanying each chart is brief but clear, and not only gives the formula upon which the chart is based but also provides a general background to the problem. The method of use of each chart is fully explained by means of a key and is illustrated by examples.

In this fourth edition five new charts have been added. One enables the frequency response of single tuned and band-pass circuits to be determined; another gives the coupling coefficient of intermediate frequency transformers; and a third the resonant impedance of a quarter-wave line. The other two are concerned with the design of resistance-coupled amplifiers. Of the remaining charts, five cover the interrelation between inductance, capacity and frequency in resonant circuits over a wide range of values and another group deals with the design of radio-frequency coils, including the effect of screening cans. Assistance in the design of mains transformers and chokes, output transformers, transmission lines and resistance attenuators is also provided. Data on the D.C. resistance of wires, the power dissipated by a resistance and the reactance of coils and condensers, together with scales for the conversion of frequency to wave-length and ratio to decibels, complete this comprehensive collection of 'abacs'.

The main features of this volume which commend it to the radio engineer are the ease and speed with which design problems can be solved and the way in which the effect of changes in the values of the parameters involved can be readily determined.

B. G. P.

Modern Magnetism

By Prof. L. F. Bates. Second edition, revised and enlarged. Pp. xi+440. (Cambridge: At the University Press, 1948.) 25*s*. net.

BATES'S "Modern Magnetism", first published in 1939, is widely appreciated as a general survey in which adequate attention is given to the experimental side. In preparing a second edition, the author's aim was that it should be reasonably up to date. Unfortunately, "the difficulties of the times made large-scale alterations of the existing pages impracticable", and the bulk of the new material, mostly on work published since 1938, is collected in six additional chapters, occupying about a hundred pages. These chapters deal with a wide variety of topics falling under the general headings of hysteresis, ferromagnetic substances, weakly magnetic substances, radiofrequency spectroscopy, adiabatic demagnetization, and paramagnetic absorption and dispersion. In view of the author's notable contributions in some of these fields, particular interest is attached to his presentation of cognate work; and the chapter on radiofrequency spectroscopy provides almost the only recent short survey of the elegant techniques applied in determining nuclear moments. The treatment in the new chapters is, no doubt, deliberately, somewhat uncritical; and the 'adding on' of the miscellaneous new material inevitably leads to some lack of coherence in the book. It is much to be hoped that conditions will later enable the author to reshape the book into an artistic whole. For the present, however, many readers will be most grateful to the author for collecting together so much interesting information about recent work in magnetism.

E. C. S.

The Romance of Rhodesia

Being the Impressions of a Sight-seeing Tour to Southern and Northern Rhodesia *via* Seychelles, Mombasa, Zanzibar and Dar-es-Salaam. By Ardaser Sorabjee N. Wadia. Pp. xiv+146+16 plates. (London: J. M. Dent and Sons, Ltd., 1947.) 21*s*. net.

MR. WADIA'S ready pen has this time been turned to describe a tourist trip to Rhodesia that was made before the War. He departed rarely from the conventional tourist route, and his brief sketch contains little that is new in factual information. Mr. Wadia touches frankly, however, on many of the problems that Rhodesia and other parts of Africa have to face. Thus he has reflexions on racial discrimination, the colour problem, the scope of missionary endeavour, and especially of the problem of Indians in South Africa. Generally he is critical of existing relations between races, but supports British rule. His criticisms are worthy of attention. The book is beautifully illustrated.

SIGNIFICANCE OF NUCLEAR CHANGE IN DIFFERENTIATION

By Dr. K. MATHER
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IN the process of differentiation, cells derived from a common ancestral cell take on different, though mutually adjusted, forms and functions. Some determinants must therefore change during this process in either the cytoplasm or the nucleus, or, of course, both. The genetical problem of differentiation is to discover what the properties of these determinants are, and how they are related to those other determinants, the genes, the permanency of which we recognize by their transmission from generation to generation in sexual reproduction.

There is a growing body of evidence that differentiation is at times, though by no means always, accompanied by changes in the nucleus. These changes appear to be of three main kinds: changes of elimination, replication and manifestation.

Changes of elimination involve specific whole chromosomes or specific parts of chromosomes, in which latter case the process is more commonly called diminution. Elimination is a rare occurrence, most cases being known in the Diptera[1]. In *Ascaris*, where the process is properly diminution, it affects every chromosome at the second to fifth cleavage divisions in those cells ancestral to the soma, the cells of the germ line showing no change. In *Miastor* only whole chromosomes are eliminated, 36 disappearing out of 48 from the somatic line at the third and fourth cleavages in females, and 42 out of the 48 in males[2]. Other Cecidomydæ behave in essentially the same way[3]. There is a possibility that this change in the Cecidomydæ is only one of reducing a polyploid nucleus to a diploid or haploid condition, so being unspecific for members of the basic complement. In *Sciara*, as in the Cecidomydæ, the elimination again differs according to whether the individual will become male or female; but it goes on over a longer period of development, and at least one chromosome, and possibly more, is eliminated in the germ track. In this fly, too, the members of the basic set are differentially eliminated, and genetical evidence shows further that even homologous chromosomes behave differently, those of paternal origin being eliminated while maternal chromosomes remain. One case of elimination is known in plants, supernumerary chromosomes vanishing from the nuclei of what we may call the root line in *Sorghum*, but remaining in at least part of the shoot line, from which, of course, the reproductive cells develop[4].

It thus appears that elimination essentially brings about a difference between the nuclei of germ line and somatic line, the former obviously retaining the full complement of chromosomes, except in *Sciara*, where the loss in the germ line is offset by later and equally remarkable multiplication. In no case is there evidence that the nuclei of the various somatic tissues characteristically have different chromosome complements as a result of further elimination. The precise function of the eliminated chromosomes or chromosome parts is not clear, but in *Ascaris*, and probably in *Sorghum* too, they are heterochromatic[5], and hence presumably lacking in major genes.

Changes of replication are in nearly every case non-specific, all the chromosomes showing the change equally. The chromosomes divide more often than does the nucleus. This leads to polyploid nuclei where the centromeres divide with the chromosomes, and to polytene nuclei, the chromosomes of which have multiple strands as in the salivary glands and other tissues of *Drosophila*, where the centromeres do not divide. The difference between polyploidy and polyteny is thus a minor one from our present point of view, and the two are conveniently pooled under one name. Two such names appear to be in use, and of them endopolyploidy is preferable to polysomaty, for the latter might easily become confused with the term polysomy, which has an entirely different meaning. Sometimes, also, the nucleus may divide without the cell doing so, so giving a third variant, the multinucleate cell or coenocyte[6].

Replication seems commonly to mark the end of active cell division and the onset of differentiation, and White[1] states that the various tissues of insects all have their characteristic degrees of endopolyploidy, some being mosaics of different multiples of the original number of chromosomes. He regards it as likely that the phenomenon is widespread in other animal groups. It is also fairly common in plants, particularly, it would appear, in cortical tissues[7,8]. Here again mosaicism is frequent, and one of its genetical consequences is the production of a proportion of tetraploid shoots among the diploids regenerated from callus originating in the cortex of decapitated tomato stems. The reverse of replication seems also to occur, though less commonly. Apart from the possibility that elimination in the Cecidomydæ is a change of this kind, equal reduction, by what must be tantamount to somatic meiosis, has been recorded in *Culex*[9] and in onion and barley roots, especially in the latter case after treatment with growth substances[8].

We have already noticed that changes of replication are generally non-specific or balanced; but in a few cases replication is confined to specific chromosomes. The so-called X doubles itself once oftener than any other chromosome at meiosis in normal male *Sciara*, and the X of *Drosophila* does the same when the males are carrying the 'sex-ratio' super-gene. In *Sciara* this behaviour compensates for an elimination early in the germ track, and in sex-ratio *Drosophila* the Y is eliminated simultaneously[10]. This relation of specific or unequal replication and elimination may well be significant in animals. It has been claimed that similar replication also occurs in the root tissues of certain orchids where no elimination is known, but the evidence for this behaviour cannot be regarded as final[11].

Changes of manifestation strictly involve no alteration in the number or balance of the genes. A typical example is afforded by the different rates of condensation of the chromosomes in the two daughter nuclei produced by the first division in pollen grains. This difference depends in no way on a genetic inequality between the nuclei, for sometimes by either accident or treatment the spindle is formed 90° out of its true line and then the nuclei condense at equal rates. A cytoplasmic gradient must be the cause of the difference[12]. The difference between two daughter nuclei, one destined to divide again and the other not, at the margin of a meristematic region also marks a change of manifestation, as must many differences of chromosome size and contraction. Some of these changes, such as that concerning future division, must affect the chromosomes equally, but in others heterochromatin and euchromatin may behave differently.

Changes of manifestation, though not themselves involving changes of genic number, may be associated with other changes that do. Thus the daughter nucleus, the fate of which it is to divide no further, may undergo a change of replication. Also the chromosome fragmentation which immediately precedes diminution in *Ascaris* would seem properly to be regarded as a change of manifestation, for of itself it involves no change in the genes (apart from a possible change in position effect), but only a partial breakdown of their linear organisation. It, too, seems to depend on a cytoplasmic gradient like the difference between the pollen grain nuclei[13].

What is the significance of these various changes for our understanding of differentiation ? To answer this question we must see that it consists of two parts, and ask not merely what are the effects of the changes, but also what are their causes.

On the various occasions when it has been recorded that nuclear change accompanies differentiation, there has usually been a suggestion, implicit in the presentation rather than explicit in the statement, that the process of differentiation was an effect of the change in the nucleus. This suggested relation is seldom capable of the direct test of experimental breeding, for the differentiated cells and tissues cannot usually be induced each to regenerate an individual organism sufficiently complete for its genetic constitution to be ascertained. Even in plants, where asexual propagation is possible from roots, shoots and even leaves, regeneration is most often from complexes of different tissues. Nevertheless, when all the myriad examples of asexual propagation afforded by everyday horticulture are taken into account, the conclusion seems inescapable that in plants, with the exception of occasional polyploidy, the cells and tissues are genetically alike. Nor can polyploidy, nor any form of endopolyploidy, be regarded as a type of change intrinsically likely to produce differentiation. Polyploidy is one of the most common differences between individuals in plants, and is also known in a number of animals like flies and newts. Apart from the upsets of sexual development predictable from their detailed chromosome constitutions, the polyploid individuals have a normal structure with all the customary tissues developing and co-operating in the customary fashion. Indeed, it often requires a practised eye to distinguish diploid and polyploid by inspection. Whatever their other significance, changes of replication can scarcely be taken as a cause of differentiation.

The case against changes of elimination is a little different. Where they occur, they are commonly associated with a major dichotomy in the fates of the cells, to give soma as opposed to germ line, or root as against shoot. The soma, or the shoot, has, however, itself a host of differentiated tissues associated with no further elimination. Also, as we have seen, elimination is a rare phenomenon, and its counterpart, unequal replication, even rarer. Thus even if elimination (or unequal replication) should in truth cause the differentiation with which it is associated, another and more general cause must still underlie most tissue differences. Furthermore, genetical experience shows that, like polyploidy, monosomy and polysomy in a wide range of plants and animals can characterize whole individuals, all of the tissues of which differentiate and co-operate sufficiently well for viability (though admittedly with rare exceptions all monosomics and polysomics are somewhat abnormal in form and may even be inviable where the genic unbalance is too great). In these species simple elimination could scarcely account for differentiation.

It might, of course, be argued that these observations should be given little weight, that physical elimination or unequal replication as a cause of differentiation is a phenomenon of individual genes rather than of whole chromosomes or of large segments of chromosomes. To do so would be to postulate a process for which there is no independent genetical or cytological evidence. Nor could it give a complete account of the process, for we should still be faced with the problem of why the genes were eliminated or multiplied differentially just at the appropriate times. Indeed, no hypothesis which makes differentiation the outcome of elimination or multiplication, whether balanced or unbalanced, affecting chromosomes, segments or individual genes, can be regarded as satisfactory, for it leaves unexplained the cause of the nuclear change itself. In adopting such a view we should merely replace one genetical problem of differentiation by another. The answer to our question must be sought in another direction, one to which changes of manifestation point the way.

We now have a wide range of evidence to show that the behaviour of a cell depends immediately not on its nucleus, but on its cytoplasm, which, though ultimately determined by an associated nucleus, may be acting in a manner reflecting the nucleus of a past association rather than that of the present. This persistence of the effect of a nucleus in the cytoplasm shows us that the nucleus, though remaining constant in its genetic content, can have a changing effective action. It is constantly acting on and altering the cytoplasm, so that the circumstances in which it finds itself are altering and with them the future effect of its action[13,14].

The nucleus itself affords a sensitive test of the constitution of the cytoplasm, so sensitive that it enables us to detect differentiation within the cell, as we have already seen in pollen grains. Indeed, we have several lines of evidence showing us how the fate of the nucleus depends on the cytoplasm. The timing of nuclear processes in great blocks of tissues, like the spermatogonia of animals, must be brought about through the cytoplasmic connexions of the cells. Pairs of pollen grains with nuclei showing complementary unbalance (5 and 7 chromosomes in place of the normal 6 in *Rhœo*[15], and 6 and 8 or 5 and 9, etc., in place of the normal 7 in *Uvularia*[16]) can live and their nuclei divide so long as they have cytoplasmic connexions through which the products of locally unbalanced gene action can be evened out ; but they die when the cytoplasmic connexion

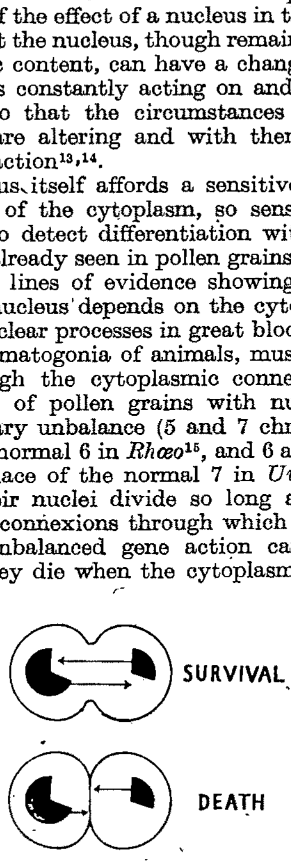

Fig. 1. PAIRS OF POLLEN GRAINS THE NUCLEI OF WHICH SHOW COMPLEMENTARY UNBALANCE, ONE CARRYING IN DUPLICATE THE CHROMOSOMES FOR WHICH THE OTHER IS DEFICIENT, CAN SURVIVE AND THE NUCLEI CONTINUE TO DIVIDE PROVIDED THAT WALL FORMATION IS NOT COMPLETE SO THAT THEY ENJOY A CYTOPLASMIC CONNEXION. WITH COMPLETE WALL FORMATION AND LOSS OF THE CYTOPLASMIC CONNEXION THEY DIE

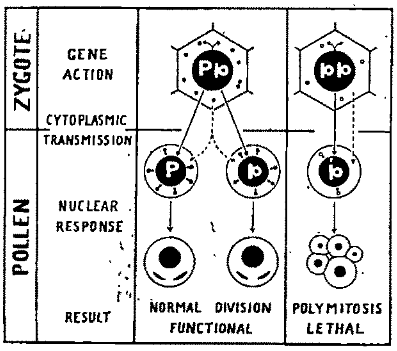

Fig. 2. POLYMITOSIS OF THE NUCLEI IN MAIZE POLLEN GRAINS DEPENDS ON THE ACTION OF A RECESSIVE GENE IN THE SPOROPHYTE. THE NORMAL OR POLYMITOTIC BEHAVIOUR OF THE POLLEN GRAIN'S NUCLEUS DEPENDS NOT ON THE GENE IT CARRIES, BUT ON THE CYTOPLASM THE POLLEN GRAIN INHERITED FROM ITS PARENT ZYGOTE, WHERE THE CYTOPLASM'S CONSTITUTION WAS DETERMINED BY THE ACTION OF THE DIPLOID NUCLEUS WITH WHICH IT WAS THEN ASSOCIATED

is lost (Fig. 1). Furthermore, the cytoplasm can, in its regulation of nuclear processes, reflect the action of a gene no longer contained in the nucleus. This we can see in Beadle's[17] polymitotic maize, where plants homozygous for the gene produce pollen grains all the nuclei of which undergo premature supernumerary divisions. The chromosomes do not show corresponding divisions, so that the nuclei come to contain reduced numbers of chromosomes, some, in fact, having only one. The result is a group of pseudo pollen grains which all die. Plants heterozygous for the gene must produce two genetically different kinds of pollen, one of which will be like the lethal polymitotic pollen borne on the homozygous plants. But none of this pollen shows polymitotic behaviour. Thus polymitosis is like incompatibility in heterostyled plants[18]. The nuclei of the pollen grains do not determine their own fate. Their behaviour, normal or polymitotic, is determined by the cytoplasm transmitted from the parent zygote, where, however, its constitution was determined by the diploid nucleus with which it was then associated (Fig. 2). This principle even applies to the process of elimination, for the loss of one or two X's, to give females or males, depends in *Sciara* on the genic constitution of the mother, from whom the cytoplasm must have been derived even though the determining gene may not have been passed on to the individual showing the elimination.

Changes of manifestation, which have no direct effect on genic constitution, and so can never of themselves cause differentiation, thus show us how the cytoplasm of one cell can be differentiated so that the fates of the daughter cells will depend, not on which daughter nucleus each obtains (for these will be alike), but on which part of the cytoplasm each inherits. By the aid of these changes we can see how the continuation and adjustment of the processes of nuclear division depend on the cytoplasm, and hence how endopolyploidy can be a response to the condition of the cytoplasm. We can even see how elimination is but another example of cytoplasmic control. Finally, we can see how the cytoplasm, in determining these changes of the nucleus, is itself reflecting the past action of that same nucleus or of some other nucleus with which it has been earlier associated.

All these nuclear changes can be interpreted as responses to an accomplished differentiation of the cytoplasm, and many of them, indeed, demand such an interpretation. The nuclear change is but a consequence of the earlier action of the unchanged nucleus. Differentiation is neither generally nor necessarily dependent on the physical elimination or unequal multiplication of the genes and chromosomes to produce what would be seen in a complete individual as a genetic unbalance; it depends on the physiological reduction or enhancement of gene action by the constitution of a cytoplasm itself reflecting the earlier action of these same genes. The nuclear changes we see are special effects rather than general causes of differentiation. They are special examples of the general process to which all differentiation must be referred.

As an organ the nucleus, like other organs, is part of the phenotype and its behaviour is under the control of its own genes acting in their customary fashion through the cytoplasm. It is true that the phenotypic changes of the nucleus may have a special significance in that some of them might mean changes of the genotype. But this should not blind us to the fact that, even though these secondary changes of genotype may have an adaptive significance in some special cases like *Sciara*, they are nevertheless still secondary. They still depend on a previous change of the nucleus acting as phenotype to the genotype it carried in its earlier and unchanged form. Only if we are careful to distinguish between these two aspects of the nucleus, the recently understood phenotypic as well as the long appreciated genotypic, can we hope to assess the true significance of nuclear change in differentiation.

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BIOLOGICAL ASPECTS OF WATER POLLUTION

AT a meeting of the Association of Applied Biologists on March 22, five papers were contributed to a symposium on "Biological Aspects of Water Pollution".

Dr. B. A. Southgate, who introduced the subject, said that it includes the treatment of sewage and industrial wastes, the effect of effluents on natural waters to which they might be discharged, and the treatment of polluted water to render it fit for drinking or for other use.

The constituents of domestic sewage are mainly derived from fæces, urine, paper, soap, and vegetable and animal matter. In towns, these are usually augmented by the constituents of gas works liquor, which contains thiocyanate, phenols, ammonia and sulphide, and of such trade wastes as are associated with industries peculiar to the town. Effluents from manufacturing processes may contain a variety of substances in solution, such as metals or complex cyanides from the metal and electro-plating industries, or plant extracts from such operations as the retting of flax or the washing of vegetables before canning or drying. Colloidal and suspended material is derived from a number of sources, including soil and plant debris.

It is important for several reasons that such wastes should be adequately treated before discharge to surface waters, which are the chief source of domestic water supplies. A high standard of quality is frequently necessary, too, for an industrial water supply, and cases are known in which an industry has had to be moved to a fresh location because the river from which its supply was drawn had become polluted. The purity of rivers is important also to agriculture and to inland fisheries.

In the biological treatment of sewage, purification is effected by interaction of the sewage with the biological film of a percolating filter or with flocs of activated sludge. In both types of treatment bacteria, fungi and protozoa play an essential part, and in the percolating filter the scouring action of worms and fly larvæ is also necessary. Certain types of industrial waste are amenable to separate biological treatment, under anaerobic or aerobic conditions, and some can be so treated that they can be re-used in industrial processes. Inorganic substances such as chromates and cyanides, if present in industrial wastes in appreciable amounts, often have to be removed by chemical means before the effluents are discharged to streams or to sewers.

Dr. L. A. Allen, who dealt with some microbiological problems of the treatment of sewage and trade wastes, said that microscopic examination of the biological film from a percolating filter, or of an activated sludge floc, reveals a mass of bacteria and fungal hyphæ, embedded in gelatinous or mucoid material, together with smaller numbers of protozoa. This material presents to the sewage with which it comes into contact a large and active biological surface which adsorbs a large part of the colloidal and dissolved substances. Microbial metabolism then results partly in oxidation of the adsorbed material and partly in its conversion to fresh cell substance, leading to an increase in the quantity of film or sludge.

Even under most favourable conditions, the effluent discharged to a river from a sewage treatment plant may contain several hundred coliform bacteria per ml. It has been observed, however, that in the course of a few miles natural processes in the river frequently reduce the fæcal organisms to a small fraction of the number discharged. Such an effluent cannot be treated with chlorine to destroy bacteria without first considering the possible effects on the life of aquatic organisms. With some effluents, for example, a dose of chlorine much smaller than the chlorine demand is sufficient to make the liquid highly toxic to fish.

Three examples of trade wastes were chosen to illustrate different types of microbiological problems.

Effluents from dairy premises are particularly liable to cause blocking of percolating filters, the high proportion of carbohydrate resulting in excessive growth of biological film. Investigation has shown that if this film, which consists largely of a tough mat of fungal mycelium, be subjected to starvation, the protoplasm becomes concentrated in certain cells of the mycelium, leaving others empty, thus weakening the mechanical strength of the fungal mat, which quickly disintegrates. In practice, this period of starvation is ensured by employing two filters in series, the effluent from the first filter being fed to the second filter. At suitable intervals the order of the filters is reversed. By this process—now known as alternating double filtration—it is possible to treat certain liquids at three or four times the normal rate.

Disposal of highly polluting waste liquors from the retting of flax has been avoided by subjecting the liquid to continuous aeration during the process of retting. Bacterial oxidation prevents the liquor from becoming acidic and foul-smelling, and reduces the content of organic matter, so that the liquid can be re-used for successive batches of flax.

In the manufacture of beet sugar, the practice of re-circulating the waste waters to diffusers in order to avoid discharging them leads to corrosion in the re-circulation system. Investigation has shown that this is due to formation of acid by thermophilic lactobacilli which can be prevented from growing by applying chlorine to the contents of the battery supply tank or by maintaining the re-circulation system at a sufficiently high temperature.

Mr. T. G. Tomlinson described the percolating filter as an artificial habitat in which both terrestrial and aquatic organisms are found in far greater abundance than in their natural surroundings. The types of fungi which predominate there are largely determined by the character of the liquid being treated. *Saprolegnium*, for example, is encouraged by domestic sewage and by waste waters from processing of food but is inhibited by the trade wastes from large towns; in filters treating the latter, it is usual to find instead two species of *Sepedonium*, characterized by tuberculate chlamydospores, accompanied by *Ascoidea rubescens*, which often produces large ovoid conidia. *Fusarium aqueductum* occupies a rather special place in the surface flora of percolating filters because its holdfast, prostate system of filaments enables it to cling firmly to the medium when washed by the jets of liquid from the distributor.

The population of protozoa shows a gradation throughout the depth of the filter. Polysaprobic zones at the surface contain *Opercularia*, *Paramecium caudatum*, *Colpidium*, and *Glaucoma*. In the mesosaprobic zones lower down are *Aspidisca costata*, *Euplotes*, and testaceous rhizopods; rotifers are found towards the bottom.

Of the Oligochæta, *Lumbricillus lineatus*, a small red worm possessing hæmoglobin, occurs universally in percolating filters throughout the whole year. The handicap of a long generation time and low fecundity is compensated by a low metabolic rate and a strongly gregarious habit.

Among the more numerous insects are two species of *Psychoda*, two of *Spaniotoma*, two of *Metriocnemus*, *Anisopus fenestralis*, *Anisopus collembola*, *Achorutes subviaticus*, and *Tomocerus minor*. The controlling factor in the balance of these species is the amount of film, which in turn depends on the rate at which sewage is applied to the filter. During the warmer months *Psychoda alternata*, with a life-cycle of four weeks at 15° C., and of two weeks at 21° C., is dominant. *Anisopus fenestralis* develops more slowly than *Psychoda*, requiring three months for completion of its life-cycle at 10° C., but its larvæ remain active at temperatures below 10° C., so that eggs laid in late autumn may give rise to a generation which matures slowly throughout the winter and emerges in the spring.

Dr. Ll. Lloyd, describing the part played by insects and worms in the disintegration of the biological film in a percolating filter, said that whereas in winter surface growth is usually much in evidence and the medium is slimy throughout the depth of the filter, in summer the same medium often appears perfectly clean. In general, depletion in the quantity of biological film has no effect on the efficiency of the filter.

The effect of film depletion is reflected in the behaviour of the flies, and a very good example is afforded by the study of species of *Psychoda* at Leeds. Here the number of *Ps. severini* reaches a peak in May but is small at any other time of the year. *Ps. alternata* shows a peak in June which is followed by a steady decline, and the sequence is then taken up by *Spaniotoma minima*, which builds up an enormous population in the autumn. If the supply of food is sufficient, all three species will breed abundantly from spring to autumn; curtailment of the food supply tends to restrict development, the species which predominates depending on factors which give it a seasonal advantage over its competitors. Introduction of midges (*Metriocnemus* species) introduces a complicating factor. Although essentially grazers on film, they take readily to a predatory habit and when present they tend to restrict the numbers of the three species of flies just mentioned.

There is also some evidence that food supply affects the size of flies. In the absence of other factors, size depends on temperature, wing-length increasing by about 2 per cent for each fall of 1° C. in later larval life. In fact, however, the steady increase due to this factor in the size of flies emerging from August onwards shows periodic interruptions which suggest the effect of shortage of food.

Mr. F. T. K. Pentelow said that the effects of pollution on fisheries may result from damage either to the fish themselves, to their spawn or spawning ground, or to their food. Conclusions from toxicity experiments are complicated by the fact that toxicity is greatly affected by the concentration of such substances as calcium in the diluting water, by the concentration of dissolved oxygen, and by the temperature. An idea of the toxicity of different substances is given by the following figures, which express, in parts per million, the concentrations found to be toxic to trout under average conditions: cyanide, 0·15; sulphide, 1·0; chlorine, 0·2; phenol, 9·0; sulphuric acid, 10·0; *para*-cresol, 6·0; 1.2.6 xylenol, 10·0; the toxicity, to sticklebacks, of copper is about 0·02 and of zinc about 0·3.

The mode of action of poisons varies widely. Cyanide, for example, destroys the enzyme responsible for transferring oxygen from the blood to the tissues, phenols and cresols appear to be nerve poisons, and heavy metals prevent respiration by coagulating the mucus over the body and gills. With some poisons the toxic action is reversible, affected fish recovering after transference to fresh water, but with other substances it is not. Thus, a shoal of fish subjected to the action of phenol from a temporary discharge of gas liquor might easily recover if the current carried them to a zone of cleaner water, but fish affected by discharge of chlorine or ammonia in similar circumstances would die. The behaviour of fish towards a particular substance is no criterion of its toxicity. They will, for example, keep strictly away from waters containing the less toxic zinc salts, but are so indifferent to the presence of the highly toxic copper salts that they are rapidly killed.

Bacterial oxidation of discharged organic matter results in depletion of oxygen in the river water. Though fish may not be actually asphyxiated until the oxygen content falls to between 0·1 and 0·2 part per 100,000, in practice it is frequently found that fish are absent from waters in which pollution has reduced the value to about 0·5 part per 100,000.

The effect of pollution on spawn and spawning grounds is almost unknown territory, but more is known about its effect on fish food. In general, pollution of streams by organic matter frequently results in replacement of the characteristic flora and fauna by other types, but without necessarily reducing the total quantity of material acceptable to fish as food. Pollution by inorganic substances is a very different matter. For example, discharge of copper wastes to a stream has been known to render it unable to support the life of trout, even in zones downstream where the concentration of copper is much too small to be directly toxic; this is because the copper has destroyed the animal life on which carnivorous fish like trout depend.

THE ROYAL ACADEMY, 1948

By Dr. A. TINDELL HOPWOOD
British Museum (Natural History)

SOCRATES once likened books to pictures because, "the creatures of the latter art stand before you as if they were alive, but if you ask them a question, they look very solemn and say not a word". To an argumentative old man the lack of response was deplorable; but to the pictures themselves, had they been sentient, it would assuredly have been the height of wisdom. Many a canvas would be covered with confusion, and mantled with blushes, were it suddenly to be faced by Socrates and to hear the dread question, "Why were you painted ?" Imagine the unease of the self-confessed pot-boiler, the tearful admission of the failures, and the venomous hatred of the shams. No, it is just as well that pictures cannot reply in words. On the other hand, our questions are not left entirely unanswered; but some degree of skill is needed to decipher the very solemn faces masking the replies.

Now, morally there is nothing wrong with an honest pot-boiler. A certain snobbish section of the public is only too ready to repeat hollow phrases about 'art for art's sake', without pausing to reflect that artists, like other men, must eat. Provided that the painter of a pot-boiler has the pride proper to a good craftsman, he plays a useful part in life, even though he does not produce a masterpiece. After all, and we may just as well admit it, none of the great masters of the past, not even Rembrandt or Turner, was consistently inspired; many a picture to which a famous name is attached is to be valued for its craftsmanship rather than for its genius. So let us praise honest craftsmanship wherever we find it, rather than indulge in unkind sneers at the unfortunate whose inspiration has forsaken him for a while.

Failures and shams are another matter; each reflects upon the character of its author. The failure exposed to public view argues a lack of that sensitivity which is necessary for the recognition that success has eluded one's efforts. As for the painters of shams, it can only be hoped that their spirits may meet with Socrates in the shades: that were punishment infinitely worse than the torment reserved by Dante for the hypocrites.

Why all this? Well, it's a dull Academy this year, and I do not like dull academies. Good ones are exhilarating, bad ones can be interesting; but dull ones are just dull. Perhaps the hanging is not quite up to standard, and the hanging can make or mar an exhibition. Indeed, the skill and knowledge needed to hang a single wall well, let alone a whole room, seldom receive the recognition which is their due. As a rule, visitors are so busy with the details that they spare no thought for the whole. On the other hand, every experienced gallery-goer has memories, either of good pictures spoiled by bad hanging, or of mediocre pictures vastly improved by good hanging.

Some may remember a certain north wall in one of the Academy's own rooms that was a masterpiece of the hanger's skill a few years ago; two pictures, which normally would have been pushed into a quiet corner, were put in the very centre of the wall, and their sophisticated crudity of colour allowed to lose itself among pictures of an entirely different type and key. The arrangement of that wall revealed the touch of a master; but this year it seems that some of the best pictures are overshadowed, perhaps outshone would be the better word, by the stronger colour of less meritorious neighbours.

The first thing to strike the eye as one ascends the staircase is a curious, whitish, skeletonized structure dominating the Central Hall; actually it is a ferro-concrete version of Bellerophon astride Pegasus, but it also serves to suggest that we begin with the sculpture for a change. Two portraits are of particular interest. One is "Sir Alexander Fleming, F.R.S.", by E. Roland Bevan, and the other "The Viscount Nuffield", by Maurice Lambert. This latter is remarkable for the skill with which the problem of combining originality of treatment with the conventions of formal statuary has been solved; as proof of the sculptor's versatility there is "Starbird" in the South Room. The Lecture Room contains many pleasant pieces; among them are several good figures of animals. "Hunting Leopard" and "Cheetah", both by Pamela Ascherson, "Friesian Bull" and "Complacent Cat", by Marjorie Drawbell, "Cat" by Richard Garbe, and "Falcon" by John M. Luxmore, are only a random selection.

The Lecture Room leads into Gallery IX, the black-and-white room, which contains four drawings of antelopes by Frank Dobson, those of the "Kenya Impala" and the "Black Buck" being particularly good. Barbara Greg's pen and wash drawing of "Adelaide Crescent, Hove", which hangs a few feet away, deserves a better place than it occupies at present. Her woodcut, "A Meeting of the Hell-fire Club", is less successful.

As a rule the Architectural Room contains smaller pictures by lesser lights; but this year there is an imposing array of academicians to keep them company and to spur them on to greater efforts. Here hang "The Blue Sitting Room, Trent Park" by Winston S. Churchill, and "Herrings and Lobster" by Edward le Bas, as well as "Kippers" by Robert H. Hurdle—a newcomer, I think—whose "Round Table: Still Life" in Gallery IV is one of the best pictures of its type in the exhibition.

Of the younger artists, as I judge them to be, Lionel Miskin (No. 30) and Kenneth Martin (No. 42) seemed to be the best in the first room, and Ernest Sandoe (No. 35) is better this year than last. In Gallery II "The Interval", by Jean Primrose, more than maintains the high level of her pictures last year; "Bannockburn", by Colum Gore-Booth, also deserves a word of praise.

Gallery III is, of course, the main room, and one does not expect many beginners to grace its walls; but two pictures by less well-known painters ought to attract favourable attention; they are "A Present from Provence", by Enid Solomon, and "The Bay", by Adrian Hill. Mr. Churchill's "Blenheim Tapestries" is not so satisfying as his "Goldfish Pool, Chartwell", in the previous room. In portraiture, Henry M. Carr vies with Sir Gerald Kelly, pitting his "F.-M. The Viscount Alexander of Tunis" against the latter's "Sir Malcolm Sargent": one feels that each was completely absorbed in his sitter.

Among paintings in other rooms are "The Fiddler", by Violeta Janes, and "Copying at the National Gallery", by Douglas Mays, both in Gallery V. Apparently this is the first time Miss Janes has exhibited, whereas Mr. Mays, who is 'on the line', made his first appearance last year.

The water-colours, in the South Rooms, are an attractive and varied display. Vivian Pitchforth and John Nash are a continuing inspiration to many, though few come anywhere near them in execution or content. Of the others, I particularly liked "Suffolk Landscape", by Rowland Suddaby, Dorothea Maclagan's flower pieces, "Haze Lifting, Newhaven", by Hadley Rowe, "Propeller Stacks, Deptford Creek", by Innes Meo, and "Cotswold Landscape", by Elizabeth Sorrell.

OBITUARIES

Dr. H. W. Richmond, F.R.S.

Herbert William Richmond, the eminent geometer, died of heart failure in the Evelyn Nursing Home, Cambridge, on April 22, at the age of eighty-four. At the time of his death he was senior fellow of King's College, Cambridge, where he had resided almost continuously for sixty-five years. The only substantial break in this long period of residence was during the First World War, from 1916 until 1919, when he worked at ballistics at Portsmouth with A. V. Hill and the late Sir Ralph Fowler; during this period he helped to make important contributions on the effects of winds on high-angle trajectories and the effects of spin on the motion of a shell. The last-mentioned work was done in conjunction with R. H. Fowler, E. G. Gallop and C. N. H. Lock; it was published in the *Philosophical Transactions of the Royal Society*, and afterwards became a classic. After the War he edited at Cambridge the confidential "Text-Book of Anti-Aircraft Gunnery", Vols. 1 and 2.

Richmond was born on July 17, 1863, at Tottenham (Middlesex), at Draper's College, of which his father, the Rev. Wm. Hall Richmond, was headmaster. He was educated at Merchant Taylors' School (1875–82), and went up to King's College, Cambridge, in 1882 with an Eton scholarship thrown open on this occasion. In 1885 he was Third Wrangler in Parts 1 and 2 of the Mathematical Tripos, and he was placed in Division I of Part 3 of the same Tripos six months later. He was elected a fellow of King's in 1888, and remained a fellow for the rest of his life. He was lecturer in mathematics at King's from 1891 until 1927, and University lecturer at Cambridge during 1901–19 and again during 1926–28. He was elected a fellow of the Royal Society in 1911. He was president of the London Mathematical Society for 1920–22, and he received the honorary degree of LL.D. from St. Andrews in 1923.

Richmond's mathematical interests lay chiefly in the fields of pure and algebraic geometry. He has left it on record that the side of geometry that appealed to him and fascinated him, in his undergraduate days and later, was the algebraic geometry of Steiner, Hesse, Cayley and Salmon—the geometry of cubic and quartic curves and surfaces worked out by methods of elementary algebra. This (he went on) was not exhausted, but was largely worked out, as he discovered when he went on to research, although a new field of research was opened up in geometry of four dimensions. Richmond's skill lay in the discovery of relations between apparently dissimilar groups of theorems, and his papers achieved much with notable economy of effort. He never failed to be interested in chains of theorems in plane geometry; but he also took pleasure in deducing theorems in the theory of numbers by geometrical methods. He was wont to consider the modern pure mathematician's restriction of interest to the *positive* integers as artificial and as reducing the geometrical implications of such theorems as Waring's. He continued his output of original work up to shortly before his death.

Richmond had a deep love for music—he devoted himself to this for a period after taking his degree. He also took a keen delight in all living creatures, and he was no mean naturalist. In his earlier days he went regularly to the Orkneys and Shetlands to photograph sea-birds and their nests. He had served on the Committee for Wicken Fen. But no bare record of his interests and achievements can do justice to the true qualities of the man. He had a rare genius for friendships with men of all generations, and in spite of his shyness he made a point of being helpful to men who came up from the lesser known schools without friends or influence. His modesty was terrific—that adjective alone fits. One recalls also his engaging humour, his humanity and his impatience with anything pretentious or shoddy. It was lovely to know him. His death robs Cambridge of a retiring but much-loved character.

E. A. MILNE

Prof. P. A. C. Dangeard

PIERRE AUGUSTIN CLEMENT DANGEARD was born at Ségrie-Vernie (Sarthe) on November 23, 1862. The son of a peasant stock, from which he doubtless inherited his individualism and determination, he entered l'Ecole Normale Primaire d'Alençon in 1878, becoming a school-teacher three years later. In 1883, his botanical aptitude having attracted the attention of Morière, then professor of botany at Caen, he was appointed demonstrator there, and lecturer in 1886. He moved to Poitiers in 1891, and was promoted professor in 1894. In 1908 he left Poitiers for Paris, where, in 1924, he succeeded G. Bonnier in the chair of general botany at the Sorbonne. He retired to the family property at Ségrie in 1944, and, after two years of troublesome illness, died there on November 10, 1947.

Dangeard was elected to the Academie des Sciences, Paris, in 1917. In 1931 the University of Cambridge conferred the honorary doctorate of science on him (family illness had prevented him from attending the Fifth Botanical Congress in 1930). The Linnean Society of London elected him a foreign member in 1935. Dangeard was awarded his doctorate by the Faculté des Sciences, Paris, for his "Recherches sur les organismes inférieurs" (1886), a contribution to botany which brought him the support of the algologist Bornet, and the Prix Desmazières (1887), and which laid down the main lines of many of the investigations which occupied him for the rest of his life. Developments and extensions brought further important publications (1896, 1903, 1904), on the cytology and sexuality of the fungi; these were recognized by the Grand Prix des Sciences Physiques de l'Institut de France. These contributions not only extended his own work, but they later generated a great volume of research by numerous workers all over the world on subjects which still claim the active attention of a number of botanists. Dangeard's demonstration of the nuclear fusions in young asci and basidia stands as a solid addition to our knowledge, though perhaps because investigations by other workers in the same field may have been over-valued, especially outside France, recognition was slow in coming to him.

In 1887 Dangeard began to issue *Le Botaniste*, a periodical supported from his own resources, which eventually ran to thirty-one volumes of some three hundred pages each, very many written by Dangeard himself. In the first issue, he explained that he had founded *Le Botaniste* so that he might have a means of publication which was wholly under his own control, in which he could express freely and defend adequately his own ideas, and in which he could assail freely any views which he deemed to be faulty. This explanation, and the contents of the periodical, illustrate the character of the man. He was extremely independent in his outlook, a tireless and accomplished observer, and a bold expositor of wide generalizations. With all that, and with a periodical completely his own, he was a fair controversialist. Throughout his life, Dangeard was greatly interested in those organisms which lie on the boundary between the plant and animal kingdoms, and in their relatives. He described a great number of new genera and species, he made detailed studies on the structure and physiology of the cell, and he put out a very clear exposition of the nature of sex, stripping that much-debated matter of morphological complications. At times, his wide outlook and his genius for broad generalizations may have put his conclusions in advance of his evidence, but his conclusions were certainly not sterile, for they led to renewed research. As we always expect from a Frenchman, his writings are clear and brilliantly luminous, so easy to read that a careless reader is in danger of missing a great deal that lies in the background.

P. A. C. Dangeard has left, in *Le Botaniste* and elsewhere, a noble record of a long life of active devotion to his subject. May that record stimulate those now working in his field, for the lower organisms and the cell have not yet yielded all their secrets.

B. BARNES

NEWS and VIEWS

Study of Public Administration

In his inaugural lecture from the new chair of public administration at the London School of Economics and Political Science on February 3, 1948, Dr. W. A. Robson welcomed the creation of the chair as a sign of the extended recognition now accorded to the study of public administration by the University of London (London: Stevens and Sons, Ltd. Pp. v+26. 2*s.* 6*d.*). It is impossible, however, for this vast field to be covered adequately in regard either to teaching or research, he said, unless far greater provision is made for senior posts at academic institutions throughout Britain. The expansion in the scale and scope of public administration is a dominant feature of our times and is to be seen not only in the growth and multiplication of government institutions and of the public corporations, but also in the new conception of the task of government. The keynote of most of the recent developments has been extreme centralization, and Dr. Robson expressed the view that contemporary trends are not in conformity with the best democratic principles and that we are not making the most efficient use of our resources of political energy, administrative ability and experience. In particular, he criticized the failure to appreciate the need for a democratic form of regional government, and supported the view advanced since in the second report of the Local Government Boundary Commission that the Commission should be given wider powers. Public ownership and the nationalization of industry both call for much greater efforts to measure the results of public administration in relation to its cost in terms of money and effort, and he believes that the question of centralization and decentralization needs discussion in the universities before a coherent body of principle is likely to be evolved for practical use.

At the Cabinet-level also, there are changes which call for further study and discussion, and such problems as questions of personnel administration, the distribution of powers, methods of control, organic relationships and constitutional development require re-examination, quite apart from the new problems presented by nationalized industries and the relations between public corporations and Parliament. He urged that the Economic Survey should be accompanied by a corresponding survey of public administration at intervals of not less than a year. Overshadowing all is the problem of how to ensure that the vast powers which are needed by the executive are conferred and exercised in conformity with the political traditions and the liberal spirit of the British people. He urged that we should cease to think of freedom only in terms of the absence of restraint and consider it also in terms of opportunity. He suggested that Parliament should take pains to define more carefully the executive powers which it confers; to state more clearly the purposes for which they are to be used; and to see not only that the rights of the public and the duties of public authorities are reciprocal, but also that the obligations of the citizen and the executive are mutual. Finally, he pleaded that the universities of Britain have a special contribution to make to the discussion of such problems, by diffusing a knowledge of the principles underlying a sound system of democratic government among the wide range of students, by helping the community to become more discriminating in its attitude to government, more critical of defects and more appreciative of achievements in the public service, and by investigating the working of institutions and analysing policies and processes. The more closely the different branches of social science can co-operate in a combined attack on the complex problems confronting us, the more effective the result is likely to be.

Annular Eclipse of May 8–9

Bad weather conditions went far to spoil the project of the National Geographic Society to link up the triangulations of Asia and of the United States and Canada by exact timing of contacts at the recent eclipse (*Nature*, March 13, p. 389). Only two expeditions—those to Rebun Jima, a little fisher-folk island off the north-western tip of Japan and to Bangkok in Siam—were favoured by clear enough conditions to get satisfactory results. Dr. C. H. Smiley, head of the last-named party, reported thin cirrus clouds, while Dr. John A. O'Keefe of the other party had ideal conditions due to a last-moment clearing. These two observations may link up the Indian geodetic triangulation with those of Japan and possibly Korea. A link-up with the American triangulation may also be possible owing to the successful photographs secured from two *B*29 Superfortress planes working from an air base on Shemya Island in the Aleutians. Short-range navigation methods were used, radar signals being sent out from the aeroplanes and received by ground stations the exact locations of which were known. Obviously fresh problems are involved in the use of data from moving aeroplanes, and it will be interesting to see the final reports when the material obtained has been examined. It is to be hoped that Great Britain, from which the suggestion first originated that eclipse observations might be used for geodetic studies, may before long take a part in securing some valuable results along these lines.

Hylean Amazon Institute

A nine-nation Conference for the creation of an International Institute of the Hylean Amazon, called jointly by the Governments of Peru and Brazil and by Unesco, has successfully concluded its deliberation at Iquitos, Peru. A convention establishing the Institute was agreed upon and will come into force upon final acceptance by the founding nations. The following nations signed the final act of the Conference: Bolivia, Brazil, Colombia, Ecuador, France, Holland, Italy, Peru and Venezuela. The scientific programme for the Institute was formulated, and a budget of approximately 300,000 dollars was set for the first year of the Institute's operation. A financial protocol was also signed by Bolivia, Brazil, Colombia, Ecuador, France, Holland, Peru and Venezuela, which determined the scale of national contributions toward financing the Institute. The United States and the United Kingdom expressed great interest in the Institute, and will study ways of actively participating in its work.

Pending the initiation of the operation of the Institute, an Interim Commission was established and the first meeting of the Commission opened in Manaos, Brazil, on May 13. In accordance with instructions from the Unesco General Conference held in Mexico last year, the Director-General has obtained the services of outstanding world experts to carry out surveys in anthropology, biology and soil science to guide the investigators of the Institute during its first years of operation in the Hylean

Amazon region. A survey will also be made of the existing scientific knowledge of the region and of the work carried out by institutions in other parts of the world on man's relation to a tropical environment.

The Wool Industries Research Association

THE report of the Director of Research for the Wool Industries Research Association for 1947–48 summarizes a five-year building plan to provide permanent buildings for plant and workshops on the lower half of the Torridon plot. Construction of a new physics block, with provision for workshops and drawing offices and a central steam-raising plant for heating and process is already in progress, and together with a new woollen block is to be completed in 1948. The provision of a new wing for a library, offices and canteen is postponed until conditions become easier. As a result of a conference of eight research associations, a standing conference is to be constituted and the exchange and study of programmes of textile research is to be commenced immediately. A survey of shortened drawing processes in members' mills has emphasized the attention which must be given to yarn characteristics when considering a reduction in the number of drawing processes; other surveys lending themselves to detailed statistical analysis have covered the occurrence of slubs and faults in yarns and the scouring and milling of woollen and worsted pieces. Progress is also reported in the measurement of the characteristics of a yarn as they affect its ultimate performance, high-draft spinning and the mathematical and experimental study of the drafting process.

Fundamental investigations noted in the report include the confirmation and extension of the theory of water absorption by wool, the diffusion of formic acid and of large molecules in keratin, the behaviour of ions in horn keratin and a physico-chemical study of the washing of raw wool. Evidence was obtained that the molecular arrangement of the amino-acid residues of which the keratin molecule is composed is much more complex than was entertained in current theories. A new method of breaking down wool to macro-molecular components apparently similar to those obtained by Mercer by the use of enzymes has yielded extremely interesting results, and investigations of peroxide bleaching have continued, as well as biochemical work on the naturally occurring polypeptides, gramicidin *S* and tyrocidine. Analysis of the peptides derived from wool containing the dicarboxylic acids and of the peptides containing cystine has continued. Biological research has included fleece studies of the Romney flock maintained at Cambridge as well as follicle studies; while in the technological field, in addition to completing a detailed examination of the resistance to washing of proprietary moth-proofing agents, the Association has suggested to the Society of Dyers and Colourists the establishment of a committee to investigate the standardization of larval testing and of washing processes appropriate for assessing moth-proofing agents. Laboratory work on combing oils, woollen oils and fastness tests has continued, as well as studies of speciality fabrics, mechanical properties of yarn and cloth, and the performance of rapid regain measurement machines on the market.

The British Boot, Shoe and Allied Trades Research Association

THE first annual report of the Council of the British Boot, Shoe and Allied Trades Research Association covers the year ended December 31, 1947. The new Council, elected in June 1947, consists of members elected on a regional basis, together with co-opted members; the Scientific, the Industrial and the Statistics Committees supervise, respectively, the work of the Scientific and Technical Division, the Industrial and Productivity Division and the Trade Statistics and Economic Research Division. The chairmen of these three Committees are also members of the Finance Committee which controls the work of the Information and Administration Division. Of the 973 consulting questions recorded during the year, 45 per cent related to wear complaints, chiefly perspiration and damage by heat. Reports are in preparation on service trials of boots containing test components, tests of a co-polymer of vinyl acetate and vinyl chloride as a lining fabric, the use of 'Mycocide L' under factory conditions, the deformation of various shoe materials, a survey of children's feet and an analysis of American Army foot measurements. An interim report on the performance and quality of welt-sewing needles has been published, and work on the water-proofness testing machine is almost complete. Experiments on the use of a Baldwin moisture meter modified for use with leather have been completed, and practical applications are being investigated. A small laboratory has been set aside for testing adhesives, and work on the effects of perspiration on upper and insole leather has continued. The Council has also endowed a Satra Research Fellowship at University College, London, tenable for two years in the first instance, for research on the structure of the human foot and on the mechanics of human locomotion, and the first fellow, Dr. R. H. Hardy, commenced his duties on January 1, 1948.

The Society for Psychical Research

IN a recently published pamphlet entitled "The Society for Psychical Research: an Outline of its History" (London, 1948. 2*s*.), which has been issued by the Society and written by its president, Mr. W. H. Salter, the author has provided a very useful account of the Society's activities from its foundation in 1882 until the present day. It is not generally realized what an immense amount of work has been done by members of the Society, a fact illustrated by its forty-eight volumes of *Proceedings*. Although the quality of the material presented is by no means uniform, the standard set by the more cautious members of the Society has always been a high one in spite of the persistent and sometimes successful attempts of its more emotional adherents to minimize the paramount importance of sound evidential material, and to introduce papers which tend to discredit the work of the Society both at home and abroad.

In his admirably objective account of the Society, the president has passed in review the various stages of its eventful career, although the general reader would scarcely realize from the author's smooth-running narrative that the two schools of thought mentioned above were always present within the Society, and that both are to this day still striving for mastery. It is these wide differences of opinion that make the Society so unlike the majority of scientific societies. For on one side we have those who believe that the Society's main function is to preserve the highest scientific standards both in research and publication, whereas on the other are grouped those who would make the Society a kind of academic and dignified spiritualist body voicing the views of those who find in popular spiritualism a system of thought and practice too crude to attract the more educated believer. As a well-balanced and judicious survey of the Society for Psychical Research past and present, this little book is to be highly commended. It shows the Society in what may be thought by some to be its best role, namely, a nucleus around which are gathered research workers of varied opinions who can use its platform for their results and get expert help and guidance when required for improving the quality of their work and assessing its value. The Society has had a long and distinguished career, and much of its published material is of the greatest value both to the psychologist and to the student of evidence and the value of testimony. To those who wish to inform themselves more fully of these aspects of the Society's work, no better introduction could have been devised than this little book.

Learning and Industry

A VALUABLE means of bringing about active co-operation between industry and the universities has recently been shown by the United Steel Companies, Ltd. At the invitation of the chairman, Sir Walter Benton Jones, fourteen mechanical and production engineering professors from British universities spent four days, beginning on April 12, in visiting the branches of the United Steel Companies at Sheffield, Scunthorpe and Stocksbridge, and in joint discussion both at the various works and at the Sheffield headquarters. Among the topics discussed were the design of Siemens open-hearth furnaces, the fuel balance of an integrated steelworks, and, led by Sir Charles Goodeve, director of the British Iron and Steel Research Association, some general research problems of the iron and steel industry. [illegible] was clear from the discussions that the research staff of the United Steel Companies were grateful for suggestions thrown out by the professors, while he latter were appreciative of the new problems put o them and which, in some cases, could usefully be followed up by them and their research staffs. By arranging this tour the United Steel Companies have shown a way in which industry and scholarship an work together for their mutual help and the well-being of British economy.

Australia and New Zealand Association for the Advancement of Science

THE report of the twenty-fifth meeting of the Australia and New Zealand Association for the Advancement of Science, held at Adelaide during August 1946, with its list of officers and research committees, balance sheet, constitution and by-laws, ectional transactions and reports of research committees, is something more than a useful reference work for the Association. In addition to Dr. P. Marshall's presidential address on "The Permanent acific" and Dr. Adrien Albert's Liversidge Centenary Lecture on "What can Chemistry Contribute to the Mastery of Disease?", it includes the addresses of the ctional presidents. Some of the latter, such as those of Dr. Ian W. Wark to the Chemistry Section on "Australian Research on the Theory of Flotation", r. W. M. Bryan on "The Geological Approach to the Study of Soils", Dr. J. Pearson on "Some Problems Marsupial Phylogeny", Dr. R. Wilson on "Facts d Fancies of Productivity", Dr. H. W. Bennetts on "The Pathological Approach to Problems of Animal isease", and Prof. E. Ashby's "Survey of Botany in the Soviet Union" appear to be of notable scientific interest and deserve the wider audience that they can now reach. Among other addresses included are those of R. Lemberg on "New Aspects of the Theory of Function of Respiratory (Hæmatin) Enzymes", A. Gottschalk on "Some Aspects of the Relationship between Chemical Structure and Enzyme Specificity", and of A. T. S. Sissons on "The Widening Front of Pharmaceutical Science".

Archæology in South Africa

THE report for 1946–47 of the Archæological Survey of the Union of South Africa has been published (Johannesburg). The most interesting piece of information therein is that the Little Caledon River has apparently cut its bed down some 300 ft. through Beaufort Sandstone since the occupation of the upper part of the valley by early Stellenbosch man. Sandstone, of course, is not such a hard material as basalt; nevertheless, a long period of time must be postulated since early man lived in those regions. Dr. van Riet Lowe has published a note in the *South African Archæological Bulletin*, 2, Pt. 8 (1947) on some interesting tanged and winged arrow-heads. This type of tool has not been found heretofore in the Union. Dr. van Riet Lowe assigns them, no doubt rightly, to a Neolithic stage of development. He does mention, incidentally, the discovery of somewhat similar arrow-heads in a so-called Solutrean *milieu* in eastern Spain; but it may be premature to assign Dr. Pericot's finds definitely to the European Solutrean culture. Spanish prehistory south of the northern mountain ranges looks mainly to North Africa for its connexions. Maybe the word Aterian will have to be substituted for Solutrean eventually. But the occurrence of tanged and winged arrow-heads in the South African Neolithic is indeed an interesting addition to knowledge.

Identification of Important Indian Timbers

IF any one factor could be picked out as justifying forestry research in the tropical and sub-tropical forest containing many timber species growing in mixture, it would consist in some popular means of identifying the various kinds. This problem first presented itself in India during the First World War, when many species of timber, practically previously unmarketable, came into use. The demand on the Indian forests was far greater in the Second World War. For the use of the Army, six leaflets entitled "How to Identify Timbers" were issued from Dehra Dun. These have now been collected together into *Indian Forest Record* (Utilisation), Vol. 3, No. 7, by the wood technologist of the Forest Research Institute, and keys and photomicrographs of the timbers that are commercially available in the different military zones of inspection have been added. The photomicrographs, on which 114 timbers are shown in 57 plates, are very clear. The writer says they will be as useful to the commercial trader as to the military authorities; he might have added also to the district forest officer and his staff in parts of the country where new timbers, previously unmarketable, are now commercially salable.

The Food of Humming-Birds

AN excellent monograph on the feeding and related behaviour of humming-birds (with special reference to the black-chin, *Archilocus alexandri*) was prepared by Frank Bené before his death in 1943 and has now been published as a Memoir of the Boston Society of Natural History (9, No. 3; October 1946). The work was carried out during 1939–42 in Phœnix and other localities of Arizona, and, because of its docility, its fondness for commercial sweets, and its regularity in returning to feed from artificial sources of food, the humming-bird proved to be an amenable subject for observation and experiment. The black-chinned humming-bird is strongly migratory, and its arrival on the spring breeding ground coincides with the flowering of its food plants. The sexes select and maintain isolated territories and meet on a neutral ground, the lex. Feeding habits of the humming-bird support Howard's theory of the nutritive function of territory. The monograph also describes the feeding routine, type and quantity of food consumed and the three feeding techniques—flower-probing, hovering-pecking and fly-catching. The Memoir contains twelve black-and-white plates which should delight all bird lovers.

The Brotherton Collection, Leeds

The eleventh and twelfth reports of the Brotherton Collection Committee, University of Leeds, covering the sessions 1945–46 and 1946–47, respectively, estimate the contents of the Collection on June 30, 1947, as 22,700 books, 15,413 pamphlets, 473 manuscripts, 4,105 deeds, 31,158 letters and 25 maps; the increase on June 30, 1946, being 61 books, 65 pamphlets and 32 letters. Undergraduates continued to use the Collection for special studies, particularly in English literature, and the return to more normal conditions was shown by an increasing number of inquiries from abroad. Many of the visits to the Collection during 1945–46 were specially arranged in connexion with an exhibition of the collection of English county atlases and road maps presented to the University by Dr. Harold Whitaker. The practice of holding exhibitions of the Collection's treasures is to be revived, and during 1946–47 an exhibition of bindings was arranged in connexion with the Leeds Conference of the International Society of Leather Trades Chemists. The re-cataloguing of books in the English literature section continued and 2,601 slips were added to the Supplementary Catalogue in 1945–46 and 880 in 1946–47. Ten books and pamphlets were presented in 1945–46 and 101 purchased, the corresponding figures in 1946–47 being 74 and 52 as well as 52 autograph letters presented.

Linnean Society of London: Anniversary Meeting

At the anniversary meeting of the Linnean Society of London held on May 24, the Linnean Gold-Medal was presented to Dr. Agnes Arber, and Trail Awards and Medals were presented to Dr. Honor Bridget Fell and Dr. Cyril Dean Darlington. The following were elected officers for the session 1948–49: *President:* Prof. G. R. de Beer; *Treasurer:* Colonel F. C. Stern; *Secretaries:* Dr. B. Barnes (Botany), Dr. A. Tindell Hopwood (Zoology). The new members of council were Mr. James M. Fisher, Mr. N. B. Kinnear, Prof. W. H. Pearsall, Dr. W. R. Philipson and Mr. N. Y. Sandwith.

South Eastern Union of Scientific Societies

The fifty-second annual congress of the South-Eastern Union of Scientific Societies will be held at Great Yarmouth during June 14–19, under the presidency of Mrs. Jacquetta Hawkes, who will speak on "Archæology and the Present". The meetings will be held in the Town Hall. The sectional presidents and the titles of their addresses are: H. J. Howard (Botanical Section), "The Mycetozoa of Sand-dunes and Marshland"; Lieut.-Colonel S. E. Glendenning (Archæological Section), "Local Materials and Craftsmanship in Norfolk Buildings"; C. D. Ovey (Geological Section), "Foraminifera in Stratigraphy with Special Reference to the Ecology of Living Forms"; Major Maxwell Knight (Zoological Section), "The Study of Bird Pellets as a Subject of Interest and Instruction to Amateur Naturalists". On June 17 there will be a "Young Naturalists' Evening", at which Nature films will be shown and a 'brains trust' held. A discussion on the functions and organisation of local societies, to be opened by G. E. W. Gosnell, will be held on June 18. The local secretary of the meeting is Mr. P. E. Rumbelow, 27 Rodney Road, Great Yarmouth; the honorary general secretary of the Union is Mr. F. J. Epps, 78 Dunwich Road, Bexleyheath, Kent.

Population and World Resources in Relation to the Family

An International Congress on "Population and World Resources in Relation to the Family" will be held at Cheltenham during August 23–28. The programme for the Congress, which has been organised by the Family Planning Association of Great Britain, includes general sessions devoted to the following topics: world resources; essential standards of living; migration as a factor in the adjustment of national populations; sociological implications of family limitation in various typical countries; birth control as a factor in the adjustment of national population; ethical and medical advantages of planned family limitation; current and future research in problems of fertility, infertility, sex and marriage; agencies for the dissemination of knowledge and propaganda. Further particulars can be obtained from the Cheltenham Congress Organiser, 37 Park Street, London, W.1.

Announcements

Sir James Chadwick, honorary fellow of Gonville and Caius College, Cambridge, and Lyon Jones professor of physics in the University of Liverpool, has been pre-elected Master of the College to succeed Mr. J. F. Cameron, who retires on September 30.

The Association of British Science Writers is holding its first forum discussion meeting on "Science and the Press" on June 9 at 7.30 p.m. at the Society for Visiting Scientists, 5 Old Burlington Street London, W.1. The meeting will be open to the public and admission is free.

A research scholarship of the value of £400 per annum and tenable for two years has been offered by the Aluminium Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a Committee of the Institution of Naval Architects and it is hoped to make the award in September. Full particulars of entry, which close on July 31, can be obtained from the Secretary Institution of Naval Architects, 10 Upper Belgrav Street, London, S.W.1.

Erratum. In the communication entitled "Transmission of Bactericidal Radiation through Glass (*Nature*, May 29, p. 856), the lettering of the tw curves should be interchanged.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Meson Scattering with Nuclear Excitation

In examining a number of Ilford *C*2 plates, loaded with boron, and exposed to cosmic rays in aeroplanes at an average altitude of 8,000 ft. for about 72 hours, we have come across an interesting track which is reproduced herewith. The track starts at one surface of the emulsion, extends for a length of about 470 μ and then suffers a sharp bend through an angle of 29° at the point *b*. It thereafter continues for a distance of 134·4 ± 0·5 μ and ends in the emulsion.

For a number of other tracks in the same plate which end in the emulsion, the total number of grains N has been counted as a function of the residual range R, and $\log_{10} N$ then plotted as a function of $\log_{10} R$. In this way we obtain a figure similar to Fig. 4 of the article by Lattes, Powell and Occhialini[1]. The tracks fall into two clearly differentiated groups, one of which can be identified as due to protons, the other as due to mesons. Now counting the number of grains as a function of the residual range for the track *eb* yields points lying *within* the set of points obtained for mesons, and on the side of higher rather than lower grain density. This allows one to identify the track unambiguously as due to a meson which comes to rest in the emulsion, though we cannot, of course, say whether it is a π-meson or a μ-meson. The grain density just after the bend is 0·76 grains/μ, which is in good agreement with that to be expected from our curves for the observed residual range of 134·4 μ. Coming now to the part of the track *ba* before the bend, we have counted the number of grains along it for every ten scale divisions of track, up to a total length of 420 μ, starting from the point *b*. The last 50 μ of track is too near the surface of the plate to allow accurate grain counts, and this portion has therefore been omitted. The result is given in Table 1.

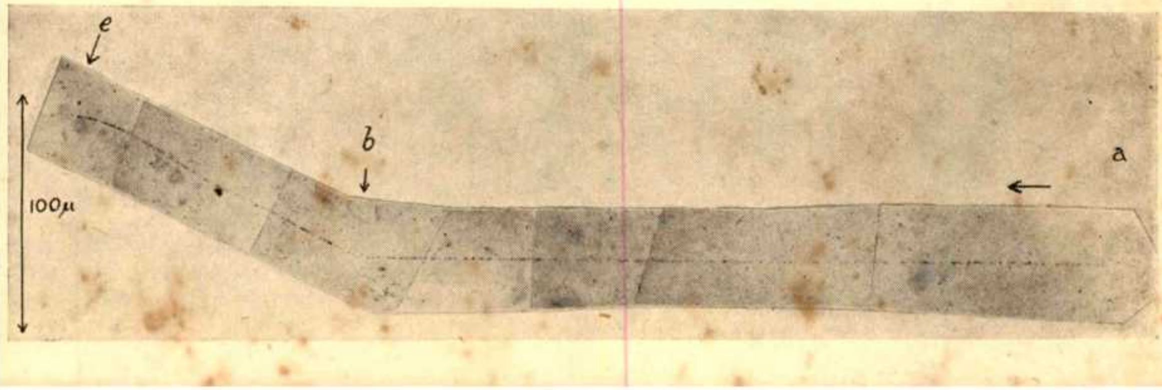
TABLE 1. *P*, PORTION OF TRACK IN SCALE-DIVISIONS; *N*, NUMBER OF GRAINS IN THIS PORTION

P	0–10	10–20	20–30	30–40	40–50	50–60	60–70
N	12	13	12	16	10	12	11
P	70–80	80–90	90–100	100–110	110–120	120–130	130–140
N	9	8	11	11	9	14	11
P	140–150	150–160	160–170	170–180	180–190	190–200	200–210
N	11	8	11	10	10	10	8

Fitting a straight line to these figures by the method of least squares, we obtain a line with a slope of 0·16 grains per ten scale divisions, per ten scale divisions, while the mean height at its centre is 10·8 grains per ten scale divisions. The standard deviation of the points from this line is 1·8 for a count of ten scale divisions. Since a scale division is 2·1 μ, it follows from these figures that the grain density near *b* is 0·60 ± 0·09, while at *a* it is 0·46 ± 0·09 grains/μ.

From our curves it follows that the residual ranges for these two grain counts are approximately 320 μ and 800 μ respectively if the particle is assumed to be a meson, giving a length of about 480 μ between the points *ba*. This is in fairly good agreement with the observed length of 420 μ. On the other hand, if the particle be assumed to be a proton, the residual ranges corresponding to grain counts of 0·60 and 0·46 grains/μ are 3,802 μ and more than 10,000 μ respectively, requiring the track length *ba* to be greater than 6,000 μ, in complete disagreement with the observed length. It can therefore be concluded with some confidence that the particle producing the track *ab* has not a protonic mass. However, since the mass determination now depends on the slope and length of the track *ba* and not on the total grain count against residual range, the determination is much less certain than in the case of the track *be*, and we cannot exclude the possibility of the particle having a mass a few times that of a π-meson.

The most obvious explanation of the bend at *b* is to assume that it is due to the scattering of a meson by collision with a nucleus in the emulsion. Now the energy and momentum of the particle just after the bend can be estimated from the grain count and the residual range, and is 1·5 ± 0·1 MeV. and 17·7 ± 0·7 MeV./*c* if the mass of the meson is assumed to be 200 *m*, where *m* is the mass of the electron. Similarly, the energy and momentum of the particle just before the bend are 3·3 ± 0·4 MeV. and 26·2 ± 1·3 MeV./*c* respectively. Since momentum is conserved, the momentum of the recoil nucleus can be deduced to be 13·8 ± 0·8 MeV./*c*. This gives it a kinetic energy of approximately 0·9 KeV., 1·2 KeV. or 0·1 MeV., depending on whether the recoil nucleus is that of silver, bromine, or hydrogen respectively. Hence even in the case of hydrogen the calculated energy is less than a tenth of what it should be for an elastic collision, namely, (3·3 ± 0·4) − (1·5 ± 0·1) = 1·8 ± 0·5 MeV. Thus, if the bend is to be explained as due to scattering, we must conclude that the recoiling nucleus is excited to the extent of about 1·8 MeV. The possibility that the meson might have been scattered with emission of radiation can be ruled out almost completely because of its low velocity. The radiation loss of mesons is 40,000 times less than that of electrons, due to their greater mass. Moreover, even in the case of electrons, radiation loss becomes negligible compared with scattering at non-relativistic velocities, and this effect would still further diminish the chance of radiation loss relative to scattering for the meson under consideration. The



mechanism for the observed bend is clear. Assuming the nucleus to be a heavy one, like silver or bromine, one finds that a proton of 10 MeV. kinetic energy moving in a suitable direction in the nucleus could absorb the required amount of energy and momentum to explain the observed tracks. The extra energy acquired by the proton would be immediately divided among the other particles in the nucleus. If the track be due to a π-meson with a mass of 300 m, then a corresponding calculation shows that the track can also not be explained by an elastic collision. In this case the recoiling nucleus would be excited to the extent of about 2·7 MeV.

There is, however, another possible explanation of the track which we have to consider, namely, that at the point b a heavy particle decays *while in motion* into a lighter one, with the emission of a neutral particle, as, for example, a π-meson decaying into a μ-meson. Assuming different values for the mass m_l of the light meson and mass m_h of the heavy meson, the mass m_n of the neutral particle can be calculated. The result is shown in Table 2.

TABLE 2

m_l	m_h/m_l	m_h	m_n/m
170	1·5	255	79·5 ± 14·7
170	1·7	289	114·8 ± 21·2
200	1·5	300	93·6 ± 17·3
200	1·7	340	135·0 ± 24·9
300	1·5	450	140·4 ± 22·4
300	1·7	510	202·5 ± 32·4
300	3·33	1000	695·5 ± 111·2

Thus assuming the mass of the light meson to be 170 m and the ratio of the masses of the heavy and light mesons to be 1·7, as in the case of the π- and μ-mesons of Lattes, Powell and Occhialini[1], we find the mass of the neutral particle to be 0·68 ± 0·08 times that of the μ-meson, giving it a mass of 115 ± 21 m. Although this agrees within the limits of error with the mass of the neutral particle required by these authors, our calculated energy release would be 2·5 MeV., whereas they find an energy release of about 10 MeV. We are therefore inclined to believe that if our track is to be explained as a decay process at all, it would have to be the decay of a heavier particle into a π-meson. The only evidence for preferring such an interpretation to that of simple inelastic scattering is that the part of the track after the bend b shows noticeably greater scattering than before the bend. Some support for this visual impression can be obtained by a more quantitative measurement of the scattering along the track. The mean square of the scattering angle $\overline{\theta}^2$ in a length t of track varies inversely as the square of the kinetic energy E. Thus $E^2\overline{\theta}^2$ should depend only on the properties of the material for a particle of given mass. We have worked out the mean value of $E^2\overline{\theta}^2$ for eight intervals of length 15 μ each before the bend, and twenty similar intervals after the bend, and obtained 9·2 and 2·5 respectively in arbitrary units, assuming the mass of the particle to be 300 m throughout. On the other hand, if the mass of the particle before the bend were twice that after the bend, the values of $E^2\overline{\theta}^2$ would become more equal. This argument has, of course, to be taken with extreme caution, since the statistics are small and the fluctuations large. If the track observed by us is really to be interpreted as the decay of a heavier particle into a π-meson, then it cannot be identified with the process suggested by Rochester and Butler[2], as the last line of Table 2 shows. The mass of the neutral particle would have to be quite different.

We may summarize the above discussion by saying that the track reported by us is due to the scattering of a meson by a nucleus in which the nucleus is not disrupted but simply excited. Although we should expect such a process to occur, this is the first time that experimental evidence appears to have been obtained showing it.

We wish to express our thanks to Prof. H. J. Taylor for his invaluable assistance. We also wish to thank Mr. Malkarnekar for help in preparing the photomicrograph.

H. J. BHABHA
R. R. DANIEL
Tata Institute of Fundamental Research,
Bombay.
April 14.

[1] Lattes, Powell and Occhialini, *Nature*, **160**, 453 and 486 (1947).

[2] Rochester and Butler, *Nature*, **160**, 856 (1947).

Investigation of the Radioactivity of Rocks by the Photographic Method

MADAME IRENE CURIE has pointed out[1] the feasibility of estimating the total uranium and thorium content of rocks by using the photographic method. H. Yagoda and N. Kaplan have more recently employed the method for determining the disintegration constant of U^{238}, getting values in concordance with previous results[2]. We have now tried the method on various rock specimens and the results obtained have been definitely encouraging. The method employed is to place an Ilford Nuclear Research plate at a distance of about 0·1 mm. from a flat surface of the specimen cut with a diamond saw, and expose it for one to three weeks, depending the probable activity of the specimen. In more recent experiments the plate has been placed in contact with the cut surface, as this makes easier the identification of α-ray tracks, which all originate from one nucleus. Theoretically, from the frequencies of two-, three-, four- and five-ray stars, it should be possible to estimate the separate amounts of uranium and thorium present. Enough data have not yet been obtained to determine whether this method will prove possible.

As might be expected, the plates show that the distribution of the radioactive elements in rocks is sporadic. This specially applies to coarse-grained rocks such as granites: Fig. 1 is a photomicrograph of a very active spot obtained from a Finnish granite. More than two hundred tracks can be counted in the area shown, an area of about 7 × 10^{-4} cm.^{2}.

The average number of tracks for the same area taken over a gross area of 0·1 cm.^{2} was only about five. It will be seen that the tracks show a very definite tendency to be radial, and that the tracks increase in apparent length as they recede from the centre. The plate was separated from the rock surface by an air space of about 0·1 mm., so both observations agree with the view that the radioactive source is concentrated in a small volume of rock nearly opposite the centre of the photograph. This would agree with the usual hypothesis of the method of formation of pleochroic halos. The fact that for some rocks such large local concentration of activity occurs renders the quantitative estimation of the average radioactivity of these rocks more laborious.

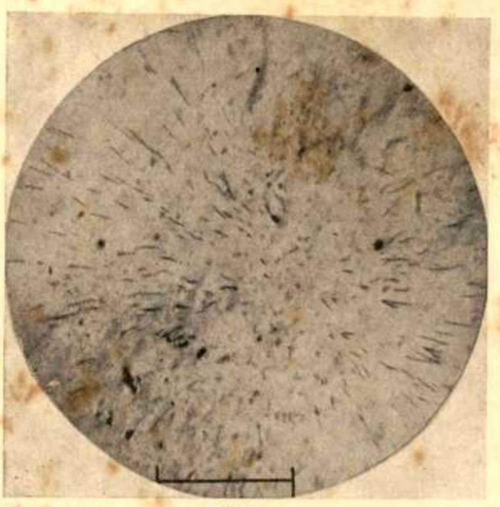


Fig. 1

It must be remembered that some of the α-tracks observed may be due to radioactive elements present either in the glass of the plate or possibly even the emulsion. This question has been investigated by developing some of the plates without exposure to any rock, and as might be expected, a fair number of tracks, most of which originate in the glass, were found. Two-, three-, four- and one five-ray star were observed: Fig. 2 is a photomicrograph of a four-rayed star which apparently actually originates in the emulsion, but such stars are rare. A rough estimate gives the number of these tracks as about 0·1 track per cm.^{2} per hour. Fortunately, as the great majority of these tracks originate in the glass, it is fairly easy to distinguish them from the α-tracks from the rock. Alternatively, the tracks on a part of the plate which has not been exposed to the rock can be counted, and the necessary correction applied to the figure obtained for the portion exposed to the rock.

The presence of these α-ray stars in our plates would seem to cast some doubt on H. E. Huntley's hypothesis that similar stars observed in plates exposed at 11,000 ft. are due to cosmic rays[3]. Our plates have been kept at sea-level, and hence their exposure to cosmic rays has been small. To date, only one undoubted cosmic ray disintegration of an atom has been found, and yet the frequency of the stars observed is at least as high as that found in Huntley's plates. It would, as a matter of fact, be surprising if the glass of the plates were so free from radioactive materials that the small number of stars observed was not present. Probably the main source of the radioactive elements is the optical sand used in the manufacture of the glass, and it would not be expected that the radioactive elements present in the sand would be nearly totally eliminated during the process of manufacture.

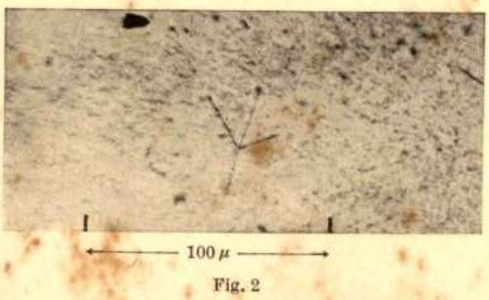


Fig. 2

J. H. J. POOLE
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April 15.

[1] Joliot-Curie, I., *J. Phys. et le Rad.*, **7**, 313 (Nov. 1946).
[2] Yagoda, H., and Kaplan, N., *Phys. Rev.*, **72**, 356 (1947).
[3] Huntley, H. E., *Nature*, **161**, 356 (1948).

Lightning Arrester Discharge Currents

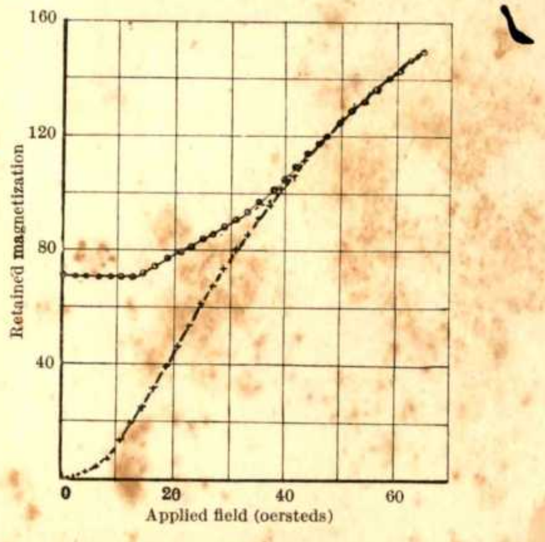
DURING the last five years an investigation has been made of the discharge currents of a number of 38,000-volt lightning arresters. The transmission system on which these arresters were installed is operated with its neutral point earthed through Peterson coils; the lines are not equipped with overhead ground wires. The earth lead of each single-phase arrester was equipped with a pair of magnetic links. In addition, paper-puncturing recorders were used to indicate when arresters had operated.

Among the results obtained last season were two of particular interest. The pairs of links involved were evaluated by the new step-method put forward by Prof. H. Norinder[1]. From the results it was apparent that the links had not been magnetized by a unidirectional current discharge. Reversals of direction of current flow were clearly indicated and could be evaluated. The magnitudes of the discharges were also evaluated by the older method[2] of comparing the relative magnetizations of the inner and outer links, assuming the presence of a single reversal. The values obtained were as follows:

Result No.	Norinder method		Value derived from relative magnetization of inner and outer links (amp.)
	Inner link evaluation (amp.)	Outer link evaluation (amp.)	
36 *S*	+1150, −390, +80	+1130, −370	+1220, −400
36 *T*	+1570, −250, +530	+1650,* − ?	+1590, −210

* Further evaluation of this link spoiled by a laboratory accident.

The characteristic curve obtained for the inner link of result No. 36 *T* is shown in the accompanying graph.



The Norinder method has been applied to the results obtained during the greater part of last year. Using this method, evidence of reversals of current flow have been obtained sufficiently frequently to show that it is not a rare phenomenon. In most cases, however, the discharges were not of sufficient magnitude to enable them to be evaluated with any degree of accuracy.

There would appear to be four possible explanations for the reversals observed : (*a*) Reversal of direction of current flow in the originating lightning flash itself[3–5]. (*b*) The record was the combined result of two or more flashes, that is, one flash made direct contact with the line conductor, others being a near miss or possibly also making contact with the conductor but being of opposite polarity. The flashes in question would have to occur within a maximum period of about five minutes or else they would have been recorded as separate punctures on the paper-band recorders. (*c*) A multiple flash, the component strokes of which did not all make contact with the line. (*d*) Restriking inside the arrester after the first current zero[6]. Many more data are required to elucidate this matter.

Unless the new method of evaluation is used, the presence of reversals such as those reported above can lead to erroneous interpretation of magnetic link observations of arrester discharge currents. This is especially liable to occur in the case of the more common small current discharges, as in such cases it is not possible to detect reversals by comparison of inner and outer link magnetizations since the outer link magnetization will be almost negligible.

It is hoped to publish fuller details of these investigations at a later date.

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University College,
Dublin.

Feb. 12.

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[1] Norinder, H., *Ark. Mat. Ast. Fys.*, **31** A, No. 13 (1944).

[2] Surge Phenomena, E.R.A. Report, p. 70 (1941).

[3] Wagner, C. F., McCann, G. D., and Beck, E., *Trans. Amer. Inst. Elect. Eng.*, **60**, 1, 222 (1941).

[4] McEachron, K. B., *Elect. Eng.*, **60**, 885 (1941).

[5] Norinder, H., *Frank. Inst. J.*, **244**, 167 (1947).

[6] McCann, G. D., and Beck, E., *Trans. Amer. Inst. Elect. Eng.*, **66** (1947).

Effect of Lattice Distortions on the Mean Rate of Propagation of Large Barkhausen Discontinuities

THE well-known experiments by Sixtus and Tonks[1] on the propagation of large Barkhausen discontinuities have been repeated and extended, using slightly more refined methods.

The relation between the mean rate of propagation, V, and the external field, H,

$$V = A(H - H_0) \qquad (1)$$

was found to be strictly valid in all cases investigated.

Extensive experiments on a 60–40 nickel–iron alloy (which for this purpose has certain advantages over other alloys[2]) showed that A is very sensitive to defects in the lattice structure, an effect which hitherto seems to have escaped notice.

Table 1 refers to data obtained on a wire which was cold-drawn to a diameter of 0·01 cm. and then annealed at increasing temperatures, the highest (1,000° C.) including a slow cooling in a magnetic field. After this the wire was plastically stretched by a few per cent and measurements of A and H_0 again made.

TABLE 1

Condition of the wire	λ (cm.)	R ($\mu\Omega$/cm.)	H_0 (Oe)	A (cm./sec. Oe)
I	8·0	75	2·70	11,000
II	9·0	63	2·00	14,000
III	8·5	69	0·11	42,000
IV	11·5	—	0·08	38,000
V	10·0	71·8	0·56	35,000

I, cold drawn state.
II, I followed by heating for 4 hr. at 420° C. in hydrogen.
III, II followed by heating for 1 hr. at 850° C. in hydrogen.
IV, III followed by heating at 1,000° C. and slowly cooling in magnetic field.
V, IV followed by plastically stretching by a few per cent.

The last column and the last column but one contain the measured values of the constant A and H_0 in equation (1). There is a clear inverse relationship between the two quantities.

The length, λ, of the discontinuity does not vary much as a result of either cold work or annealing (cf. col. 2, Table 1).

The heat-treatment at 420° C. was aimed at producing the maximum amount of ordering in the lattice compatible with the cold-worked state. The effect of this treatment on the electric resistance, R, of the wire is very marked (cf. col. 3, Table 1), but the accompanying change in A is nevertheless small. Moreover, it is opposite in sign to the change to be expected as a result of an increased eddy-current damping.

The rate of propagation of the discontinuity in the cold-worked sample is not entirely uniform, as is indicated by the presence of irregularities in the oscillogram giving the voltage induced in the test coils surrounding the wire as a function of the time. In carefully annealed wires, on the contrary, propagation is quite smooth and at a constant rate.

Measurements were also made at the temperatures of liquid air and boiling water. This was done by passing these liquids through a glass tube surrounding the specimen.

These experiments brought to light a surprising effect, namely, that for a given wire the ratio A/R is practically independent of the temperature (cf. Table 2).

TABLE 2. Ni–Fe 60–40; diameter of wire, 0·01 cm. Measurements at T_1 = 93° K.; T_2 = 287° K.; T_3 = 368° K.

Cold-drawn state A_2 = 11,900 cm./sec. Oe					Annealed at 850° C. A_2 = 42,250 cm./sec. Oe				
T/T_2	A/A_2	R/R_2	H_0	λ	T/T_2	A/A_2	R/R_2	H_0	λ
0·32	0·35	0·36	3·36	10	0·33	0·34	0·37	0·11	10
1·00	1·00	1·00	2·44	10	1·00	1·00	1·00	0·03	10
1·28	1·36	1·39	2·20	10	1·28	1·37	1·41	0·05	10

To a less extent it might also be said that A is proportional to the absolute temperature in the region studied. Since we know of no other way of accounting for the observed substantial decrease in A with decreasing temperature except by assuming an increase in the eddy-current losses, we are inclined to suggest that perhaps a more refined eddy-current theory which makes due allowance for the fact that the rate of propagation in cold-worked samples is not uniform might account for all the facts.

A more complete account of our measurements will appear in due course in the *Philips Research Reports.*

L. J. DIJKSTRA
J. L. SNOEK

Natuurkundig Laboratorium der
N.V. Philips' Gloeilampenfabrieken,
Eindhoven.
Jan. 27.

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[1] Sixtus, K. J., and Tonks, L., *Phys. Rev.*, **42**, 419 (1932).

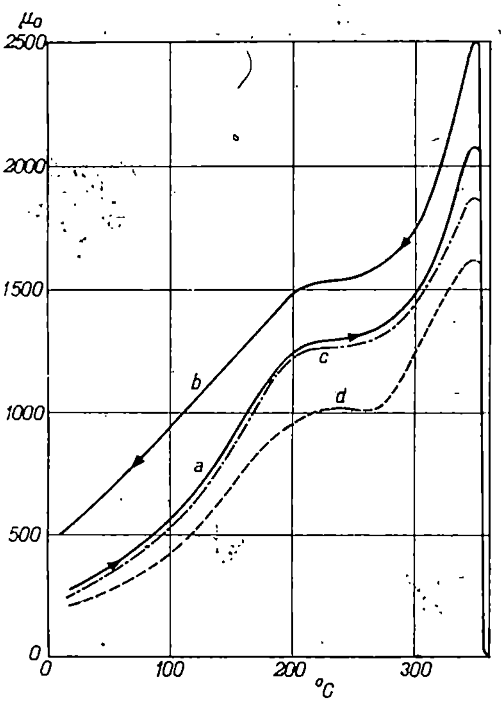
[2] Kersten, M., *Z. Tech. Phys.*, **19**, 546 (1938).

Metastable States of Nickel Characterized by a High Initial Permeability

IN text-books on the subject, it is usually tacitly assumed that the initial permeability, μ_0, of a ferromagnetic material not subject to ordering, ageing or allotropic transformations is a unique function of the temperature. We have found that this is not true for pure and well-annealed nickel.

Circular bars having a diameter of 4·5 mm. and a length of 250 mm. were examined by us in an arrangement permitting the measurement of μ_0 at any temperature between room temperature and the Curie point without displacing or touching the sample. The temperature could be varied at a mean rate of about 20° C. per minute.

It was found that the curve for μ_0 when taken at rising temperatures differs markedly from the curve obtained at decreasing temperatures (see accompanying graph). The new value of μ_0 at room temperature is nearly double that observed after demagnetizing and is appreciably higher than any value reported so far in the literature[1].



VARIATION OF THE INITIAL PERMEABILITY OF NICKEL WITH TEMPERATURE:

(*a*) at increasing temperatures; (*b*) at decreasing temperatures starting from a temperature slightly above the Curie point; (*c*) curve found after demagnetizing the sample at the temperature of the measurement; (*d*) curve found after slightly tapping the arrangement at the temperature of the measurement. Curves (*c*) and (*d*) are independent of the previous heat-treatment.

Slightly tapping the arrangement or demagnetizing the sample brings the initial permeability down to values which—though mutually different—are independent of the previous heat-treatment. A waiting period of twenty-four hours usually brings the permeability down a good deal. It was assumed by us that this might be due to slight vibrations in the building. Measurements in quieter surroundings—a small observatory—confirmed this view. The abnormally high value of μ_0 in the observatory remained constant for periods varying between ten minutes and many hours, after which a sudden—usually small—decrease in μ_0 occurred.

Observations with a vibration indicator showed that the basement of the observatory—though much quieter than our previous surroundings—also was not absolutely at rest.

Our observations thus seem to show that temperature agitation itself does not bring about the more stable condition, but that small mechanical shocks or a demagnetizing treatment are required.

In order to bring about an abnormal increase of μ_0, it is not necessary to heat the sample at a temperature above the Curie point. Actually a variation of the temperature by ± 100° suffices to bring about an abnormal increase in μ_0.

A more complete account of the measurements will appear in the *Philips Research Reports.*

J. L. SNOEK
J. F. FAST

Natuurkundig Laboratorium der
N.V. Philips' Gloeilampenfabrieken,
Eindhoven.
Jan. 27.

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[1] Kirkham, Don, *Phys. Rev.*, **52**, 1162 (1937).

Audio-Frequency Magnetic Fluctuations

A RECENT letter by Menzel and Salisbury[1] raises the question of the existence in Nature of electromagnetic waves of audio-frequencies and refers to observations covering the range 25–400 c./s. Magnetic fluctuations at these frequencies have been recorded at the Admiralty Research Laboratory, and on various occasions during the past year field measurements have been made, including some at an isolated site on Bodmin Moor, Cornwall, remote from man-made sources of electric disturbance. These measurements covered the range 5–1,000 c./s.

The detector consisted of a coil wound on a long laminated mu-metal core, the complete unit being light and easily portable. The signals were amplified, and measured by a wave analyser having a passband of 4 c./s. The entire equipment was operated from batteries.

At the higher frequencies the magnetic fluctuations are very weak, and the principal difficulty in the design of the equipment is to keep the resistance noise of the detecting coil adequately below the level of the 'magnetic noise' to be measured. To be certain that any one reading was due to magnetic noise and not to the noise of the coil itself was not always easy. Latterly, however, we have employed two similar coils for reception, located parallel to one another, sufficiently separated to make their magnetic coupling small, but at the same time close enough to ensure that their responses to magnetic fluctuations are in phase. If the coils are connected in series, the effects of the magnetic fluctuations reinforce one another; but if they are connected in opposition, these effects are cancelled. In the case of resistance noise it makes no difference which way the coils are connected provided their coupling is small. By switching the coils in series and opposition at each reading, it is then easy to decide to what extent any one measurement is due to genuine magnetic fluctuations.

The accompanying table gives typical values for the fluctuations of the horizontal magnetic field measured at Bodmin Moor in April and November 1947. These fluctuations were the same in all directions of the horizontal plane :

Frequency	Magnetic fluctuations for 1 c./s. pass band*
5 c./s.	6×10^{-8} Gauss
10	3×10^{-8}
20	8×10^{-9}
40	5×10^{-9}
100	1×10^{-9}
200	5×10^{-10}
400	7×10^{-11}
800	4×10^{-11}

* If these magnetic fluctuations were the magnetic components of an electromagnetic wave field, the corresponding electric field values, measured in micro-volts per metre, would be obtained by multiplying the above magnetic values by 3×10^{10}.

It is considered that these fluctuations are of natural origin. The absence of any directionality in the horizontal plane suggests that the fluctuations do not arise from the nearest highly populated area (Plymouth); and furthermore, the results showed no trace of the line spectrum obtained in such a populated area, other than a weak signal at 50 c./s.

The noise values show a rapid decrease with frequency, roughly inversely as the power 3/2. Beyond 1,000 c./s. it has not been possible to detect magnetic fluctuations above the noise of the existing detector system, and the observations suggest that there may exist a very silent region of the spectrum between 1,000 c./s. and the lowest radio frequencies.

Although the magnetic noise showed no directionality in the horizontal plane, it was often much less in the vertical direction, even at frequencies as low as 20 c./s. It is possible that this is due to eddy currents set up in the earth. If we suppose, for example, that the magnetic fluctuations arise from distant current movements in the atmosphere, near the earth's surface, then theory shows that the magnetic fields which they produce at ground-level at sufficiently large ranges will be largely horizontal, even at very low frequencies. In the experiments described above, the attenuation of the vertical fluctuations may have been accentuated by the fact that the ground was wet at the time. Above dry ground one would expect greater vertical fluctuations.

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Feb. 17.

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[1] Menzel and Salisbury, *Nature*, 161, 91 (1948).

Structure of Plasteins

THE molecular weight of the 'plastein' precipitated from a pepsin hydrolysate of egg albumen at *p*H 4 was found to be about 300 in determinations performed cryoscopically in a phenol solution[1]. Since the average molecular weight of peptides in pepsin hydrolysate is between 300 and 400 [2], no lengthening of peptide chains seems to take place in the formation of plastein, still less protein synthesis, as had generally been thought. For this reason we regarded the plasteins as being constituted of mixtures of cyclic peptides which are formed under the influence of certain proteolytic enzymes from low-molecular peptides in protein hydrolysates[1]. Of the earlier investigators, Folley[3] alone has supported the view of the low molecular-weight structure of plasteins.

In further studies on the formation and nature of plasteins, we employed chiefly the pepsin hydrolysate of zein. Crystalline pepsin was regularly used.

(1) The molecular weight determined by the cryoscopic method in a phenol solution was ascertained to be about 300 with three preparations of zein plastein. The values in phenol solutions are, however, too low as derived from the results of plastein hydrolysis recorded below. The average molecular weight of the known amino-acid residues in zein and plastein is about 116.

(2) The formation of plastein with pepsin has a strong maximum at *p*H 4. On the acid side, the limit of the reaction is at about *p*H 2·5; on the alkaline side about *p*H 7.

(3) The amino-acid composition of plastein and zein are very similar when the values are calculated on amide-free material. Since the amide-nitrogen chiefly splits off in the pepsin hydrolysis in the form of ammonia, the plastein preparations of zein contain only two to three per cent of the total nitrogen as amide-nitrogen. We found in zein-plastein (the values for zein[4] are in brackets): arginine + histidine 7·1 (7·0), glutamic + aspartic acids 23·1 (23·1), alanine + valine + leucine + *iso*leucine + phenylalanine + methionine 39·6 (39·3), proline 8·7 (9·7), tyrosine 3·6 (3·1). All values refer to amino-acid nitrogen as a percentage of total nitrogen in amide-free material.

The results of analyses suggest that the amino-acid composition of plastein corresponds roughly to that of protein. The differences in the proline and tyrosine values seem, however, to indicate that small variations may exist regarding some amino-acids. The analysis of the amino-acid groups derived from hydrolysate of egg albumen also gives an indication of the similarity of the amino-acid composition in protein and in the corresponding plastein.

(4) The free acid and basic groups in plastein were determined in two different ways. (*a*) We found on the basis of the safranine fixation[5] the quantity of the acid groups in zein plastein (containing 1·9 per cent of the total nitrogen as amide-nitrogen) to be $19 \cdot 4 \times 10^{-4}$ mol. per gm. The calculated value for cyclic peptides (the groups binding safranine: aspartic acid, glutamic acid, tyrosine, cysteine) is about 22×10^{-4}, for open tripeptide chains about 60×10^{-4}, and for pentapeptide 45×10^{-4}. The agreement is thus fairly good for cyclic structure.

(*b*) Titration with 0·1 *N* sodium hydroxide solution with a water suspension of plastein using thymol phthalein as indicator revealed that $22 \cdot 9 \times 10^{-4}$ mol. of sodium hydroxide had been bound per gm. plastein. Formol titration gave the value 21×10^{-4}. On the basis of the quantities of aspartic and glutamic acids in plastein, the theoretical value would be about 21×10^{-4} mole per gm. plastein, when cyclopeptide is concerned, and about 42×10^{-4} in the case of open peptide chains with one amino-dicarboxylic acid residue.

Determination of amino-nitrogen by Van Slyke's method (a plastein preparation dissolved in borate–sodium hydroxide solution at *p*H 10·0) gave the following values: 5 min. shaking, 4·4 per cent, 30 min. shaking, 6·8 per cent of total nitrogen. The small quantity of amide-nitrogen and a part of the arginine nitrogen may have reacted in the first place with nitrite. This result, too, supports the cyclic structure of plastein.

(5) Plastein is formed in the pepsin hydrolysates of all proteins examined which contain abundantly amino-dicarboxylic acids. Gliadine, which contains 25·5 per cent of total nitrogen as amino-dicarboxylic acid-nitrogen, yields under the same conditions more plastein than does zein containing 18·8 per cent amino-dicarboxylic acid-nitrogen. On the other hand, amino-nitrogen did not decrease and plastein could not be obtained with papain nor with pepsin, in a papain hydrolysate of gelatine, although plastein is precipitated from the papain hydrolysate of zein with both enzymes. The results so far seem to indicate that the acid groups in the peptides are indispensable for the formation of plastein. In a mixture containing glycyl-glycine, glycyl-*l*-leucine, *l*-leucyl-*l*-tyrosine, *l*-leucyl-glycyl-glycine, *dl*-alanyl-glycine, chloracetyl-*l*-tyrosine and hippuryl-glycine, amino-nitrogen was not lowered by pepsin action at *p*H 4, nor was plastein precipitated.

(6) In the trypsin hydrolysates of zein and casein, pepsin produced at *p*H 4 only 1–1·5 per cent plastein of the weight of protein used. In corresponding circumstances, ten to fifteen times more plastein was obtained from pepsin hydrolysates. Since pepsin and trypsin break the peptide bonds of protein at different points, it probably explains the difference. In the pepsin hydrolysis of zein, the peptide chain seems to break at the point nearest glutamic acid[2].

(7) Plasteins are slowly hydrolysed in hydrochloric acid at *p*H 1·5 at the opening of the ring. The reaction takes place much more rapidly under the action of pepsin in the same conditions. Acid hydrolysis (*p*H 1·5 and 37° C.) without pepsin brought 67 per cent of the plastein into solution in 33–55 days. On the basis of the amino-groups set free the average molecular weight of cyclopeptides would be the same as that of tetrapentapeptides. In the soluble and insoluble fraction the amount of amino-dicarboxylic acids seems to be practically the same, which supports the idea of each cyclopeptide molecule having one amino-dicarboxylic acid residue. On the contrary, proline is accumulated in the insoluble fraction. The soluble fraction, again, contains considerably more basic acids as well as acids of the group alanine + valine + leucine + *iso*leucine + phenylalanine + methionine than does the insoluble fraction.

The elementary composition of zein plastein (water and ash-free material) was as follows: C = 54·3, H = 7·6, N = 12·9 (calculated values for cyclic peptides: C = 54·1, H = 7·1, N = 13·8). Nitrogen of the amino-acids hitherto estimated in zein accounts for 94 per cent of the total nitrogen. The rest of the nitrogen is still of unknown nature. The calculated values are therefore only approximate.

We regard the present results as confirming the concept of the cyclic structure of plasteins. A detailed account of our work and further developments will be published in *Acta Chemica Scandinavica*.

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Jan. 27.

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[1] Virtanen and Kerkkonen, *Acta Chem. Scand.*, 1, 140 (1947).

[2] Laine, *Ann. Acad. Sci. Fenn.*, Ser. A. II, Chem. No. 11 (1944).

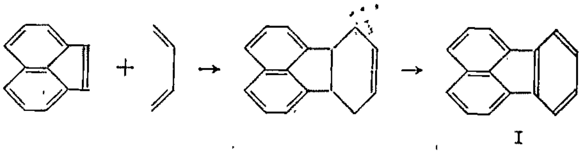
[3] Folley, *Biochem. J.*, 26, 99 (1932).

[4] Chibnall, *J. Intern. Soc. Leather Trades' Chem.*, 30, 1 (1946).

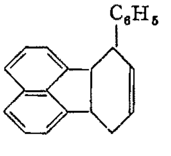
[5] Fraenkel-Conrat and Cooper, *J. Biol. Chem.*, 154, 239 (1944).

A Synthesis of Fluoranthene Derivatives

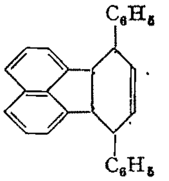
IN a recent investigation[1], the theory has been put forward that the formation of aromatic hydrocarbons in the high-temperature cracking of petroleum or petroleum fractions is due to diene syntheses between butadiene, which is one of the primary cracking products, and olefinic hydrocarbons. It occurred to us that fluoranthene (I), which is a characteristic product of this aromatizing cracking, may be formed from acenaphthylene and butadiene by the following reaction:



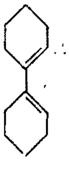
It has, indeed, been found that acenaphthylene reacts easily at 160–200° with dienes to give hydrogenated substituted fluoranthene derivatives: from 1-phenyl-butadiene and 1·4-diphenyl-butadiene, for example, 10-phenyl- and 10 : 13-diphenyl-9 : 10 : 13 : 14-tetrahydro-fluoranthene (II, III) have been obtained.



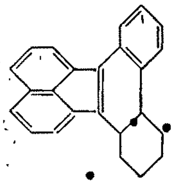
II



III



IV



V

Compound (II) had m.p. 156°, after recrystallization from alcohol (calc. for $C_{22}H_{18}$: C, 93·6; H, 6·4; found: C, 93·6; H, 6·4), and (III) had m.p. 202°, after recrystallization from chlorobenzene (calc. for $C_{28}H_{22}$: C, 93·9; H, 6·1; found: C, 93·6; H, 6·1).

With dicyclohexenyl (IV) the condensation seems to be accompanied by partial dehydrogenation and the analysis of the product corresponded to formula (V), of a 10 : 11-benzo-12 : 13-tetramethyleno-12 : 13-dihydro-fluoranthene[2]; it crystallized from a mixture of chlorobenzene and butyl acetate as a white, crystalline powder (calc. for $C_{24}H_{18}$: C, 94·1; H, 5·9; found: C, 93·9; H, 5·7).

It is interesting to note that sorbic acid behaves also as a diene[3]; in the course of the condensation with acenaphthylene, however, the carboxyl group is split off.

Acenaphthylene behaves, therefore, towards dienes like indene[4] and certain styrene derivatives[5]. This is in keeping with the fact that it contains an evidently very reactive double bond which makes the hydrocarbon also prone to polymerization and co-polymerization reactions[6,7].

A detailed description of the experiments will follow when the obvious possibilities of extension of this reaction will have been explored. It becomes possible to determine the position of substituents entering the fluoranthene molecule[8], from the location of substituents in the acenaphthene molecule, the reactions of which have been thoroughly investigated[9].

E. Bergmann

Daniel Sieff Research Institute,
Rehovoth.
Nov. 28.

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[1] Weizmann, Ch., and co-workers, *Ind. Eng. Chem.* (in the press).

[2] Such dehydrogenation has also been observed in the reaction of acenaphthylene and tetracyclone (Dilthey, Henkels and Schaefer, *Ber.*, **71**, 974 (1938)).

[3] This has been observed before in some isolated instances: Diels and Alder, *Liebigs Ann.*, **470**, 91 (1929). Farmer and Warren, *J. Chem. Soc.*, 906 (1929). Wagner-Jauregg and Helmert, *Ber.*, **71**, 2535 (1938). Wicks, Daly and Lack, *J. Org. Chem.*, **12**, 713 (1947), who also observed decarboxylation in the course of the reaction.

[4] Alder and Rickert, *Ber.*, **71**, 379 (1938). See Bergmann, E., and Bergmann, F., *J. Amer. Chem. Soc.*, **60**, 1805 (1938).

[5] Hudson and Robinson, *J. Chem. Soc.*, 715 (1941). Tamayo, *Chem. Abs.*, **41**, 4468, 6539, 6840 (1947).

[6] See, also, for references, Flowers and Miller, *J. Amer. Chem. Soc.*, **69**, 1388 (1947).

[7] Acenaphthylene shows dienophilic properties also towards tetracyclone and acecyclone: Dilthey and co-workers (ref. 2).

[8] See v. Braun and co-workers, *Ber.*, **63**, 2608 (1930); **67**, 4051 (1934); *Liebigs Ann.*, **488**, 111 (1931); **496**, 170 (1932). Tobler *et al.*, *Helv. chim. Acta*, **24**, 100 E (1941).

[9] It is substituted in 5-position (see, for example, Fleischer and Wolff, *Ber.*, **53**, 925 (1920). Dziewonski and Spirer, *Bl. Acad. Polon.*, A, **232** (1931). Liebermann and Zsuffa, *Ber.*, **44**, 207 (1911); but sulphonation at 100° attacks the 3-position (Dziewonski *et al.*, *Chem. Zentralbl.*, **97**, II, 2816 (1926); Dziewonski and Stolyhwo, *Ber.*, **57**, 1531 (1924); Morgan and Yarsley, *J. Soc. Chem. Ind.*, **44**, 513T (1925)).

Chemical Mechanism of Permanent Set

The permanent set which strained wool fibres acquire in steam or boiling water is believed to be due to two consecutive intramolecular reactions, namely, hydrolysis of the disulphide bonds to give sulphenic acid and mercapto side-chains, followed by condensation of the sulphenic acid, or the aldehyde to which it gives rise on decomposition, with the basic side-chains of lysine and arginine[1]. Disulphide bond breakdown promotes relaxation, and the relaxed structure is stabilized by the new cross-linkages. The main evidence that the basic side-chains play an essential part in the linkage-rebuilding reaction is the failure of deaminated fibres to acquire a permanent set in steam. It seemed desirable that further evidence should be obtained because of recent suggestions[2] that the breakdown and re-formation of hydrogen bonds between the peptide chains may be sufficient to impart a permanent set to strained fibres. The setting power of wool treated with 2 : 4-dinitrofluorobenzene has therefore been examined.

Purified Lincoln root wool was treated with 2 : 4-dinitrofluorobenzene according to Sanger's procedure[3]. The wool (0·2 gm.) was first wetted out with a solution of sodium bicarbonate (0·2 gm.) in water (5·0 ml.). After adding a solution of 2 : 4-dinitrofluorobenzene (0·2 ml.) in ethanol (10 ml.), the wool was heated in the reagent for 23 hours at 40° C., the resulting gain in weight being 9·4 per cent. For reference purposes, a further sample of wool was treated with all the reagents except 2 : 4-dinitrofluorobenzene for 23 hours at 40° C. The setting power of these wools was then compared with that of untreated wool.

Each fibre was stretched 40 per cent in distilled water and set by immersion in a boiling 2 per cent solution of borax for 30 minutes. To determine the extent and permanence of the set, the fibre was then released in boiling water and its length redetermined at intervals. A summary of the results is given in the accompanying table, each value being the mean of ten observations on different fibres.

Wool	Percentage set retained after release in boiling water for 0 min.	2 min.	15 min.	60 min.
Untreated	40·0	26·1	25·3	24·4
Buffer-treated	40·0	24·0	23·2	21·0
Treated with 2 : 4-dinitrofluorobenzene	40·0	16·9	15·3	11·8

Since the setting power of wool is reduced to such a striking extent by treatment with 2 : 4-dinitrofluorobenzene, it seems reasonable to conclude, in accordance with earlier evidence, that the free amino-groups of wool play an essential part in the cross-linking reaction which is responsible for permanent set.

We are indebted to Mr. W. R. Middlebrook for the preparation of the wools used in this investigation.

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Feb. 3.

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[1] Speakman, *J. Soc. Dyers and Colourists*, **52**, 335 (1936).

[2] Rudall, "Fibrous Proteins", 15 (Society of Dyers and Colourists, 1946). Phillips, *ibid.*, 39.

[3] Sanger, *Biochem. J.*, **39**, 507 (1945).

Energy of the Central C–C Bond in Diphenyl

The value of the energy of the central C—C bond in diphenyl (that is, the heat of dissociation of the molecule into two radicals (or atoms) formed by the fission of this bond) is of considerable interest. The difference between the energy of this bond and the energy involved in the C—C bond of ethane provides a measure of conjugation which was generally considered as 6–8 kcal. only[1]. We use the following two thermochemical equations for the calculation of the energy of the central C—C bond in diphenyl:

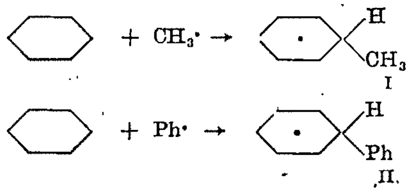
$$\Delta H_f(C_6H_5.C_6H_5) = 2\Delta H_f(C_6H_5) - D(C—C);$$

$$2\Delta H_f(C_6H_6) = 2\Delta H_f(C_6H_5) + 2\Delta H_f(H) - 2D(C—H).$$

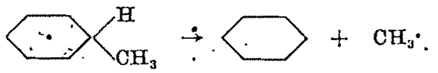
The heats of formation of diphenyl and benzene were estimated by Huffman[2] as 20·8 kcal./mole for solid diphenyl and 11·6 kcal./mole for liquid benzene. The heat of sublimation of diphenyl is 16·4 kcal./mole[3], that of vaporization of benzene 8·1 kcal./mole. For the C—H bond energy in benzene we accept the suggested value of 106 kcal.[4], which seems to be very plausible. Thus we obtain for the central C—C bond energy in diphenyl a value of 110 kcal. Its strengthening as compared to the C—C bond in ethane is 25 kcal., which shows how considerable is the contribution of the conjugation to the bond energy. This strengthening effect makes it possible to predict the length of the central C—C bond in diphenyl as 1·43–1·45 A., using the relationship between the bond energy and bond length.

There are two experimental studies dealing with the length of this bond. Dhar used the rotating crystal X-ray technique[5]; his value is 1·48 A., the estimated accuracy being about 10 per cent. Karle and Brockway[6] used an electron diffraction method. Assuming that both phenyl rings are regular hexagons having sides of 1·39 A., they find for the central C—C bond a length of 1·54 A.; if they assume the hexagons to be slightly irregular, having sides of 1·38 A. and 1·40 A., it is 1·48. In view of the great strengthening of this C—C bond, found in the present work, it seems that it has a high degree of double-bond character, which implies that the phenyl hexagons are strongly deformed. Therefore we suggest that the correct value for the central C—C bond in diphenyl which should be obtained from the electron diffraction study is even less than 1·48 A. The assumption that the hexagonal rings in diphenyl are irregular is supported by Jeffrey's work[7], which indicates the irregularity of the phenyl rings in dibenzyl.

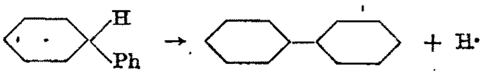
Chemical evidence also indicates that the energy of the central C—C bond in diphenyl is considerably increased and is certainly greater than 106 kcal. It is known[8] that free radicals produced in solutions of aliphatic hydrocarbons extract hydrogen from them. Methyl radicals thus produce methane and phenyl radicals give benzene. In benzene solution, however, methyl radicals do not extract hydrogen at all, and phenyl radicals react giving diphenyl. To show that this is the result of a reaction with benzene, and not a result of the dimerization of phenyl radicals, chlorobenzene was used as a solvent instead of benzene. In this solvent the main product of the reaction is *p*-chlorodiphenyl. We suggest that these facts should be explained by the following mechanism:



The point inside the ring symbolizes the odd electron. We may assume that the intermediates (I) and (II) stabilize themselves by releasing that component which is least strongly bound. In the case of (I), the most weakly bound component is CH_3 and the reaction is

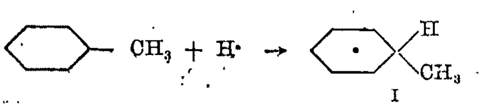


Therefore the net result is that no reaction occurs, as is observed experimentally. In the case of (II) the product is diphenyl, showing that the phenyl group is more strongly bound than the hydrogen atom.

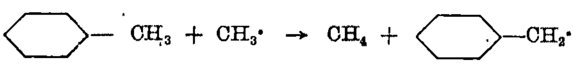


We conclude, therefore, that the C—C bond of diphenyl is stronger than the C—H bond in benzene. This must be stronger than the C—H bond in methane, because the methyl radical is not able to extract hydrogen from benzene (whereas it can extract hydrogen from an aliphatic solvent).

Another argument in favour of the proposed mechanism is found in the observation of Szwarc[9] that hydrogen atoms can react with toluene giving benzene and methane. In this case the intermediate (I) is obtained by the reaction



and this decomposes, as stated above, giving benzene and the methyl radical which gives methane by the reaction:



The benzyl radicals, being very stable, are removed by dimerization. Hence the value of 110 kcal. for the central C—C bond in diphenyl is borne out by additional chemical evidence.

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[1] Pauling, L., "The Nature of the Chemical Bond", 137 (Cornell University Press, 2nd edit., 1940).

[2] Parks and Huffman, "Free Energy of Some Organic Compounds", 90 (Chemical Catalog Co., New York, 1932).

[3] Wolf and Weghoffer, *Z. Phys. Chem.*, B, **39**, 194 (1938).

[4] Steacie, "Atomic and Free Radical Reactions" (Reinhold Pub. Co., 1946).

[5] Dhar, *Ind. J. Phys.*, **7**, 43 (1932).

[6] Karle and Brockway, *J. Amer. Chem. Soc.*, **66**, 1974 (1944).

[7] Jeffrey, *Proc. Roy. Soc.*, A, **188**, 222 (1947).

[8] Hay and Waters, *Chem. Rev.*, **21**, 169 (1937).

[9] Szwarc, *Nature*, **160**, 403 (1947); *J. Chem. Phys.*, **16**, 128 (1948).

Stress Corrosion

No really satisfactory explanation of stress corrosion (season-cracking) in brass and similar alloys has yet been offered, and in a recent critical review, Read, Reed and Rosenthal[1] were forced to conclude, somewhat unconvincingly, that stress corrosion might be due to an inherent susceptibility of crystal boundaries to corrosive attack on account of their 'lattice imperfection'. This view, however, would imply that grain boundary corrosion is a normal form of attack instead of being, as it is, abnormal.

It may be recalled that stress corrosion occurs only when susceptible alloys are internally stressed and then kept in certain specific corroding environments. These stressed alloys may be stored indefinitely in a pure atmosphere and, moreover, do not crack indiscriminately in all corroding media. Thus stressed brass does not crack in nitric acid (although, of course, it is attacked and dissolved), but cracks readily in air containing a mixture of ammonia, water vapour and carbon dioxide[2].

In speculating on possible mechanisms, I have previously suggested[3] that the basic cause might be selective chemical attack at the grain boundaries, localized by the formation of a protective film of corrosion product over the faces of the alloy crystals. Such a film might conceivably be protective only when its structure corresponds to the regular structure of the underlying crystals. At the grain boundaries where the regular structure of the alloy is interrupted, discontinuities in the adhering film might be expected. The effect of stress is considered to be simply that of widening the cracks first formed and thereby accelerating attack.

An observation made in these Laboratories on the stress corrosion of 9 ct. gold alloys in acidified ferric chloride solution lends support to this hypothesis. Alloys containing 37·5 per cent of gold with the balance made up of copper, silver and zinc, cold-rolled to about 80 per cent reduction in thickness, crack in less than five minutes in this solution. If, however, a sample, protected on one side with wax, is immersed so that the exposed surface bears against a small rotating brush, no cracking can be detected after thirty minutes, although considerable general corrosion takes place.

It seems difficult to account for this result on any grounds other than that of the removal of a local protective film from the surface of the metal. It is hoped that it may be possible to continue this work and publish a more detailed study elsewhere.

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Feb. 18.

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[1] Read, T. A., Reed, J. B., and Rosenthal, H., Amer. Soc. Test. Mat. and Amer. Inst. Mech. Eng., Symposium on Stress Corrosion Cracking of Metals, 90 (1945).

[2] Edmunds, G., Anderson, E. A., and Waring, R. K., *ibid.*, 7.

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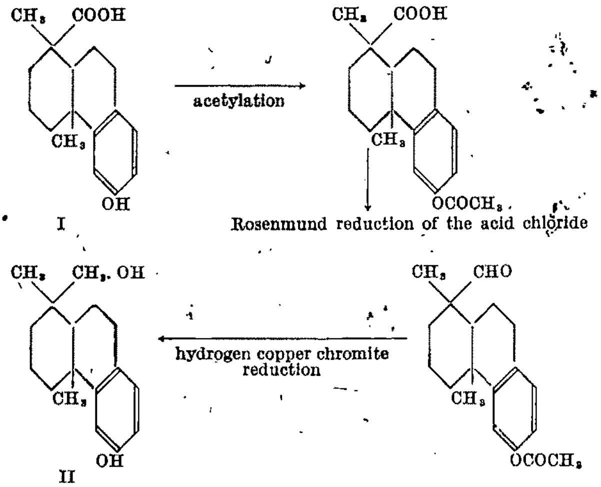
Podocarpic Acid as a Source of an Œstrogenic Hormone

Podocarpic acid occurs as crystalline 'heart shakes' in the wood of *Dacrydium cupressinum*, a forest tree endemic to New Zealand. It has been shown to possess the structure I by the work of Sherwood and Short[1] and Campbell and Todd[2,3]. The latter workers established that the 7-*iso*propyl derivative of podocarpic acid differs from 6-hydroxydehydroabietic acid only in the configuration of the methyl and carboxyl groups at C_1. The carboxyl group in podocarpic acid is, in fact, much more highly hindered than that of other resin acids.

In the course of their study of the configuration of podocarpic acid, Campbell and Todd[3] prepared 6-methoxy podocarpinol (for conversion to the 1-ethyl compound by the Wagner Meerwein rearrangement) but did not demethylate to podocarpinol II.



Fieser and Campbell[4] had previously prepared 6-hydroxydehydroabietinol and found it to possess considerable œstrogenic activity. Since this compound differs from podocarpinol only in configuration at C_1 and the presence of an *iso*propyl group at C_7, it was thought that podocarpinol might also possess œstrogenic properties.

We have recently prepared podocarpinol through the route shown, which differs slightly from that employed by Campbell and Todd. Preliminary physiological tests carried out by I. G. Cunningham, of the Animal Research Station, Wallaceville, New Zealand, suggest that podocarpinol possesses œstrogenic activity.

Details of the preparation of this compound and of the physiological tests will be reported fully elsewhere. Other modifications of podocarpic acid of possible hormonal activity are also in course of preparation.

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[2] Campbell and Todd, *J. Amer. Chem. Soc.*, 62, 1287 (1940).

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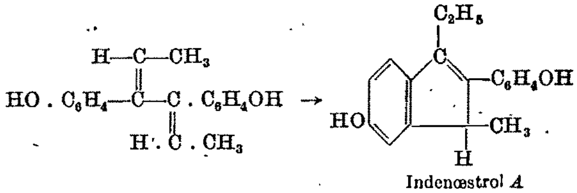
Isomerization of Dienœstrol

During experiments on the metabolism of dienœstrol in man and in animals it was noticed that hydrolysis of dienœstrol-containing urines, 1 N with respect to hydrochloric acid, always entailed a loss of about 90 per cent of the original œstrogenic activity. Further, chemical determination of the dienœstrol content of such urines by the method of Sahasrabudhe and Wilder Smith[1] showed an even greater loss of œstrogen after hydrolysis. In working out the latter method, dienœstrol was added to benzene extracts of hydrolysed urine, so that the added dienœstrol escaped the hydrolysis process. Afterwards it was found that hydrolysis of dienœstrol glucuronide[2] under similar conditions gave negligible yields of the free œstrogen (cf. Stroud[3]). On the other hand, the same hydrolysis technique (1 N hydrochloric acid, 3 hr. refluxing) gave excellent yields of hexœstrol from hexœstrol monoglucuronide. Thus it was suspected that the dilute acid was decomposing the dienœstrol liberated.

This was confirmed by treating dienœstrol (m.p. 232°) for 1 hr. under reflux with 1 N hydrochloric acid in a stream of nitrogen, when an 80 per cent yield of an isomer, m.p. 175–176°, was obtained which was not identical with Hobday and Short's[4] *iso*dienœstrol, m.p. 189°. Its acetate, benzoate and *p*-nitrobenzoate were prepared and shown to be isomeric with those of dienœstrol but not identical.

A search of the literature revealed that Adler and Hägglund[5] prepared the same isomer from dienœstrol by treating its chloroform solution with boron trifluoride. These authors identified the substance as 1-methyl-2-(*p*-hydroxyphenyl)-3-ethyl-6-hydroxyindene, which they called 'indenœstrol *A*'.



Indenœstrol *A*

We have found this indene to possess about one tenth of the œstrogenic potency of dienœstrol, when tested by the method used in this Institute[6], thus accounting for the originally observed losses of activity on hydrolysis of dienœstrol-containing urines.

It has been found that, as well as 1 N hydrochloric acid, 1 N sulphuric and 1 N phosphoric acids are equally effective in realizing the same cyclization. This presumably may take place by 1 : 4 addition of the elements of water or of the respective acid, followed by resplitting off of the hydroxy group or the acid radical with the hydrogen atom in the ortho position. Similar mild conditions were required for the cyclization of other comparable types of dienes. The addition of a trace of hydrogen chloride or concentrated sulphuric acid to a solution of dienœstrol in glacial acetic acid in the cold gave a good yield of the same cyclization product after a very short reaction period.

Fuller details will be published elsewhere.

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Feb. 23.

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Glycerol Dichlorhydrin and Vitamin A

The use of 'activated' glycerol dichlorhydrin as a reagent for the colorimetric or absorptiometric estimation of vitamin A has been proposed by Sobel and Werbin[1]. As reported, the reaction appears attractive in view of the stability of the chromophor, which makes for ease of measurement. A disadvantage is the low activity of the reagent compared with chloroformic antimony trichloride (Carr–Price reaction); the E(1 per cent, 1 cm.) 550 mμ value per unit of vitamin A is only about 25 per cent of the corresponding E(1 per cent, 1 cm.) 620 mμ (Carr–Price) value. The pure compound does not react at all; 'activation' is effected by distillation with 1–2 per cent antimony trichloride[1]; but no account of what causes 'activation' has yet appeared.

It has been found here that the activating principle is hydrochloric acid (or, perhaps, hydrogen ions, in so far as sulphuric acid has some activating effect), small quantities of which are formed during distillation. The same result, therefore, can be obtained more easily by the addition of about 2 per cent of concentrated hydrochloric acid to the dichlorhydrin. If used within a short time of mixing, the product behaves in a similar manner to that activated by the original method. On storage, the activity increases still further, but does not approach that of the Carr – Price reaction. On the other hand, the stored reagent loses the very desirable property of stability of the chromophor, which develops and fades in much the same way as with the Carr – Price reagent.

It appears, therefore, that the reagent can be made sufficiently sensitive to replace the Carr – Price reagent only at the expense of the advantage which it claims over it, namely, stability of the chromophor.

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Feb. 18.

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[1] Sobel, A. E., and Werbin, H., *J. Biol. Chem.*, **159**, 681 (1945); *Ind. Eng. Chem. (Anal. Ed.)*, **18**, 570 (1946); *Anal. Chem.*, **19**, 107 (1947).

Pressor Effect of Renin on Pulmonary Artery Pressure

In 1940 Katz and Steinitz[1] reported that following the production of hypertension in dogs by means of an experimental renal ischæmia, no change was observed in pulmonary arterial pressure. These workers used a modified London cannula technique so that observations could be made without anæsthesia in the intact animal. Using a similar method, Friedberg, Katz and Steinitz[2] found an increase in pulmonary arterial pressure in the dog after the injection of renin. They concluded that this was not due to a vasoconstrictor effect on the pulmonary bed, but to a reflexion of the change in systemic blood pressure through back pressure on the pulmonary circuit. We have confirmed the pressor effect of renin on the pulmonary artery pressure but are at variance with the opinion of the previous workers as to its causation.

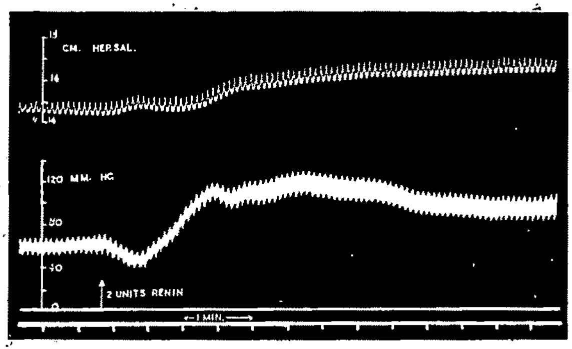
Renin was prepared from rabbits' kidneys by a modification of the method of Helmer and Page[3], and a study made of its effects on pulmonary artery pressure in dogs, a simultaneous record of femoral artery pressure being taken. Renin was injected into the femoral vein. Femoral artery pressure was observed by cannalization of the artery, a mercury manometer recording on a kymograph.

Pulmonary artery pressure was recorded by tying a T cannula, connected with a heparin-saline manometer, into the pulmonary artery extra-pericardially. Lateral pressure was therefore recorded in continuity. Such a procedure necessitated thoracotomy, performed by sub-periosteal resection of the sixth rib. Observations have been made with an open chest under pump respiration.

In all cases a rise in pulmonary artery pressure was observed. In the particular record shown, the initial blood pressure is rather low, in that it was taken from an animal on which a pneumonectomy had previously been performed, in the course of other work by one of us. Two units of renin, assayed on a 2-kgm. cat, were injected.

Both systemic and pulmonary artery pressures rose, the systemic reaching a peak in 2½ min., the pulmonary artery in 6½ min. Each pressor effect was sustained for 13 min. These figures apply to the particular experiment of which a portion of the record is shown, but similar durations were found in all cases. Before the pressor effect, the ratio between systemic and pulmonary artery pressures was 6 : 1, during the effect 10 : 1. Therefore the rise in pulmonary artery pressure was absolutely and relatively much less than the rise in systemic arterial pressure, although the durations of the two were similar. The slight initial rise in pulmonary artery pressure is due to the transient increase in venous return to the right heart occasioned by the injection of 2 ml. renin and 2 ml. saline wash.

While agreeing with the findings of Friedberg, Katz and Steinitz that the injection of renin produces a rise in the pulmonary artery pressure, our findings as to the details of this pressor effect differ from those of these authors, in that they found a greater percentage increase in pulmonary artery pressure than in systemic arterial pressure, which former rise was of shorter duration.



The pressor effect on the pulmonary artery pressure as described and illustrated in the figure is presumably due to one of, or a combination of, three causes: (*a*) bronchiolar constriction produced by renin; (*b*) a back pressure effect from the rise in systemic arterial pressure; (*c*) direct vaso-constriction, by renin, of the arterioles of the pulmonary circuit.

Further analysis of the cause of the effect is proceeding.

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[1] Katz and Steinitz, *Amer. J. Physiol.*, **128**, 433 (1940).

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A Culture Method for *Lymnæa truncatula*

The amphibious snail *Lymnœa truncatula*, which serves as an intermediate host of the liver fluke, *Fasciola hepatica*, has been found in the past to be somewhat difficult to maintain in laboratory culture. In connexion with current work on the epidemiology of the severe disease of grazing animals which is caused by this parasite, one of our first problems was to establish satisfactory means of culturing the snail. Our attempts have proved so far successful that we are able to grow the snails in unlimited numbers, at different seasons of the year and to a larger size than they usually attain in their natural habitat.

On account of the particular interest of this mollusc and its association with *Fasciola hepatica* in the teaching of biology, as well as for the benefit of research workers in the field of parasitology, we felt that a description of the culture method might be of interest and value.

Having met with little success by aquatic culture methods, we proceeded with an attempt to reproduce in glass and earthenware vessels the natural habitat of the snail. This habitat comprises the small open mud flats that lie between pools of shallow water and low grassland. Finally, we developed the following technique. Unglazed earthenware pans, without holes in the bottom, 12–18 in. in diameter, of the kind used by nursery men serve as containers for the mud. Before use the pans are soaked for some days in pond water, then they are dried and coated, on the outer surface only, with paraffin wax, in order to prevent undue loss of water by evaporation. The mud which is to form the substratum of the culture is mixed with pond water in such proportions as to give it a wet plastic consistency. It is then sterilized by heat to destroy unwanted trematode infection and is placed in each pan in such a way as to form an even slope extending from near the upper lip on the one side to the floor of the pan on the other side. Depressions are made on the surface of the slope in several places, simulating on a small scale the footprints of animals, and sufficient pond water is poured over the surface of the mud to form a small pool at the bottom of the slope. The pan is then covered by a piece of glass and placed in a greenhouse where there is abundant light, to encourage the growth of algæ, and heat adequate for rapid development of the snails.

In two or three weeks the mud becomes covered with a thick growth of algæ and is then ready for the introduction of the snails. A light sprinkling of a mixture of equal parts of finely powdered natural chalk and fine oatmeal flour is applied to the surface of the mud at weekly intervals. This supplement to algal food, along with the addition of distilled water which is poured over the surface of the mud to make up for slight loss by evaporation, is all that is needed for the maintenance of the culture. It is important that the water and the mud should be of the most suitable kind for the culture of this snail, and it has been our practice to collect the mud from a heavy clay soil on which the snails are found to thrive particularly well in the natural state. The water used in the first preparation of the mud slope and for the first pool in the culture dish is also collected from this natural habitat. The sterilization of the mud is only carried out to eliminate unwanted fluke infection for the purpose of our particular work, and might not be necessary for ordinary purposes.

Our experience has revealed a much more rapid rate of multiplication of this snail than we had anticipated, and maintenance of a culture is such a simple matter that there would appear to be every reason for developing its use in the teaching of biology for demonstrating the life-history of a trematode.

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Resistance to 'Inanition' in Grass Seedlings

Resistance to 'inanition' in the early seedling stage of various species of herbage grasses when grown in competition with older established plants has been reported by Chippindale[1,2]. Recent observations on perennial ryegrass (*Lolium perenne* L.) suggest that a similar resistance occurs in larger seedlings, nine to ten weeks old, both in competition with plants of the same age and species, and also

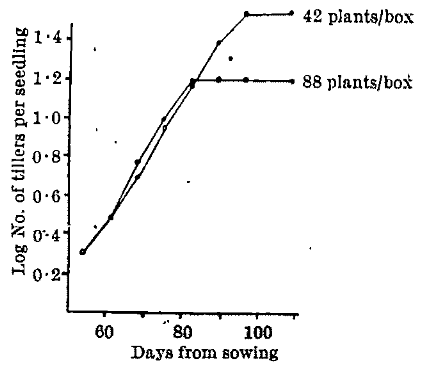

Fig. 1. MODAL SEEDLINGS FROM BOX POPULATIONS OF DIFFERENT DENSITIES. SOWN JAN. 20, 1947

when grown as single individuals with a limited root range and supply of soil nutrients.

In seedling studies on perennial ryegrass, attempts were made to obtain standard measurements of growth, which, unlike the usual dry-weight determination, did not involve destruction of the seedling, and could thus be traced throughout the life of the plant. Tiller number per seedling proved to be one of the most useful of these measurements, being highly correlated with dry weight, a typical box population giving $r = + 0{\cdot}7416$, $n = 41$, $P < 0{\cdot}001$. For these experiments, any tiller visible above its subtending leaf-sheath was given unit value.

During early seedling growth, tiller number increases exponentially with time for each plant (Figs. 1 and 2), the exponential rate of tiller production decreasing with decrease in temperature, until below 38–40° F. no tillering occurs. For any one set of environmental conditions, this rate of tiller production is similar in all seedlings of a population, high or low tiller counts being the result of early or late initiation of tillering (Fig. 2). There is a highly significant correlation between tiller number and rate of leaf production in the initial stages of seedling growth, as would be expected since the tiller arises as a bud in the leaf axil. A typical example gives $r = + 0{\cdot}6350$, $n = 35$, $P < 0{\cdot}001$.

When seedlings are grown with limited root range and soil nutrients, either in a box population or individually in small paper pots, after a time the initial exponential growth is sharply curtailed. Tillering ceases and leaf production is greatly reduced and may stop completely. This situation presumably corresponds to the 'inanition' observed in very young seedlings.

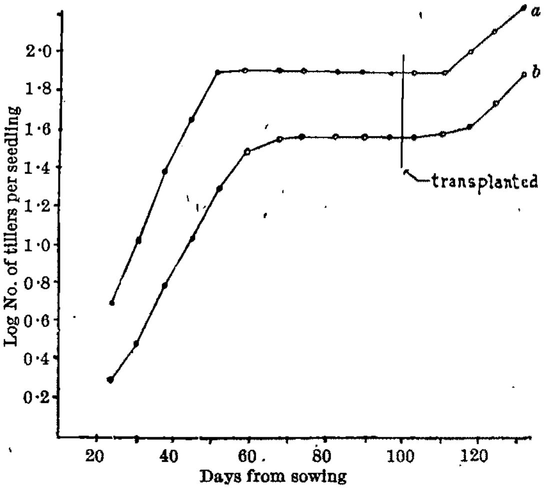

Fig. 2. EARLIEST (*a*) AND LATEST (*b*) TILLERING SEEDLINGS FROM INDIVIDUAL POTS. SOWN JUNE 29, 1947

Fig. 1 shows the increase in tiller number with time, for modal single plants from box sowings of Irish commercial ryegrass, at seedling densities of 42 and 88 plants per box. This gives an average root space per plant of 259 and 124 c.c. respectively. There is no difference in the exponential rates of tillering in the two boxes, but tillering ceases much sooner with the denser spacing. These seedlings were transplanted to the field 110 days after sowing and quickly began to tiller vigorously. In these box sowings there was no competition for soil moisture, water being supplied regularly. The other possible limiting factors were competition for light, root interaction, and competition for soil nutrients. To eliminate the effects of root interaction and competition for light, seedlings from the same sample were grown individually in small paper pots of cubic capacity 195 c.c. Fig. 2 shows the increase of tiller number with time, for the earliest and latest plant to begin tillering. There is again no great difference in the initial rates of tillering, and for each plant, tiller production suddenly ceases, presumably when the soil nutrients in the pot have become exhausted. In general, seedlings which begin tillering earlier reach a higher limiting tiller number, even in the absence of inter-plant competition, and also attain their limiting size earlier.

When tillering had ceased in all these seedlings, each was transplanted to a larger pot (2,025 c.c.), thus giving a further supply of soil nutrients. In each case, tillering recommenced after a short interval and proceeded exponentially. By the time growth started again, the most highly tillered seedling had remained in a state of 'inanition' for 60 days, without any apparent dying-back of any of the tillers.

These observations, although confined to perennial ryegrass, do suggest that this resistance to 'inanition' caused by lack of soil nutrients may be an important factor, not only in initial establishment, but also in subsequent competition in the sward.

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Occurrence of Volcanic Bomb in the Agglomeratic Slates of Kashmir

THE specimen of volcanic bomb described here was collected in June 1946 by Mr. S. R. N. Rao, reader in geology, University of Lucknow, from a ridge near the village of Bren (lat. 34° 6½′ N., long. 74° 52¾′ E.) about 5½ miles north of Srinagar. It comes from the formation known as the Agglomeratic Slates, which form the lower part of the Panjal Volcanic Series. They are gritty or greywacke-like, and often grade into slates. In the fine matrix, angular fragments of quartzite, slate, porphyry, granite, etc., are distributed at random. The Agglomeratic Slates of Bren contain Lower Gondwana plants, associated with a series of sandstones and shales containing a marine brachiopod fauna[1] and *Eurydesma.*

Two views were put forward by Middlemiss[2] for explaining the origin of the Agglomeratic Slates of Kashmir: (1) that these rocks were a product of explosive volcanic activity and sub-aerial deposition; (2) that the deposit resulted from frost action under glacial conditions, the frost-weathered matter being transported to lakes through the agency of floating ice. Wadia[3], after a detailed study of the rocks, favours a pyroclastic origin for the Agglomeratic Slates.

VOLCANIC BOMB FROM BREN SPUR NEAR SRINAGAR, KASHMIR. 3/5 NATURAL SIZE

Our specimen appears to be the broken half of an ellipsoidal volcanic bomb. It measures 5·7 in. along the longer axis and 2·3 in. along the shorter. The structure is clearly revealed by the broken surface. There is an outer crust, of an average thickness of about ¾ in., enveloping a core of typically vesicular rock. The crust is compact, slightly earthy and greenish-yellow in colour. The core is yellowish-brown, with cavities which are elliptical or triangular in shape and aligned parallel to the length of the bomb. If the bomb had been completely preserved, its thickness through the centre would have been about 3·6 in. The outermost portion of the crust appears to have been of a deep brown colour. A small patch of this colour, about 4 mm. in thickness, can still be seen on one side.

A detailed petrological study reveals that the rock of the volcanic bomb is felso-andesite.

The discovery of a volcanic bomb in the Panjal Agglomeratic Slates proves beyond doubt that these rocks are due to explosive volcanic activity.

I am obliged to Mr. Rao and Dr. P. K. Ghosh, of the Geological Survey of India, for confirming my observations.

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Proposed Central Publication of Scientific Papers

MANY of the problems of scientific publication that will be considered at the forthcoming Scientific Information Conference called by the Royal Society of London for June[1] could be solved by use of the method of auxiliary publication that has been in use in the United States since 1936 [2,3].

Auxiliary publication on demand does not interfere with the free and normal channels of scientific publication. The benefits of the central distribution of scientific papers proposed by Bernal can be obtained without the dangers of centralized control set forth by Sir George Thomson and Dr. J. R. Baker[4].

Some three thousand scientific papers, called 'documents', are on deposit with the auxiliary publication service of the American Documentation Institute at Washington, D.C., and additional material is being deposited constantly. A catalogue of such ADI Auxiliary Publications is available[5]. Primarily, the existence of the 'document' and its availability on order is notified to scientific men and others by publication of notices in the journals whose editors transmit the documents for deposit. 'Documents' are noted in abstract journals in the same manner as other articles. Those who desire a 'document' order it and receive it in microfilm or photoprint form.

The auxiliary publication plan has been adopted by such large-scale literature distribution operations as that of the Office of Technical Services of the U.S. Department of Commerce, which has on file more than five million pages of material, largely technical German documents, which it distributes in this manner. In the world organisation of scientific literature, it would be desirable to co-ordinate and provide interchange between auxiliary publication centres when they are established in various countries or geographical regions.

The detailed operation of auxiliary publication, applicable to original publications, translations, reference material, illustrations and tables alike, is as follows.

The editor of a journal can publish as much or as little of a technical paper as he wishes. In the case of a very specialized paper, it may be only an abstract or summary. He appends to the notice or article a note saying that the full article with diagrams, pictures, etc., can be obtained by remitting a certain price and specifying the document number under which this full article has been deposited at the central agency operating the auxiliary publication service. Orders are sent by readers directly to this central agency, which is the American Documentation Institute at Washington, D.C. Microfilms of the 'document' or, when desired, enlarged photoprints readable without optical aid are made only if and when ordered. In this way the 'document' is perpetually 'in print' but no extensive, space-consuming stocks need be stored—only the 'document' itself and the microfilm negative from which positives are made for distribution. The operation of the plan is simple and uncomplicated, and editors may use it when, how, and if they find it helpful. No financial participation or guarantees on the part of the editor or author are required. While the plan of auxiliary publication suggested could be used with other methods of duplication, microfilm is the least expensive and most universal, in that it will handle text and illustration of any sort.

WATSON DAVIS

Science Service,
Washington, D.C.
May 19.

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MESONS AND NUCLEONS

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I SHOULD like to direct attention to an approach to the problem of the relation between mesons and nucleons, which, although speculative, seems to give a reasonable account of the main features of our present knowledge, including the fundamental work recently carried out at Bristol. The main assumptions, some of which have already been discussed by other physicists, are given below. We use the nomenclature employed by the Bristol observers for the different categories of mesons observed in photographic plates.

(1) The ordinary cosmic-ray meson (μ-meson), and its neutral counterpart, are particles of spin $\hbar/2$ with Fermi statistics. The decay of a charged meson is a true β-process, giving rise to a neutral meson, an electron and a neutrino.

(2) These particles interact by means of a Yukawa field corresponding to positively and negatively charged particles of integral spin, Bose statistics, and masses of mesonic order of magnitude. There being only charged particles of this kind, interactions of pair type will be essential. The role of these particles, and their properties, being similar to those of the photons, we may perhaps call them 'electro-photons', reserving the name meson for the particles mentioned in (1). Some σ-mesons may be of this kind, and they may be expected to occur in penetrating showers.

(3) π-Mesons, and possibly other mesonic particles of still higher mass[1], are supposed to be metastable compound systems of mesons, held together by means of the interaction mentioned above. Moreover, as a working hypothesis, we shall assume the nucleons themselves to be stable compound systems of mesons.

Having stated them, we shall now attempt a brief discussion of the arguments in favour of these assumptions, and the difficulties which they raise. Thus, in the first place, we encounter a well-known feature of any relativistic theory: the difficulty of forming a compound system with dimensions smaller than the Compton wave-length of the constituent particles. In the present instance, this length is of the same order of magnitude as the range of the forces. Dr. N. Hu has kindly pointed out to me that this difficulty is much more pronounced in an s-state than in one where the particle has an angular momentum. This may mean that a stable compound system contains only one particle in an s-state—two such particles involving a great increase in the strength of the field in which each of them moves—and, in addition, as many particles in states with an angular momentum, as is required to make the binding energy per particle as high as possible. Without a more developed theory of the interaction, it is, of course, difficult to predict how large the number of particles will be, but making use of the actual mass values of the particles in question, we may, hypothetically, regard a neutron as being built up of seventeen neutral mesons. We may assume that these particles form complete p-groups (six particles), d-groups (ten particles), and a single particle in an s-state. Of course, this classification of the separate particles according to their angular momentum is only valid in the Hartree approximation; nevertheless, it would seem to be a sufficient approximation in the present case. In order to balance the very high kinetic energy of these particles, contained in a volume of the order of magnitude $(\hbar/\mu c)^3$, where μ is a mass of mesonic order of magnitude, the forces must, of course, be much stronger than those occurring between the nucleons in the atomic nuclei. Since, however, in most nuclear force theories, a 'cut-off' procedure is applied at a distance comparable with the range of the forces, this may not require any particularly high value of the interaction constant g, but only a less violent 'cut-off'.

Suppose now that the rest mass, m_ν, of the neutral meson is 120 m_e, m_e being the electron rest-mass, a value which seems to be consistent with the conclusions of the Bristol workers. In fact, the values $m_\nu = 120\ m_e$, m_μ (mass of ordinary charged meson) $= 220\ m_e$, and m_π (mass of π-meson) $= 365\ m_e$, would correspond to a kinetic energy of the decay meson in the Bristol experiments of 4·4 MeV., and a ratio $m_\pi/m_\mu = 1{\cdot}66$. Comparing the value $17 \times 120\ m_e$ with the mass of the neutron, 1839 m_e, we obtain a binding of 100 MeV. for the neutron, a value which seems not unreasonable in view of the recent Berkeley experiments, which may perhaps be taken as an indication that nucleons can be broken up in collisions at an energy of some hundred MeV.

Since, according to the above assumptions, the decay of the ordinary meson is, so to speak, the prototype of all β-processes, it is important that the value of the life-time, $\tau = 2 \times 10^{-6}$ sec., and the energy available in the process $\sim 100\ m_e c^2$, fit in very well with the value to be expected from our knowledge of the β-decay. Let ε be the energy available divided by $m_e c^2$, and F (ε) the well-known Fermi function, which for large ε-values may be taken as $\varepsilon^5/50$. We then obtain for the product $\tau . F\ (\varepsilon)$—putting $\tau = 2 \times 10^{-6}$ sec. and $\varepsilon = 100$—the value 667, which is of about the expected magnitude. The value $\varepsilon = 100$ would also seem to be consistent with the energy values indicated by the small number of cloud-chamber pictures of decaying mesons. (The above considerations were essentially stimulated by a communication kindly made to me by Prof. J. Blaton in connexion with an interesting attempt to regard the π-meson as a compound system of a neutral and a charged meson. In this approach, the component particles were supposed to be of integral spin, and kept together by forces of the original Fermi type, corresponding to an interaction by means of electron-neutrino pairs. It was then found that the interaction constant corresponding to the meson life-time is of the same order of magnitude as that to be expected from Fermi's original theory of β-disintegration, a result which is, of course, identical with that of the above calculation; see also Konopinski[4].)

Proceeding now to the proton, we shall again assume a system of seventeen particles, but with a unit charge. Owing to the strong interaction with the Yukawa field, this charge would probably belong to the whole system rather than to any individual meson. Keeping in mind that the charged meson is about 100 m_e heavier than the neutral meson, the question arises how this difference can be more than compensated in the compound system, so as to give the observed difference in mass of the proton and the neutron. A possible explanation may be that the interaction corresponding to an exchange of a single electrophoton, in the interaction between unlike particles, has to be added to the pair interaction in the case of like particles. An estimate of the constant g of this interaction, required to compensate the mass difference in question, is seen to give a very reasonable value of the order of magnitude of the electronic charge. In fact, since the size of a nucleon is probably of the order of magnitude of, or even smaller than, the range of the forces in question, we may estimate this effect by considering the decrease of potential energy of a sphere of N particles each of electric charge g, to which a particle of charge $-g$ is added. This, now, will be equal to $\frac{3}{5}\cdot\frac{(2N+1)}{a}g^2$, if a is the radius of the sphere. With $N = 16$, we obtain thus the following approximate relation

$$\frac{3}{5}\cdot\frac{33g^2}{a} \simeq 100\, m_e c^2 = 100\,\frac{e^2}{a_0},$$

where a_0 is the radius to the electron; or, $g^2 \simeq 5\,\frac{a}{a_0}\,e^2$. From the well-known sizes of atomic nuclei, we get, as an upper limit to the value, $1{\cdot}2 \times 10^{-13}$ cm.; while $a_0 = 2{\cdot}8 \times 10^{-13}$ cm.; and thus $g^2 \lesssim 2e^2$.

The problem of the capture by nuclei would, of course, be a rather different one for the mesons and for the electrophotons. The latter particles would probably behave in accordance with the theories developed along the lines of Yukawa's original ideas, mesons taking now the role of nucleons. On the other hand, the former particles may either be captured in a way somewhat analogous to the K-capture (similar to suggestions put forward by Pontecorvo and Weisskopf[2]), with the emission of a neutral meson and a neutrino pair; or in an annihilation process of the Dirac type. As Dr. B. Bruno has kindly pointed out to me, this latter process will have a considerable probability, a point to which he hopes to return in connexion with a study of the problem of meson capture.

As to the Yukawa particles or electrophotons, their relation with the meson being similar to that of mesons and nucleons in the current meson theories, we should expect to observe their creation by *Bremsstrahlung*—in processes, for example, such as the impact between fast nucleons or mesons. Moreover, we should expect that mesons could be created in pairs by electrophotons as well as by photons of high energy, a phenomenon which may, perhaps, play a part in the penetrating showers. On the other hand, collisions between fast particles and nuclei may lead to the break-up of nucleons, whereby metastable compound systems like the π-meson may be formed. In such processes we should expect an excess of positive particles, although negative particles of this kind are perhaps not excluded, owing to the strong interaction of the mesons with the electrophotons. Nevertheless, we should expect the positive and negative mesons, like positrons and electrons, to be separated by an energy gap equal to twice the rest-mass energy. Just as the ordinary neutron is closely connected with the positive proton only, we should expect that there would be two kinds of neutral mesons, connected with the positive and the negative mesons respectively, which would probably have magnetic moments of opposite sense relative to the spin.

As regards the problem of the interaction of nucleons, the above considerations would imply some modifications of the theory by the introduction of a natural radius of a nucleon; that is, a strong repulsion when the distance between the nucleons gets below a certain value, $\simeq 10^{-13}$ cm. This may have some consequence for the scattering problem, as well as for the problem of the saturation of nuclear forces. Further, if a nucleon is a compound system of some seventeen particles, the value of the interaction constant for the force between two nucleons will have a less fundamental significance than in the ordinary meson field theory. Since the Yukawa theory of β-radioactivity would have to be applied to the mesons interacting with electrophotons, we shall expect the life-time of the latter particles to be considerably shorter than that of the mesons, which may account for the lack of evidence for the existence of these particles. It would perhaps be worth while, however, to consider the possibility that the large spread of the mass values obtained for the cosmic ray mesons may be partly due to some of the measured particles being electrophotons. In an attempt to regard the nuclear field force theory as a generalization of the relativistic field theory of electromagnetism and gravitation, I obtained the following expression for the rest mass μ_e of a charged Dirac particle, as compared with the rest mass of the corresponding neutral particle μ_n:

$$\mu_e = \sqrt{\mu_n^2 + \mu^2},$$

where μ is the mass of the electrophoton[3]. Apart from the ambiguity still present in the basic assumptions, this formula neglects possible self-energy effects on the masses of the particles. Still, it is interesting that, with the above values for μ_e and μ_n, it gives a reasonable value for μ, namely, 185 m_e.

According to the view developed here, the building up, as well as the destruction in any appreciable amount, of nucleons would require conditions differing even more from those prevailing in the known parts of the universe than those necessary for the building up and destruction of nuclei. Thus an equilibrium in which there is a considerable dissociation of nucleons into mesons would seem to require a temperature corresponding, at least, to $kT \simeq 100$ MeV. At this temperature, the mass density of meson pairs, as calculated from the ordinary Fermi distribution formula, would approach that in the interior of an atomic nucleus.

In concluding these remarks, it may be stressed that owing to the strong assumed interaction between mesons and electrophotons, and the size of the Compton wave-length as compared with the range of the forces, we are at the extreme limit of the region where it is permissible to speak about systems built up of individual particles. Although this would suggest that great caution should be observed in the handling of the problem, it would not seem, *a priori*, to make fruitless an attempt such as that under consideration.

Note added to proof. Since the above was written, definite evidence has appeared in favour of a mass value $\sim 300\ m_e$ for the σ-mesons; their production in the Berkeley experiments and their star-producing capacity making it, moreover, very probable that they are the true Yukawa particles or electrophotons. Their assumed identity with the π-mesons, which, if correct, would necessitate important alterations of the hypothetical postulates put forward in the above note, seems to me less evident, however; and it is perhaps not out of place to discuss the consequences of the opposite assumption in the light of the new results.

Thus it would seem natural to assume the mass m_σ of the σ-meson to be smaller than $m_\nu + m_\mu$, the sum of the masses of the two μ-mesons, charged and neutral; while m_π, the mass of the π-meson, would have to be greater than $m_\nu + m_\mu$. Using the values of the above example, we should have $m_\pi > 340\, m_e > m_\mu$, an inequality which does not seem contradictory to present experience. While on this assumption the σ-meson could not spontaneously give rise to a pair of μ-mesons (charged and neutral), such a process would be possible in the field of a nucleus, if the energy is sufficient—as it might easily be under the Berkeley conditions. It is suggested that this may be the explanation of the comparatively large number of μ-mesons observed in the Berkeley plates. While the most probable process under those conditions seems to be the formation of σ-mesons by *Bremsstrahlung*, the observed cases of π-decay might on the above view be due to a break-up of nucleons, a process which would be expected to occur with measurable probability, the energy quantum (frequency multiplied by Planck's constant), corresponding to the collision time, being of the same order of magnitude as the assumed binding energy of the nucleon.

Without entering more closely on the consequences of the opposite assumptions—the identity of σ- and π-mesons—for the above considerations, I should like to state that in my view the interpretation of the μ-meson as an $\hbar/2$-particle with an ordinary β-decay, which is, of course, independent of the hypothesis concerning nucleons and π-mesons, has not only a better foundation than the other assumptions of the above note, but also the more important bearing on the problem of the incorporation of meson theory in the general relativistic field theory. In this connexion it should perhaps be mentioned that the argument given in the note concerning the mass value of the electrophoton can only be expected to give the order of magnitude.

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EXCITATION CURVES FOR THE γ-RADIATION FROM LIGHT ELEMENTS BOMBARDED WITH α-PARTICLES FROM POLONIUM

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A LARGE number of investigations have been carried out on the disintegration of light nuclei bombarded with α-particles. In several cases excitation curves have been obtained for the γ-radiation as a function of the energy of the α-particles. (A review of earlier polonium α-particle bombardments of light elements, particularly those which may be of interest for a possible γ-radiation, has been published by the present writer in *Arkiv. Mat., Ast. Fysik*, 35 A, No. 31 (1948). The results of different authors, however, are often inconsistent. For that reason I made use of an available polonium sample of about 40 mC. for observing the excitation functions of the γ-radiation from light elements bombarded with α-particles. The energy of the α-particles was varied by means of carbon dioxide.

Lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, chlorine, potassium, calcium and lead were investigated. γ-Emission was observed from lithium, beryllium, boron, nitrogen, fluorine, sodium, magnesium and aluminium. The intensity of the γ-radiation was measured as a function of the energy of the α-particles for all these except nitrogen (Figs. 1–2). The α-particle threshold values for γ-emission and the relative intensities (as percentage of the measured polonium γ-radiation background) of the γ-quanta are given in the accompanying table.

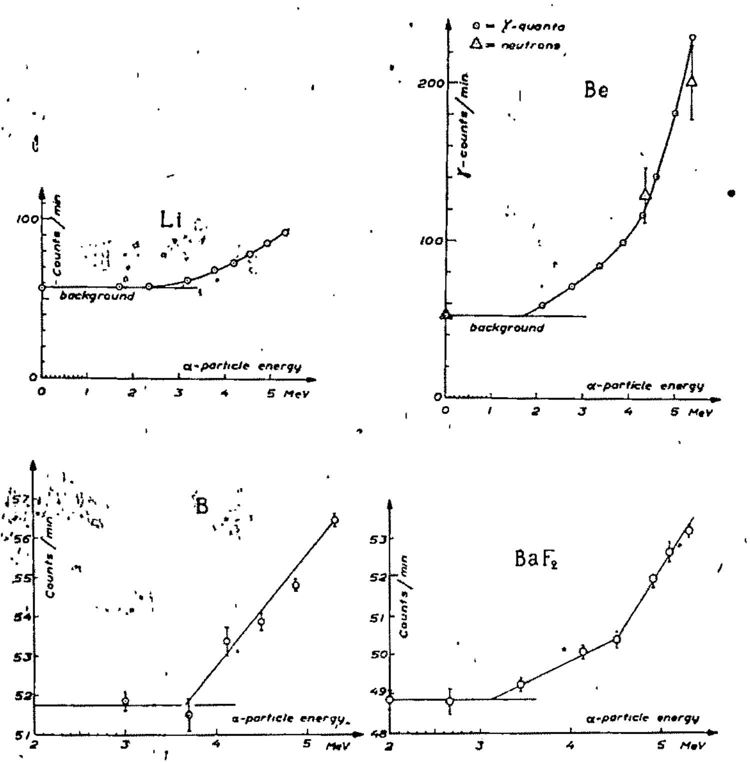

Fig. 1. Emission of γ-quanta (⊙) from lithium, beryllium, boron, fluorine, and neutrons (△) from beryllium as a function of the energy of the bombarding α-particles

Element	γ-Emission starts at the α-energy	Intensity of the γ-radiation for 5·3 MeV. α-particles
	MeV.	
Li	2·3	61
Be	1·7	340
B	3·7	9·0
N	—	2·7
F	3·1 (and 4·5)	9·0
Na	4·6	9·5
Mg	3·6	3·7
Al	4·1	7·9

The statistical errors are represented in all the diagrams except the γ-emission curves for lithium and beryllium, where the errors were too small to be

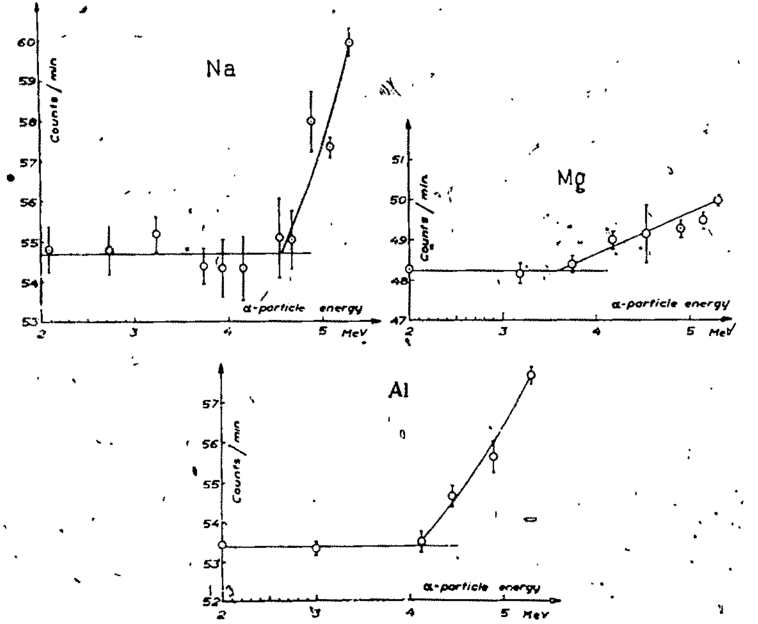

Fig. 2. γ-EMISSION FROM SODIUM, MAGNESIUM AND ALUMINIUM AS A FUNCTION OF THE ENERGY OF THE BOMBARDING α-PARTICLES

plotted ($\lesssim$ 1 per cent of the polonium γ-radiation background).

The neutron-emission from beryllium was measured for α-particles of energies 4·3 and 5·3 MeV. The results and the statistical errors are plotted on an arbitrary scale in Fig. 1.

$_3$Li. The γ-radiation is due to an excitation of the Li^7-nucleus by inelastic collisions with α-particles, as quoted, for example, in the paper by Siegbahn and Slätis[1]. The γ-radiation starts for α-particles of the energy 2·3 MeV., in agreement with the result of Schnetzler[2] but not with earlier investigations by Webster[3] (1·9 MeV.), Curie and Joliot[4] (3·1), Savel[5] (2·8–3·0).

$_4$Be. The γ-radiation maximum with 2·7 MeV. α-particles found by Becker and Bothe[6] could not be confirmed, nor the starting point of the γ-emission for α-particles of the range 1·7 cm. (3 MeV.). The neutrons seem to be emitted simultaneously with the γ-quanta, as predicted by Chadwick[7]. The energy (1·7 MeV.) of the α-particles at which the γ-emission starts is the same as Chadwick found for the beginning of the neutron emission, and is in fairly good agreement with the starting points for the γ-emission found by Webster[3] (1·9 MeV.) and by Szalay and Zimonyi[8] (1·62 MeV.). Rasetti[9] found 1·6 MeV. for the beginning of neutron emission and Curie and Joliot[4] 1·3 MeV. for neutrons and γ-quanta.

$_5$B. According to Becker and Bothe[6], the γ-radiation begins at the same α-particle energy for which the second proton group starts (also in agreement with v. Baeyer[10]). The corresponding α-particle range was 2·90 cm. (4·4 MeV.). This is not in agreement with the curve in Fig. 1, which starts at 3·7 MeV., or with the results of Webster[3] (1·9 MeV.), or those of Szalay and Zimonyi[8] (1·5 cm. = 2·7 MeV.), but in good accordance with Heidenreich[11] (3·6 MeV.) and Alichanow, Alichanian and Dzelepow[12] (2·1 cm. = 3·5 MeV.).

$_9$F. The first proton *pair* found by Chadwick and Constable[13] started at an α-range of 2·2 cm. (3·64 MeV.), the second pair at 2·7 cm. (4·2 MeV.). This result is not in agreement with my observations; I find that (Fig. 1) the γ-radiation starts at 3·1 MeV. with clearly a second component at 4·5 MeV. energy of the α-particles. The starting point 0·9–1·2 MeV., found by Savel[5], seems to be very improbable. Speh[14] discovered that the γ-radiation consisted of two components. The harder one started at 3·1 cm. α-particle range (4·6 MeV.), which is in good agreement with the second starting point of the γ-radiation shown in Fig. 1.

$_{11}$Na. According to Fig. 2, γ-emission starts at an α-particle energy of 4·6 MeV. This agrees neither with Savel's[5] result (3·7–4 MeV.) nor with Kovács's[15] (2·7 MeV. and 3·5 MeV.). König[16], however, found a proton resonance group, called *B*, which started at 4·8 MeV. This is in accordance with my result.

$_{12}$Mg. Klarmann's[17] first proton group started at an α-particle energy of 3·26 MeV., which may agree with my value 3·6 MeV. for the beginning of the γ-radiation (Fig. 2). Savel[5] found 4·3–4·5 MeV.

$_{13}$Al. Pose's[18] first proton group for an α-range of 2·50 cm. (4 MeV.) agrees well with the α-particle threshold value 4·1 MeV. for the γ-emission found by me (Fig. 2). Chadwick and Constable[13] found for the first proton pair a threshold value 4·2 MeV. for the α-particle energy, also in good accordance with my result. Savel[5] found 3–3·3 MeV. for the beginning of the γ-emission, Fahlenbrach[19] 3 cm. (4·5 MeV.) for the starting point of the (α, p)-process, Alichanow, Alichanian and Dzelepow[12] 3·4 cm. (4·9 MeV.) for the (α, n)-process. For the same (α, n)-process Waring and Chang[20] obtained 3·4 MeV. Pollard, Schultz and Brubaker[21] found possible resonance effects at 2·3 cm. (3·8 MeV.) and 4·8 cm. (6 MeV.). The former α-particle energy 3·8 MeV., as well as Fünfer's[22] value 2·3 cm. (3·8 MeV.) and the starting point 2·4 cm. (3·9 MeV.) for the γ-radiation, found by Szalay and Zimonyi[8], agree well with my α-particle energy value 4·1 MeV. for the beginning of the γ-radiation from aluminium.

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REACTIVITY AND STRUCTURE OF MOLECULES

AN International Colloquium on Isotope Exchange and Molecular Structure was held in Paris during April 5–12 under the presidency of Mme. Joliot-Curie. It had been organised, with the support of the Rockefeller Foundation, by three French scientific workers well known for their contributions to these subjects, R. Daudel, M. Haïssinsky and P. Süe. About a dozen speakers had been asked to read papers; others had been invited to contribute to the discussions. A somewhat unusual feature was the friendly insistence by the organisers on French as the only 'official' language; but as the Paris colleagues had taken the trouble of translating papers before the congress started, all foreign authors bravely presented them in the language of their hosts. During the discussions most of them preferred to express, or to hear, the arguments in their mother tongue; this caused no difficulty, as good linguists were always present and willing to act as interpreters. (One of the most competent translators sometimes even quietly amplified what had actually been said by a speaker.) A further help was the distribution of the manuscripts in their original tongue to all the participants.

The discussions were lively and inspiring; they will be printed in full, together with the addresses, in *Le Journal de Chimie et Physique*. We shall confine ourselves here to a brief summary of the papers.

Although the main subject of the colloquium was the connexion between the structure of a molecule and its ability to take part in isotopic exchange processes, several of the papers dealt only with questions either of structure, or of exchange, leaving the conclusions to be drawn to the discussion or to further investigations. A contribution to the subject in its strict sense was the opening address by Prof. L. Pauling (Pasadena) on "Structure of Complexes and the Influence of Structure on Exchange Reactions"; according to his calculations, the replacement of one group in a complex molecule by another may occur readily if the co-ordination number of the complex is smaller than the maximum permitted by steric considerations. To the same group belonged the papers by P. Süe and G. Kayas (Paris) on "The Behaviour of some perfect Cobalt Complexes in Szilard-Chalmers Reactions"; by B. Pullman, P. Rumpf and F. Kieffer (Paris) on "Isotopic Exchange Reactions and Electronic Structure of Substituted Aromatic Hydrocarbons"; and by C. K. Ingold (London) on "Isotope Exchange and the Mechanism of Heterolytic Substitution". A theoretical paper on "Free Valence in Organic Reactions" was read by Prof. C. A. Coulson (London).

Prof. C. D. Coryell (Boston, Mass.) discussed the results of studies carried out in the Clinton Laboratories on the valency states of the elements selenium, tellurium, bromine, iodine and cerium, if produced by nuclear transformations and present only in tracer concentrations; he pointed out that the results are not yet numerous enough to offer themselves for broad generalizations. It is likely that each element will show peculiarities which can only be explored by detailed studies. An example of such an investigation of a single case was given by P. Süe in his work on the ions formed in sodium arsenite, sodium arsenate and sodium cacodylate under the impact of neutrons; it seems that in these reactions the lower valency state is favoured.

M. and Mme. Daudel, in collaboration with S. May, R. Muxart and O. Chalvet (Paris), presented a paper on "The chemical reactions which are the consequences of those nuclear reactions which do not change the nature of the element". Such a nuclear reaction may consist either in the absorption of neutrons with emission of γ-rays, or in a nuclear isomerization; in the first case the observed chemical reactions are easy to foresee as following from the production of free, fast-moving atoms; the chemical effects of isomeric nuclear changes have to be interpreted by a mechanism involving the re-arrangement of the electrons in the atom concerned. E. Broda (Vienna) discussed the various methods available for the determination of the yield of nuclear reactions of the (α, *n*) type; he showed that the Szilard-Chalmers effect of the emitted neutrons offers certain advantages over the alternative methods of the ionization chamber or photographic plate. In a second paper he discussed the phenomenon of 'retention' of activity in cases where one would expect the Szilard-Chalmers effect to give complete separation of the active atoms.

Two of the contributors dealt with heterogeneous exchange reactions. M. Haïssinsky (Paris) described experimental investigations carried out, together with M. Cottin and B. Varjadebian, on exchange between metal electrodes and their ions in solutions. Their object was to compare the exchange rates with the electrochemical potentials of the metals, taking into account also the possible effect of temperature, concentration, acidity, mechanical state of the surface, and all the other factors which may be of influence on exchange rates. The authors consider the imposing experimental material they have collected only as the beginning of further researches necessary for the full understanding of the exchange mechanism. In a second paper, M. Haïssinsky examined in a critical way the possible connexions between the exchange processes on the surface of the electrode and various electrochemical phenomena; he found that his experiments support Piontelli's distinction of two classes of metals. The other paper on heterogeneous exchange was read by F. A. Paneth (Durham). The exchange of ions between solution and crystal surfaces has, since 1923, often been used as a method for the determination of the extent of the surface area. In reviewing published and a few unpublished experiments, he has come to the conclusion that the exchanging part of the surface may be much smaller than the geometrical surface, but at the same time the only important one for the phenomena of adsorption and catalysis, and therefore well worth studying. This view was supported by Prof. M. Prettre (Lyon). Furthermore, the measurement of the equilibrium between ions in crystal surfaces and non-isotopic ions in solution may help to an understanding of the precipitation reactions of tracer elements without isotopic carriers.

The unfortunate absence of the authors did not diminish the interest taken in the papers by C. C. Evans and S. Sugden (London) on "Exchange Reactions and Electrolytic Dissociation", and by M. D. Kamen, J. W. Kennedy and O. E. Myers (St. Louis) on "Kinetic Studies on Isotopic Exchange Reactions" (both read by M. Haïssinsky), but naturally restricted the possibilities of a discussion.

At the end of the last session, before the concluding words of Mme. Joliot-Curie, Prof. G. v. Hevesy (Stockholm) summed up the proceedings by giving a brief résumé of all the contributions. During a break in the meetings the guests were given the opportunity of visiting the Laboratoire de Physique Nucléaire under the guidance of its director, F. Joliot (who was also an occasional contributor to the discussions), and the French Government's Atomic Energy Establishment at Châtillon, where preparations are far advanced for the erection of a heavy water–uranium oxide plant, and an impressive array of counting equipment of all types is being produced. Châtillon is an old fort in the outer defence girdle of Paris, and the skill with which the dark subterranean rooms have been converted into modern laboratories deserves admiration.

The last day of the congress was free from lectures and offered good opportunities to continue some of the discussions in smaller circles before the final dispersal of the participants of a very successful international meeting. F. A. PANETH

FAUNA AND FLORA OF PALESTINE

PALESTINE'S fast diminishing larger fauna is bound to suffer from the Jewish–Arab war; many species of great historic interest may be exterminated, and several, like the gazelle, the geographical races of which have not yet been fully worked out by the modern zoologists in the country, may be among them. Attention was directed to the serious reduction in the numbers of the larger mammals by modern 'hunters' in special surveys reported in the bulletins of the Jerusalem Naturalists' Club in 1946. The difficulty of human food supplies will be a serious threat to the remaining numbers of ibex already on the verge of extinction in the country; and the departure of the Palestine Police Force which alone enforced the British-made game laws—these prohibited the shooting of ibex, eagles, vultures, kestrels, owls, etc., and imposed certain close seasons and preserved certain forests against goat-grazing—will leave unrestricted the activities of 'hunters' and others. The grazing of these reserves by Beduin goatherds will have a serious effect upon plant life, for the ubiquitous goat is one of the most serious destroyers of flora in the country and a contributory factor to the costly menace of soil erosion.

Bab el Wad, which has been the scene of many recent news reports of a battle on the Jaffa–Jerusalem road, is a pine forest planted by the British authorities, twenty-four kilometres below Jerusalem. It consists mainly of *Pinus halepensis* and a large summer flora including *Varthemia*, *Centaurea cyanoides*, *Helichrysum sanguineum*, *Cistus vilosus*, *Acanthus syriacus* and many Labiates (Bull. 25, Jer. Nat. Club, p. 4), while W. F. W. Harding and E. Hardy collected and photographed in the forest the interesting amaryllid, *Pancratium parviflorum*, and *Narcissus Tazetta*, the Palestine iris, and various *Crocus*, *Cyclamen*, etc. (*J. Roy. Hort. Soc.*, 71, 3; 1946).

The bird-life of Palestine, like the mammals, may see the most immediate threat since the removal of law and order to the larger birds of prey; but the netting of quail, suppressed by the British authorities, will probably be resumed for food, together with the unrestricted shooting of the many wildfowl that visit Lake Huleh and the Jordan Valley. The nightjar is among the birds recorded at Bab el Wad in Hardy's 1946 "Handlist of the Birds of Palestine", and this work pointed out that the great bustard, the Egyptian goose and the Syrian ostrich are already extinct in the country, and the white stork, the lammergeier, the imperial eagle and the white-faced duck no longer nest there.

Among the more immediate threats to bird-life in the present emergency will be that to the nesting colony of purple herons at Lake Huleh, the young of which are eaten as food by the Arabs. Other scarce birds likely to be sought to augment the food supplies are the houbara or Macqueen's bustard of the southern and Jordan deserts, which no longer nests in the country, the red-billed chukor partridge of the central hills and the Hey's sand partridge of the semi-deserts. Quail-catching and the shooting of song-birds for food will probably assume the large extent they already reach in Syria. The Hebrew University has shown an active interest in plant and bird conservation, and they and the Arab Scout movement and several private individuals were active supporters of the efforts made by the now defunct Jerusalem Naturalists' Club to conserve the rapidly diminishing fauna of the Holy Land during the last few years of the British mandate, especially at Lake Huleh and in the Jordan Valley; but with the lifting of the central authority, it is to be feared that animal life will suffer from the extensive use of rifle and poison before law and order restore close seasons, game reserves and the control of fire-arms, which are essential if the large mammals like the leopard, ibex, wolf, cheetah and gazelle are to survive.

AFFORESTATION AS A WORLD PROBLEM

IN a brochure entitled "Forestry and Forest Products—World Situation 1937–1946", issued by the Food and Agriculture Organisation of the United Nations, a graphic exposition of the world's position was produced (see *Nature*, May 8, p. 710). Prof. H. G. Champion, professor of forestry, University of Oxford, also discussed this theme in a paper entitled "Afforestation as a World Problem" before the Royal Society of Arts on March 17. In this paper he discussed various aspects of forestry and forestry work. As he correctly says, "the majority of us pay little attention to the changes which have taken place in the past in the natural vegetation which covers most of the land not taken up by buildings, roads, gardens, mines or agricultural crops. We are barely conscious of the fact that in Britain almost every acre of cultivation and bare land—except on the hill tops and in the fens—has been cleared from the forest which once covered nearly the whole surface. From being a country almost entirely under forest, England has now a lower proportion than any other country in Europe." How often did a predecessor of Prof. Champion's at Oxford, Sir William Schlich, point this out to a deaf Government?

The respective positions of Western European countries, as shown by figures given by the Food and Agriculture Organisation, are contrasted. The interesting position of the Middle East, contrasted with its position in Biblical and Roman times, is discussed; also that of America, Central and South Africa and Australia. Here the picture is chiefly one of ruthless destruction of the forests, either in the interest of agriculture or stock raising, or due to the habits of the local and introduced populations of annual unchecked firing of the countryside for whatever purpose, and over-grazing. Such actions have produced serious conditions in temperate climates. In the tropics they are devastating. For example, Prof. Champion states that in Nigeria it has been estimated that 1,000 square miles of forest are being destroyed by shifting cultivation annually. This type of affairs is proceeding throughout many parts of Africa in British, French, Belgian and Portuguese Colonies. The author contrasts the nature of the vegetation which may clothe the soil when the forest is removed "if, indeed, the soil does get or retain a cover at all". Temperate and tropical conditions are dealt with. Prof. Champion particularly stresses grazing of domestic cattle and the damage caused. "In all but the wet tropical forests, grazing is liable to be second only to direct human action as a forest-destroying agency", a statement which must be known now throughout the world, though still requiring emphatically re-stating. Protection of endangered existing forest areas by closure, re-afforesting and so forth are the remedies which are imperative in many parts of the world.

As the report of the Food and Agriculture Organisation stressed, production is not the only aim of the forester. Indirect effects of the presence of the forest on a countryside are also aimed at, and one of the vital ones is protecting the forest or rebuilding a forest to check erosion, shelter agricultural lands and stock and so forth, and the protection of all water catchment areas, including the head waters of streams and rivers.

Finally, Prof. Champion considers the immediate objectives of the larger afforestation undertakings of the world under seven heads: briefly, stabilization of moving sands, increasing local supplies of timber and fuel, stoppage of erosion on hillsides through avalanches and of areas on hills liable to ravine formation, protection by forests or woodland belts of agricultural land and stock and buildings, re-afforesting of waste land and growing timber to supply industries for export trade or to maintain or build up stocks at home. These are discussed in some detail in the paper.

SOUTH AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

THE second annual report of the South African Council for Scientific and Industrial Research (Block 1, Central Mint, Pretoria) covering the year ended October 5, 1947, refers to progress in establishing the Council's national laboratories and services as exceeding expectation in many respects, although it will still be several years before all are fully working. Four industrial research associations, covering the leather, fish, paint and sugar-milling industries, are now in being and proposals for a fifth, to deal with the clay and ceramic industries and others interested in silicates, are being discussed. During its first two years the Council has signed contracts for twenty investigations for industrial and other sponsors to a value of £13,968, and of these seven have been completed. Arrangements for the support of research in universities and similar institutions operated satisfactorily during the year, but it is probable that the Council will have to consider further means of assisting the universities to provide the large number of scientific men and women of high qualifications which will be required.

The work of the Library and Information Division increased greatly during the year. The Library now includes about 70,000 books, pamphlets and reports on all branches of science and technology. A draft guide to authors in the preparation of abstracts has been prepared for the use of South African scientific periodicals the abstracts of which will be distributed overseas. The functions of the three main divisions of the National Building Research Institute have been more sharply defined, and sub-division of the Engineering Division into three sections—engineering, materials, and soil mechanics—is already visualized. The services of the soil mechanics section are already in embarrassing demand. Details of some forty-two projects in which work is already proceeding are given in the report, and among these may be mentioned foundation design for small houses, soil-cement construction, a study of expansive mortar failures in brickwork, standardization of wear-test for flooring, termite-proofing of buildings, comfort standards, tests for the thermal properties of building materials, roof ventilators, ventilation and natural lighting of buildings and a study of native housing.

Considerable progress has been made with the National Physical Laboratory, where the Spectrographic Section has made a satisfactory start. Work has already been commenced on the design and construction of instruments for aptitude testing, the measurement of soil pressures, the use of supersonic waves as a bactericide and on general acoustics. The Telecommunications Research Laboratory has measured and studied the characteristics of the ionosphere, and work on the measurement of radio noise-levels was contemplated. Measurements have been made of the propagation of radio waves in the Witwatersrand gold mines, and a micro-wave radar set has been developed for tracking thunderstorms. At the National Chemical Research Laboratory, the Microbiological Section, working at the Onderstepoort Laboratories, has investigated new yeast-like organisms from the rumen ingesta of sheep, and work is proceeding on the determination of degradation products arising from the action of moulds on wattle tannin extract. The fats, waxes, and proteins unit has been concerned with investigations on pilchard oil, the vitamin A content of liver oil from soupfin sharks and on marine fats.

Under the National Bureau for Personnel Research, the three main projects have covered selection and classification tests for operatives in the clothing industry, classification tests for native miners and 'boss-boys', and personnel research for the Union Defence Force. The development of screening and aptitude tests for the engineering branch of the G.P.O. continued during the year. A Liaison Division was formed during the year to provide liaison between the Council's laboratories and industry, including the handling of technical inquiries, visits to industrial firms and the organisation of co-operative research in industry. This Division is also responsible for handling contracts for sponsored research and the overseas scientific liaison offices and missions.

Seven senior bursaries or fellowships were awarded by the Council during the year to enable South Africans of outstanding ability and experience to carry out at least a full year of unencumbered research. Three senior bursaries were also awarded for research in the medical field, and details of these ten awards are given in the report. Twelve bursaries of £200 a year were also awarded for postgraduate research and five others for postgraduate medical research, and eighteen bursaries of £100 a year to undergraduate research students.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, June 7

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Dr. T. Paterson: "Explorations in the Canadian Arctic".

Tuesday, June 8

Research Defence Society (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 3.15 p.m.—Annual General Meeting: Prof. P. A. Buxton, F.R.S.: "Tsetse Flies and the Development of Africa" (Seventeenth Stephen Paget Memorial Lecture).

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.2), at 5 p.m.—Prof. Pie Laviosa Zambotti: "The Origin and Diffusion of Civilization".

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Wednesday, June 9

Physical Society, Colour Group (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. R. W. G. Hunt: "The Effects of Daylight and Tungsten Light Adaptation on Colour Perception".

Institute of Petroleum (at 26 Portland Place, London, W.1), at 4 p.m.—Scientific Papers.

Manchester Statistical Society (at the Reform Club, King Street, Manchester), at 5.30 p.m.—Annual General Meeting.

Thursday, June 10

Chadwick Public Lecture (at the Chelsea Physic Garden, Swan Walk, London, S.W.3), at 4 p.m.—Prof. Frederick G. Gregory: "The Factors Controlling Reproduction in Plants".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. V. B. Wigglesworth, F.R.S.: "Insects as a Medium for the Study of Physiology" (Croonian Lecture).

Friday, June 11

Fertiliser Society (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Dr. W. G. Ogg: "Fertilisers in the National Economy".

Physical Society, Optical Group (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 3 p.m.—Mr. T. Smith, F.R.S.: "The Computation of Large Numerical Aperture Telescope Objectives"; Prof. L. C. Martin: "The Boundary Wave Theory of Image Formation".

Saturday, June 12

British Psychological Society (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Prof. A. B. Fitt: "Is Development Affected by the Season of Conception?"

Institute of Physics, Electronics Group (at the London School of Tropical Medicine and Hygiene, Keppel Street, London, W.C.1), at 2.30 p.m.—Discussion on "Substances of High Permittivity".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (Grade III) in the Department of Chemistry, with special qualifications in inorganic and physical chemistry—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (June 12).

Lecturer in Civil Engineering—The Registrar, The University, Leeds 2 (June 14).

Soil Survey Officers in the Gold Coast to supervise the collection of information about the soils of the forest region in that territory—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1 (June 15).

Agriculturist in the Southern Rhodesia Government Service—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (June 15).

Lecturers in Physics, Zoology, Botany, Chemistry and Mathematics, in the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (June 15).

Demonstrator in the Department of Zoology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (June 18).

Assistant Technical Officers (temporary) in the Agricultural Lime Department of the Ministry of Agriculture and Fisheries—The Ministry of Labour and National Service, Technical and Scientific Register, Section K, York House, Kingsway, London, W.C.2, quoting G.186/48A (June 21).

Lecturer in Plant Physiology, a Lecturer in Mathematics, and a Lecturer in Botany (Bacteriology)—The Registrar, University College of South Wales, Cathays Park, Cardiff (June 21).

Assistant Poultry Officer (male), in the Department of Agriculture and Lands, Government of Southern Rhodesia—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (June 23).

Lecturer in Mathematics in the United College, St. Andrews—The Secretary, The University, St. Andrews (June 30).

Lecturer in Physical Chemistry, and a Lecturer in Physiology, in University College, Dundee—The Secretary, The University, St. Andrews (June 30).

University Lecturer and University Demonstrators (2) in Chemical Engineering—The Secretary, Appointments Committee of the Department of Chemical Engineering, Chemical Laboratory, Cambridge (July 1).

Leverhulme Research Studentship for research into some aspect of the history or archæology of London—The Secretary, London Museum, Lancaster House, St. James's, London, S.W.1 (July 1).

Lecturer in Mechanical Engineering in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 1).

Professor of Mechanical Engineering, and a Professor of Botany, at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

Soil Analyst in the Soil Survey Branch of the Agricultural Department of the Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

Assistant and Associate Professorships in the Department of Physics—The Head, Department of Physics, University of British Columbia, Vancouver, B.C., Canada.

Junior Laboratory Technician in the Pathology Laboratory—The Secretary, Marie Curie Hospital, 66 Fitzjohn's Avenue, London. N.W.3.

Field Officer by the East Africa High Commission in the Interterritorial Tsetse Reclamation Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.21363/3F.

Young Engineer or Science Graduate to assist in the administration of research programmes on the manufacture and use of wrought steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Wrought Steel'.

Demonstrator in the Department of Chemistry—The Registrar, University College, Singleton Park, Swansea.

Laboratory Technician in the Department of Chemistry—The Secretary, University College, Gower Street, London, W.C.1, quoting Chemistry/4.

Metallurgist for investigation of problems in welding of structural alloy steels—The Director of Research, British Welding Research Association, 29 Park Crescent, London, W.1.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Liverpool Council of Social Service. Youthful Lawbreakers: a Study of Juvenile Delinquency in Liverpool made by the Department of Social Science of the University of Liverpool. Pp. 47. (Liverpool: University Press of Liverpool, 1948.) 2*s*. 6*d*. net. [194

Medical Research Council. Special Report Series, No. 263: Fatty Liver Disease in Infants in the British West Indies. By Dr. J. C. Waterlow. Pp. 84 + 12 plates. (London: H.M. Stationery Office, 1948.) 2*s*. net. [194

British Standard 1170:1947. British Standard for Treatment of Water for Marine Boilers (with a Section on Engineering Factors). Pp. 96. (London: British Standards Institution, 1947.) 10*s*. 6*d*. net. [194

The Church and the Atom: a Study of the Moral and Theologica Aspects of Peace and War. Pp. 130. (London: Church Assembly, 1948.) 4*s*. [224

Rheology in Relation to Pharmacy and Medicine. By Dr. G. W. Scott Blair. Pp. 20. (London: Pharmaceutical Press, 1948.) 2*s*. [224

List of Whole-time Awards for Scientific Research offered by Publi and Private Bodies in the United Kingdom. Fifth issue. Pp. 48. (London: Royal Commission for the Exhibition of 1851, 1948. 1*s*. [274

Psychology at Work. Vol. 1, No. 1, March 1948. Pp. 28. (London National Institute of Industrial Psychology, 1948.) N.p. [274

Public Administration To-day. By Prof. William A. Robson. Pp v + 26. (London: Stevens and Sons, Ltd., 1948.) 2*s*. 6*d*. net. [27

Acta Crystallographica. (Published for the International Union o Crystallography.) Vol. 1, Part 1, March 1948. Pp. 48. (Cambridge At the University Press, 1948.) 10*s*.; 50*s*. per vol. [27

British Standard 1000A:1948. Universal Decimal Classification Abridged English edition. Pp. 128. (London: British Standard Institution, 1948.) 25*s*. net. [29

Enquiry. (Monthly.) No. 1, April 1948. Pp. 32. (London: Horac Cox, Ltd., 1948.) 1*s*. 3*d*.; annual subscription, 16*s*. [29

Ministry of Education: Science Museum. Darkness into Daylight an Account of the Past, Present and Future of Man-made Illumination. Pp. v + 34 + 12 plates. (London: H.M. Stationery Office 1948.) 1*s*. net. [3

Other Countries

Undersökningar över Öresund. 35: On the Smaller Arthropoda o Marine Algae, especially in the Polyhaline Waters off the Swedish Wes Coast. By Erik Dahl. Pp. 193. (Lund: C. W. K. Gleerup, 1948.) [27

Annals of the New York Academy of Sciences. Vol. 49, Art. 3 Bioluminescence. By E. Newton Harvey, Rubert S. Anderson, John F Buck, Aurin M. Chase, Henry Eyring and Frank H. Johnson. Pr 327–482 + 5 plates. (New York: New York Academy of Science 1948.) 2.50 dollars. [29

Deccan College Monograph Series. 2: Anthropometric Measur ments of the Marathas. By Mrs. Irawati Karve. Pp. 72 + 9 plate (Poona: Deccan College Post-Graduate and Research Institut 1948.) 8 rupees. [29

Carnegie Institution of Washington. Publication 579: The Sola Spectrum, λ6600 to λ13495. By Harold D. Babcock and Charlotte E Moore. Pp. iii + 95. (Washington, D.C.: Carnegie Institutio 1947.) 1.40 dollars. [3

Kungl. Lantbrukshögskolans Annaler (Annals of the Royal Agr cultural College of Sweden). Vol. 15. Pp. v + 349. (Uppsala: Alm quist and Wiksells Boktryckeri A.-B., 1948.) [3

NATURE

No. 4102 SATURDAY, JUNE 12, 1948 Vol. 161

CONTENTS

Page
Food Production and Land Utilization 905
The Land of Britain and How we Use It. By Sir John Russell, O.B.E., F.R.S. 906
Britain's Scientific War Effort. By S. Weintroub 907
Empires in Transition. By Maurice Bruce 908
A Descendant of Benjamin Franklin. By Lieut.-Col. H. D. Anthony . 909
Scientific Management. By J. Leigh 910
Gas Turbines. By E. G. Sterland 910
Chemical Engineering. By Prof. H. E. Watson 911
Rivers—a National Heritage. By Dr. A. T. Doodson, F.R.S. . . 911
Effect of Present-day Whaling on the Stock of Whales. By J. E. Hamilton 913
The Enzyme-Substrate Compounds of Catalase and Peroxides. By Britton Chance 914
The Telecommunications Research Establishment, Malvern . . 918

Obituaries:

Mr. J. J. Shaw, C.B.E. By Ernest Tillotson 920
Dr. J. M. Dalziel. By Dr. F. R. Irvine 920
Mr. G. L. Overton. By M. J. B. Davy 921
News and Views 921

Letters to the Editors:

Application of Multiple-Beam Interferometry to the Study of Oscillating Quartz Crystals.—Prof. S. Tolansky and W. Bardsley 925
Transfer Rates in Liquid Helium Films.—K. R. Atkins . . 925
Diffraction of Light by Very High Frequency Ultrasonic Waves.—Prof. S. Bhagavantam and B. Ramachandra Rao . . . 927
A New Hot-Wire Vacuum Gauge.—H. von Ubisch . . . 927
Electron Tracks in Photographic Emulsions.—Dr. R. H. Herz . 928
Crystal Structure of Polyvinyl Alcohol.—C. W. Bunn . . 929
The Tollens Naphthoresorcinol Reaction for Uronic Acids.—A. H. Guerrero and R. Tecwyn Williams 930
Separation of Pyrimidine Nucleosides by Synthetic Resin Ion-Exchangers.—D. T. Elmore 931
Isolation and Separation of the Pyrimidine Nucleosides of Yeast Ribosenucleic Acid.—Dr. R. J. C. Harris and J. F. Thomas . 931
Microsynthesis of C^{14}-Labelled Ethyl Iodide.—Dr. W. J. Arrol and Raymond Glascock 932
Effect of Insulin on Intestinal Glucose Absorption in Alloxan Diabetic Rats.—Dr. A. Sols, S. Vidal and J. Larralde . . 932
Respiratory Quotient of the Mammary Gland.—Dr. S. J. Folley and T. H. French 933
Influence of Solvent Movement on Sedimentation.—Bertil Enoksson 934
Bulb Formation in the Shallot.—Dr. L. G. G. Warne . . . 935
Streptococcus faecalis in *E. histolytica* Infections.—Dr. G. T. Stewart, W. R. Jones and M. A. T. Rogers 936
Sex Reversal in Copepods.—J. G. Cattley 937
Evaluation of Herbage for Grazing.—W. F. Raymond . . . 937
Perithecia of Oak Mildew.—J. Mary Knoyle 938
Riboflavin Enhancement of Radioactive Phosphate Exchange by Yeasts. By Dr. Walter J. Nickerson and Dr. Lorin J. Mullins . . . 939
Factors Involved in the Deactivation of Penicillin Solutions by Rubber Tubing. By Dr. L. J. Bellamy and C. H. Watt 940
London's Transport System. By R. H. Macmillan 942
Radio Research in Britain. By Prof. J. Greig 943
The British Council: Annual Report 944
Plant Virus Diseases 945
Education in Guatemala 945

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FOOD PRODUCTION AND LAND UTILIZATION

A DANGEROUS situation appears to be developing in world food production. Almost everywhere populations are increasing, and in many regions the area of land available for food production is shrinking: agriculturists are being faced with the problem of producing more and more food from less and less land. The population of England and Wales has gone up by about 14 millions since 1891, but the area of land under field and crops has shrunk by nearly 4 million acres. We now have little more than half an acre of cultivated land per head of population, and it required about 1·6 acres per head to produce the pre-war dietary. Our present reduced scale of feeding, with its cut of about 20 per cent of calorie supply, calls for less land per head, but even so we are producing on our present acreage only 40 per cent of our food. And the area of cultivated land still shrinks: housing estates, road widening, surface mining, demands of the Services and other activities absorb much land and often spoil more. Of the land still left in cultivation, little more than half can be called good; the rest is only moderate, and although we still have some reserve of potentially utilizable land, the cost of reclaiming it and keeping it in cultivation would be high, often very high. At the present rate of loss, we shall be fortunate if technical advances in agriculture enable us to continue producing as much as 40 per cent of our food, unless the public will tolerate a lower dietary.

So long as Britain was the chief buyer in the world's food markets, we had a considerable voice in fixing the price; but there are now other buyers, and the commercial arrangements are different; prices have moved against us and may rise still further. Europe (excluding the U.S.S.R.) was formerly almost self-supporting in food, importing less than 10 per cent of the grain consumed and having a small net export of meat and dairy produce. Now, however, the position is entirely different: the import requirement of grain is more like 20 million tons to satisfy the reduced—in many cases drastically reduced—rations now available. In so far as this situation is due to war devastation, one can hope that before long it will be remedied.

A new problem, however, is just beginning to emerge. It has already appeared in India and may soon appear elsewhere. Until recently India was practically self-supporting in food; there was, indeed, an export of wheat and of oil seeds, but also an import of rice. But, thanks to efficient health services organised by devoted British workers, the population has risen rapidly and enormously: in 1931 it was 338 million, but by 1941 it had increased to 389 million. It has now outstripped the present food-producing capacity of the land. India has ceased to export food and has begun to import it. Until recently the growth of world population was mainly met by bringing new land into cultivation; the late Sir Daniel Hall calculated that each new head of population in Great Britain brought into use an additional 2–2½ acres of land, the yields being lower than ours. Much virgin land was still available and easily utilizable. But that kind of land is now all taken up. A great deal of what remains will need large and costly development schemes to make and keep it productive. Unfortunately, too, as in Great Britain, much of the land that has been brought into cultivation has been lost, partly through the same causes as operate here, but largely through another cause from which happily we do not suffer greatly, namely, soil erosion. This has been particularly destructive in the rather dry regions well suited to wheat, and in the wet tropics where lie our largest reserves of potential food-producing land. Prof. C. B. Fawcett has estimated that the area of potentially cultivable land in the world is about 10,000 million acres. (H. L. Shantz's quite independent estimate is higher—17,000 million acres—but includes all land under a 'crop climate', while Fawcett has eliminated mountains and other areas physically unsuitable for cultivation.) About half of this may be regarded as fairly workable. The world population is estimated at something more than 2,000 millions and increases at the rate of 20–25 millions per annum. There appears, therefore, to be about 2½ acres of fairly workable land per head—but constantly shrinking while the population constantly increases. Prasolov estimates that about 10 per cent of the land surface of the world is already cultivated, that is, about 3,600 million acres, 1·8 acres per head.

Britain is for its size the most crowded country in the world, and the most dependent on outside sources of food. We are therefore vitally affected by this fact of decreasing available land and increasing demands upon it. To a large extent the situation is outside our direct control, but under the very able and energetic guidance of Sir John Boyd Orr, the Food and Agriculture Organisation has striven to arouse recognition of the urgency of the problems among all nations.

We can, however, try to do something in Britain itself. It is clearly essential that the remaining soil resources of the nation should be carefully assessed and that the destruction of food-producing land should be halted. Unfortunately, 'planning' has not been conspicuously successful in this direction. Perhaps some better procedure may be evolved, but in the meantime methods of evaluating different soils are being elaborated. This is by no means a simple matter; for soils, climate, and management are so interlocked in food production that it is impossible to express any of them numerically. Soils can, however, be grouped, and two methods have been adopted for doing this. One is by soil analysis. This has hitherto been used chiefly for indicating fertilizer and lime requirements, and for that reason was long subordinated to the advisory section of the county agricultural activities; only recently has it been given an independent status. Large numbers of analyses have been made, but few have been adequately discussed in publications generally available; this defect will, it is hoped, be remedied in time; but meanwhile, methods are continuously under review, and fuller knowledge of the soil factors involved in crop production is being gained. Much good work done in other countries is now available; the most recent summary is contained in the new edition (the fourth) of M. Demolon's well-known treatise "La Dynamique du Sol"; American, Canadian, Australian, Russian and other work has been collated and described by the Commonwealth Bureau of Soil Science.

The other method of evaluating soils is frankly empirical but of great practical value. It is based on their performance in the use to which they are actually put, and it necessitates accurate surveys to discover that use. Agricultural surveys, of course, have long been carried out in Great Britain; the most complete were those made by the first Board of Agriculture in the early years of the nineteenth century, which still remain unequalled. In recent years agricultural officials have collected a great mass of information which has been statistically summarized in the "National Farm Survey of England and Wales" (1946), a most useful publication which provides students, experts and officials with much valuable information, and would have been even better if the parallel survey for Scotland could have been made on the same lines and for the same period, so that the results could have been strictly comparable. It has, however, little descriptive detail, and one could wish that, having collected the material, the Ministry would issue a series of volumes comparable with the old ones. Another survey, more restricted in scope, but more homogeneous in execution, was made of the grass lands of Britain by Sir George Stapledon and his colleagues. The fullest land utilization survey yet made in Britain was carried out under Prof. Dudley Stamp and is discussed below. It is the outcome of much valuable study by British geographers which has not yet received the recognition it deserves, but which has revolutionized geographical science in Britain and has furnished a solid foundation on which a sound scheme of land utilization can be built up. The need is great, and time is pressing.

THE LAND OF BRITAIN AND HOW WE USE IT

The Land of Britain
Its Use and Misuse. By Prof. L. Dudley Stamp. Pp. viii+507. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 42*s*. net.

BRITAIN has been fortunate in its geographers. As soon as the subject emerged from the purely descriptive to the more scientific stage, the need was realized for detailed studies of the land to find out the uses to which it was being put, and to discover, if possible, why a particular use was adopted. Among the pioneers were H. J. Mackinder who, in his classical work "Britain and the British Seas", discussed the marked differences between the uplands and lowlands of Britain; and H. R. Mill who, in a paper before the Royal Geographical Society, prepared a specimen description of a 1-in. Ordnance Survey map sheet. But it was Patrick Geddes who gave definite form to the idea of setting out the principles on which a survey should be based: starting with a small area and studying it intensively. The idea was taken up with alacrity by teachers of geography throughout Britain: under the wise guidance of H. J. Fleure, they formed themselves into the Geographical Association, which co-ordinated the methods and arranged for periodical discussions and exhibitions of work. In the various colleges and university departments of geography, students were trained in the methods of detailed survey, the pioneers including besides H. J. Fleure, James Fairgrieve, Profs. Eva G. R. Taylor, C. B. Fawcett, S. W. Wooldridge, Dudley Stamp, S. H. Beaver and others. The Le Play Society, founded by Patrick Geddes to carry on the work of the French geographer Le Play, has through its able and energetic director, Miss Margaret Tatton, arranged for its members to make similar studies in various European countries, and these have furnished wider experience and new ideas. Quietly and unobtrusively a large number of surveys were made by the students and staffs of university departments, but owing to absence of means of publication most of them remained only in manuscript. Nor was the work confined to the universities: it penetrated to the schools and it gave a reality and vividness to the teaching of geography that the subject had never had before. Even village schools took the matter up, and some admirable local studies were made.

Those who had seen something of the work and had had an opportunity of studying some of the resulting maps and reports could not help regretting that so much valuable work should lie unappreciated and inaccessible to many to whom it would have been helpful and interesting. The task of collecting and co-ordinating it seemed well-nigh impossible of achievement. Fortunately, Dr. L. Dudley Stamp, on his appointment as Sir Ernest Cassel reader in economic geography at the London School of Economics, realized the great possibilities and was undaunted by the difficulties; he proceeded from 1929 onwards to develop a scheme for a unified survey of Great Britain—acre by acre, every field—to be based on the 6-in. Ordnance Survey Map. The results are published in nine volumes and a series of 1-in. maps, and they furnish a remarkably full record of the land utilization of Britain before the War: they contain much new and valuable information that the busy student would not easily find, and Prof. Stamp has had the happy idea of preparing this summary volume which includes the leading results and gives references to the relevant volumes of the complete survey.

One of the unexpected generalizations that emerges is the steadily increasing part that natural geographical factors play in determining land use, contrary to the general idea that science emancipates mankind from dependence on natural conditions. Interesting examples are given in the chapter on orchards, where the importance of a proper site, especially in relation to late frost, is well brought out. Were it not for its liability to frost, the Wisbech area could, the author states, supply all Britain's requirements in cooking apples; as it is, only a small proportion is grown. It might be thought that practical men would have known this themselves—and, of course, the best of them do—but the surveyors found a surprisingly large number of badly sited orchards, including much of the fruit planted in the eastern counties during the difficult 1930's. Nothing can now be done to improve them.

Market gardening is known to require a light soil and a water-table fairly near the surface; proximity to a steady market is an obvious advantage. The housing developments near London, however, have involved so much drainage that the water-level has fallen and the suitability of the land has therefore lessened. Overhead irrigation has largely met this difficulty, but naturally makes its heaviest demands on water in times of prolonged drought when water supplies are lowest. Supplies of town stable manure and of town refuse used to be important factors in determining the location of market gardens but are so no longer. Nor does the distribution of population much affect the distribution of market gardens, but rather the steadiness of the demand for produce: determined by such factors as freedom from spells of unemployment.

The effect of transport on land utilization is well brought out. The area east of Canterbury was formerly not easily accessible; now, however, motor lorries readily penetrate, and fruit-growing and market gardening have both greatly increased. The author thinks that other regions at present rather inaccessible might similarly be opened up: he mentions some of the outer Hebrides, which have a high average temperature, much sunshine, low rainfall and sandy soils, and might be well used for some types of cultivation.

A final section records the finances of the Survey, and one can only regret that so valuable a piece of work should have had to be so largely paid for by Prof. Stamp himself, a situation that surely calls for recognition. Meanwhile, the book can be cordially commended to all interested in the land of Britain.

E. JOHN RUSSELL

BRITAIN'S SCIENTIFIC WAR EFFORT

Science at War

By J. G. Crowther and R. Whiddington. Pp. vi + 185 + 51 plates. (London: H.M. Stationery Office, 1947.) 2*s*. 6*d*. net.

IN a foreword to this popular account of how science helped the armed forces to win the War, Sir Henry Dale explains that the object of the Scientific Advisory Committee to the Cabinet in securing approval for the preparation of this work was "to make available to the public an authoritative account of some of the more important aspects of the scientific contribution to the war effort, based on official archives, but so written as to be acceptable to the reader without special scientific education". Naturally, the whole field of the scientific war effort cannot be covered in a single volume, and the authors have chosen radar, operational research, the atomic bomb, and science and the sea, because of their wide interest, as typical illustrations. All four are essentially British contributions.

The purely scientific basis of radar had been established before the War; but it was the initial foresight of Dr. H. E. Wimperis and Mr. A. P. Rowe, the inventive genius of Sir Robert Watson-Watt, the timely brilliant production of the cavity magnetron by Prof. J. T. Randall and Dr. H. A. H. Boot, and the close collaboration of scientific workers, military users and industrialists, which first saved us from aerial destruction and then allowed us to attack the enemy with deadly accuracy. The story of radar will perhaps be told in more detail elsewhere, but certainly not so vividly as in "Science at War".

Operational research owed its inception to Mr. A. P. Rowe, then superintendent of the Telecommunications Research Establishment. It is concerned with the study of weapons, tactics and strategy, and the methods which were developed in war-time can be employed, in peace-time, in industry. It is interesting to learn that the first consistent exposition of the principles of operational research was given by Prof. P. M. S. Blackett.

The section on the atomic bomb is the first adequate exposition of the British contribution to the discovery of the atomic bomb and the release of atomic energy. It is good to be reminded that British men of science were the pioneers in nuclear research, and that up to 1941 Britain led the world in this sphere of fundamental research and development. The huge task of the production of the atomic bomb, a remarkable achievement in itself, had to be left to the United States. Mr. Crowther and Prof. Whiddington content themselves and their readers by confining their story to events before the commencement of the American project.

Finally, in "Science and the Sea", we are told how Asdic works, how the magnetic and acoustic mines were defeated, and all about depth-charges and frog-men.

The book is a remarkable half-crown's worth. Not only is the subject-matter presented in an exceedingly interesting fashion, technical and scientific accounts being given in a manner that even those with little technical knowledge can easily follow, but, in addition, the volume is profusely illustrated by numerous line drawings and excellent photographs. If only some of our scientific text-books were as well provided !

S. WEINTROUB

EMPIRES IN TRANSITION

Colonial Policy and Practice

A Comparative Study of Burma and Netherlands India. By J. S. Furnivall. Pp. xiii+568. (Cambridge: At the University Press, 1948.) 36*s*. net.

Soviet Economic Development since 1917

By Maurice Dobb. Pp. vii+474. (London: Routledge and Kegan Paul, Ltd., 1948.) 18*s*. net.

THE history both of the U.S.S.R. and of the colonial territories of European States illustrates the impact of the ideas and activities of the West upon less-advanced peoples, and these two books together provide material for a comparative study which is of particular interest at the present time.

The historian of the future is likely to find less cause for wonder at the changes that have taken place in Britain's imperial position in the last few years than at the fact that that position was ever achieved at all. The century of expansion which seems now to be closing has been, indeed, a remarkable period, and its final effects can no more be estimated yet than can those of the Bolshevik Revolution. Mr. J. S. Furnivall, who has already given us a notable study of Netherlands India, here takes one part of the story, the occupation of Burma, and endeavours to see it, not only as a part of the British achievement, but also, in a wider setting, as an illustration of the clash of cultures. In order to do this he has, in effect, combined several books in one. Of his 550 pages some two hundred are devoted to a survey and critical appreciation of British rule in Burma, and a further sixty to a summary of the material already made available in "Netherlands India". These two descriptive sections are followed by a long and valuable comparative study of British and Dutch policy, in which some comparisons are also drawn with conditions in Africa. Here Mr. Furnivall is, as he admits, "treading on uncertain ground", and the points he makes are largely drawn from the writings of Lord Hailey. Finally, there is what amounts to a political pamphlet, a discussion of current problems, with proposals for their solution. "If one would understand colonial practice", Mr. Furnivall writes, "one must study it both comparatively and historically", and it is "as a contribution to such a study" that the work is intended.

A full survey of colonial government must await the pen of another Toynbee ; but Mr. Furnivall has done much to clear the ground in one part of the world. What he says of Burma elucidates a situation that was already serious before the War and that came to a head under the Japanese occupation. But it does more, for Mr. Furnivall is concerned primarily to show that British rule in Burma, like Dutch rule in Netherlands India, arose as the result of economic and political forces ; that the differences between British and Dutch policy reflect differences in the aims and conditions of existence of the two peoples. The British, with their respect for law and individual activity, tried to establish a system which would leave free play within a system of order ; the Dutch from the first intervened much more directly and sought to mould society, while protecting it as far as possible from the pressure of economic forces by the development of social welfare.

The British method would seem to have failed, for it led, as Mr. Furnivall shows, to "the disintegration of social life through the inadequacy of law to control the working of anti-social economic forces". How far this disintegration had gone in corruption and lawlessness he makes only too clear, and in the preface, written some time after the rest of the book, while approving the recognition of Burmese independence as wise and bold, he feels that "it is impossible to contemplate the future without misgivings". Yet he hopes that Burma's need of help, and a sounder view on our part of our mutual interests, may enable us still to assist in the development of the country; and in his earlier book he has indicated his reasons for believing that the introduction of the "invigorating principles of Western social life" is perhaps "the best justification of European intervention in the East". There has certainly been no lack of ideals, though as Mr. Furnivall shows, in colonial affairs "the lofty aims of policy are continually frustrated in their practical application".

Underlying the whole work, however, is a criticism of colonial rule as such, which finds fullest expression in the following passage : "Contact with the outer world should furnish new sources of inspiration and enrich native social life, art and religion. But the people are not brought into contact with the outer world except in the sphere of economics ; they remain imprisoned in a dying civilization and their social life is impoverished and not enriched." This would seem to be the view of the intellectual leaders of both Burma and Netherlands India. Whether, given the opportunity now presented to them, they can achieve more, remains to be seen. Theirs is the task of reshaping society under the pressure of developments outside their own control.

How the task has been tackled in another society is the theme of Mr. Dobb's book, and the picture of a revolutionary *élite* successfully remoulding Russia and its Eastern territories emerges with the utmost clarity from his pages. The ground has been covered before, notably in Dr. Baykov's "Development of the Soviet Economic System", but Mr. Dobb has given flesh to the bones of Dr. Baykov's study, and produced a work which will have a wide appeal.

The first part surveys the situation before 1917, and the second is a careful study of the development of the Soviet economic system from the Revolution to the end of the Second World War, while the final four chapters contain an analysis of certain aspects of that system in practice. The aim of the book is clearly indicated in its title. Here is a survey of Soviet economic development since 1917: it is not, and is not intended to be, a critical appraisal, nor does it move beyond the range of economic policy, or attempt to estimate, in human terms, the results of the Soviet achievement. Under present conditions such an attempt could scarcely be made, for we are compelled to rely on Soviet statistics and declarations of policy, and cannot, therefore, calculate the significance of the actual achievement for other less advanced peoples of the world. It would be valuable to have more records of the type of Mr. John Scott's "Behind the Urals" (to which Mr. Dobb does not refer), but that we shall have no more of these for some years seems certain. Yet some indication of the conditions under which the Soviet system has worked is given by Mr. Dobb. Thus, in speaking of the difficult early years, he says "A more developed country can afford to brave uncertainty and to learn by trial and error, where a poorer country can bet only on a certainty". Given that this is true, we may ask who decides on the certainty, and how, and who settles the "given canon of social policy" referred to on p. 11, while we recognize that these are also questions that must be asked of colonial administrations.

Underlying the whole study, indeed, are the peculiar conditions—of geography, history, political and social development, resources, and something intangible in the very nature of the people—which have made possible the Soviet experiment (and, in another context, the British Empire). Mr. Dobb feels the force of these conditions, and especially the influence of the last-named, when he writes: "Many have marvelled that men and women could possess the endurance to do such things. . . . No mere heady propaganda or iron hand, but only a rare spirit forged in a people by its history, a boundless faith in their own ability to wring achievement from the future, is capable of inspiring men to endure and to strive as the Russian people have done".

Mr. Dobb is confident that Russia's experience has something of value to offer to the development of other parts of the world, and he makes some stimulating suggestions. But how great, in fact, Russia's direct influence will be we may well wonder, though the force of the Soviet idea is not to be doubted. Taken together, these two books are a valuable commentary on present problems.

It remains to be added that Mr. Dobb has provided useful maps and an index that is worthy of the name. Mr. Furnivall's index and single map are, unfortunately, unworthy both of his book and of the price at which it is published.

Maurice Bruce

A DESCENDANT OF BENJAMIN FRANKLIN

Alexander Dallas Bache, Scientist and Educator, 1806–1867

By Merle M. Odgers. (Pennsylvania Lives.) Pp. vii + 223. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1947.) 15*s*. net.

As the sub-title—"Scientist and Educator"—suggests, this is a biography of one whose influence and work not only enriched science, but also had a profound effect on educational development in the United States. In fact, in the words of Rear Admiral Leo Otis Colbert, the present director of the U.S. Coast and Geodetic Survey, Bache was "one of the great personalities of nineteenth-century America". This man of wide interests was the grandson of a Yorkshireman, Richard Bache, of Settle, and the great-grandson of Benjamin Franklin; it is not surprising that he took such an interest in the development of science and education in Europe.

The book gives an interesting account of Alexander Bache's many-sided activities—his classical education, his training as a cadet at the United States Military Academy, West Point, his European tour during 1836–38, and his activities as head of the Philadelphia Central High School and finally as superintendent of the United States Coast Survey, a post which he held from 1843 for a period of some twenty years. On leaving the Army in 1828, Bache had been appointed professor of natural philosophy and chemistry in the University of Pennsylvania, and in addition to teaching he found time for research and for participating in the activities of learned societies. It was, however, his election as president of Girard College that widened his interests in education and led to the tour through Europe to gather information of methods and institutions. Stephen Girard, merchant and banker, had died in 1831, and in accordance with his will the College was to provide a sound education including a variety of subjects—literary and scientific—and with special reference to "a pure attachment to our republican institutions, and to the sacred rights of conscience". This set a wide horizon to Bache's inquiries abroad, and although he did not ultimately become president of Girard College, his European tour, which included visits to nearly three hundred schools, provided ample material for educational research and forged a valuable link between the Old World and the New.

With regard to his scientific work, the earlier part of Bache's career revealed a great interest in terrestrial magnetism. During the two years that he was abroad, several observations were made by means of portable instruments, and an interesting list of recording stations, varying from Westbourne Green, in London, to the summit of the Faulhorn near Grindelwald, is given on pp. 124–25. Plenty of scope for scientific research was afforded by Bache's appointment as director of the Coast Survey, and after fifteen years work the verdict of the president of the Royal Geographical Society was that though the Americans were last in the field, they had leaped into the very first rank. Apart from survey of the coast, Bache was responsible for detailed study of the Gulf Stream; nor did he neglect geomagnetism. His numerous contributions to learned societies included a paper in the *Monthly Notices of the Royal Astronomical Society* on a new method of observing transits. In the defence of Philadelphia in 1863 Bache played his part in the Civil War, but never recovered from the strain that it entailed.

It is a welcome sign that books of this nature appear from time to time on both sides of the Atlantic. Too frequently the achievements of science have been separated from their background of history and human endeavour. The author is to be congratulated in maintaining a vivid interest in Alexander Bache—the man and his times. There are numerous extracts from original sources and an exhaustive bibliography is appended. H. D. ANTHONY

SCIENTIFIC MANAGEMENT

Time Study and Common Sense

A Critical Study of some Conceptions and Methods with Suggestions for Improvement. By Abraham Cohen. Pp. viii+112. (London: Macdonald and Evans, 1947.) 10*s.* net.

Skill and Management

By G. E. Milward. Pp. x+102. (London: Macdonald and Evans, 1947.) 8*s.* 6*d.* net.

"TIME Study and Common Sense" is a disappointing book. Mr. Cohen explains in his preface that it consists mainly of lectures given to "Time Study engineers" at Royal Ordnance factories. It may be that the book lacks some of the author's personal exposition which may have made his arguments clearer in the lecture room than they are in the book. There is so much misunderstanding and misrepresentation about time study, and so many rather ponderous text-books have been published about it, that a new examination in the light of common sense would have been especially welcome. It is very much to be regretted that Mr. Cohen's work adds nothing but a vague confusion to the subject.

The book is mainly devoted to a rather scathing denunciation of a number of authors of books on time study. Mr. Cohen brings little evidence to support his attacks, and such standard authors as Barnes, Hendry and Carroll scarcely need fear comparison with this unhelpful book.

One or two quotations which are typical illustrate the quality of Mr. Cohen's thought: on p. 5 he states, "a Time Standard is a vague conception", and a little later, a time standard is defined as "some potential output which our workers are supposed to achieve". This is vagueness indeed, but it is wholly of Mr. Cohen's importation.

The main theme of the book is to discredit the method of rating work, and the addition of rest allowances which are almost universally used in time study in Great Britain. Yet this is what Mr. Cohen tells us to do on p. 52 in the chapter on "How to Set a Time Standard": "we should remember that we have to rate the recorded time up, or to rate it down, to a time we consider to be the optimum at which we want and expect our workers to work all the time—on an average". It is to be hoped that time-study men in Royal Ordnance factories found some better basis for their ratings than this.

There is a list of other works on time study at the end of the book, but no subject index.

It is perhaps a pity that the author of the above book did not follow some of the admirable and workmanlike advice given by Mr. Milward in "Skill and Management" upon the way in which the results of an investigation should be presented in writing. This book is a brilliant little work of close and coherent reasoning. Although it is primarily written for the specialist in management, it is safe to say that it could be read with profit and interest by anyone who wishes to keep in touch with modern thought on organisation.

Early in his book, Mr. Milward makes a point of great relevance to current industrial conditions when he analyses the difference between 'effectiveness' and 'efficiency'. The modern tendency towards more and more functional specialization increases the effectiveness with which separate limited ends are pursued, but it is accompanied by a growing difficulty in maintaining managerial efficiency in the broad sense. But, writes Mr. Milward, "effectiveness of performance cannot be expected to survive loss of managerial efficiency for very long".

In addition to its original contribution of some hard, straight thinking, this very well-balanced book quotes freely and appropriately from some of the classical economists and philosophers. J. LEIGH

GAS TURBINES

Modern Gas Turbines

With Special Reference to Stationary, Aircraft, Locomotive and Marine Types and to the Supercharging of Internal Combustion Engines. By Arthur W. Judge. Pp. xi+311+19 plates. (London: Chapman and Hall, Ltd., 1947.) 28*s.* net.

THE published information on gas turbines is both voluminous and widely dispersed, a considerable part of the technical literature of Britain, the United States, Switzerland, Sweden and other countries having been devoted to this subject in recent years. The object of this latest of Mr. Judge's books appears to have been to collect together at least the most important of these articles and papers, and to offer explanations and comments. It is a pity that this worthy object should be marred by several fundamental errors in thermodynamics, such as the statement in Chapter 3 that the efficiency of the Carnot cycle ". . . can also readily be shown to be represented by the following relations:

$$E = 1 - \left(\frac{1}{r}\right)^{\gamma-1}, \quad . \quad . \quad . \qquad (10)$$

where r is the ratio of volume V_0 at 0 to V_1 at 1, i.e., the isothermal compression ratio". It is well known that the isothermal compression ratio has no influence whatsoever on the efficiency of the Carnot cycle, and that r in the equation should be, using the notation of the text, "the ratio of the volume V_2 at 2 to V_1 at 1, i.e., the adiabatic compression ratio".

In the same chapter, the same expression is derived for the efficiency of the Otto cycle and for the constant-pressure cycle. These expressions are correc as they stand, but, no note having been made to the contrary, leave the reader with the impression tha all three cycles amount to very much the same thing which is far from the case.

Far more serious, however, is the confusion which appears to exist in the author's mind on the subjec of entropy. On p. 62 the following statement appears: "The entropy of a given quantity of gas is defined as the ratio of its total heat to its absolute temperature. Thus, Entropy $\varphi = H/T$, where H = total heat reckoned from a given datum level, e.g., absolute zero, and T = absolute temperature". This is a misconception of the first magnitude which must be pointed out, as this book is likely to come into the hands of students whose imagination has been fired by the rapid development of the gas turbine, and whose knowledge of thermodynamics may not be sufficient to detect such errors. There are other errors in the text which make the chapter on thermodynamics unreliable.

However, the book improves when the author confines himself to descriptive work, the chapter on aircraft propulsion being very well done and containing some excellent illustrations.

It seems a pity that more emphasis was not placed on the vast difference between the aircraft gas turbine on one hand, and the land or marine gas turbine on the other. The design of the latter type of machine is a much more difficult proposition than that of the former, both because of the thermodynamic problems involved in converting the kinetic energy of the jet into useful work, and the metallurgical problems involved in finding materials to withstand the working temperatures, not for 500–1,000 hours as in the case of the aircraft turbine, but for ten to twenty years.

The book could serve a useful purpose if some of the errors, particularly in the chapters on thermodynamics, were corrected. One of the most useful features is the bibliography containing eighty-nine references. E. G. STERLAND

CHEMICAL ENGINEERING

Chemical Engineering Fundamentals

By Chalmer G. Kirkbride. (McGraw-Hill Chemical Engineering Series.) Pp. xi+419. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 30*s*.

THE intention of this book is to enable students with little knowledge of chemistry and mathematics and none of physical chemistry to begin the study of chemical engineering, or rather of what are termed "the five technical fundamentals". It opens with a chapter on human relations in chemical engineering; the next deals with "Useful Mathematical Tools". This is followed by "Important Concepts of Physics and Chemistry"—in fifty pages. Of these it might be said that never were so many facts (sometimes not strictly accurate) compressed into so few pages. The effect of reading this part of the book is one of bewilderment and a feeling of agreement with a statement made later that "dogmatism usually irritates most readers". It is doubtful if British students, who are trained to think rather than absorb facts, could take in all that is presented, or if it would be of any value to them if they did. They might well gain the impression, for example, that there are five important aromatic compounds represented by well-drawn formulæ, one of which, styrene, is used to make synthetic rubber. Whether it is a solid, liquid, or gas is apparently immaterial, as are its chemical reactions, other than polymerization.

Apart from this too intensive matter, there are many features in the book which are original and of much value to the discriminating teacher. The chapters on material balance, energy balance, static equilibria, dynamic equilibria and economic balance (though what balances in this case is not clear) are by no means elementary and contain numerous illustrative examples. The first and last chapters, on human relations in chemical engineering and the presentation of technical reports respectively, deal with subjects now recognized as of vital importance and, if not taken too literally, may be read with great advantage not only by teachers but also by those actually engaged in industry. The fifty pages of appendix with fifteen tables and twenty-nine graphs might have been more usefully devoted to the explanation of some of the statements in Chapter 3.

H. E. WATSON

RIVERS—A NATIONAL HERITAGE

Our Rivers

By J. W. Kempster. Pp. xi + 300 + 21 plates. (London, New York and Toronto: Oxford University Press, 1948.) 25*s*. net.

LIFE in Great Britain, while not at first sight greatly influenced by rivers, in actuality is very profoundly affected by them. At one time the rivers were far more than a convenient means of disposal of sewage, and there is an increasing deepening of interest in the restoration of the rivers to something like their pre-industrial condition. Government departments which are greatly interested in these matters include the Ministry of Agriculture and Fisheries (with wide interests in fishing and in the irrigation of farm lands), the Ministry of Health (which watches zealously those rivers which are used for water supplies to the public), the Department of Scientific and Industrial Research (which is interested in water pollution research, and also in the hydraulics), the Ministry of Transport (on account of inland transport, water power, and the dangers of pollution from tarred roads), and many others. Obviously the subject is one that is important to the engineers of towns and cities and to civil engineers in general in relation to land drainage.

The author of this book has dealt comprehensively, if briefly, with all aspects of the matter. As an angler he holds that migratory fish are the best judges of pure water, and he commences by dealing with the life-history of salmon and sea trout. As a natural development he then takes up the subject of obstructions in the rivers, and devotes a chapter to river management, and another one to pollution. There follow several chapters dealing with legislation affecting rivers, and these appear to be of very great value as they cover the activities of the various bodies entrusted by Parliament with the management and control of rivers; and the over-riding Acts of Parliament are summarized. Fifteen appendixes give a mine of varied information in compact form.

The author is an enthusiast on the subject of improvements in the rivers of Britain. He regards them as a national heritage, and seeks to enlist interest and support towards conserving their utility, natural beauty and enchantment. The book is commended to all who are like-minded.

A. T. DOODSON

Canada

A Study of Cool Continental Environments and their Effect on British and French Settlement. By Prof. Griffith Taylor. Pp. xiv+524+8 plates. (London: Methuen and Co., Ltd., 1947.) 25*s.* net.

A STUDY of the geography of Canada was much needed by students, who have little access to any objective consideration of that country. Prof. Griffith Taylor has supplied this want in great measure. The book is based on extensive travels in many parts of Canada and also in Newfoundland, which is included in the volume. Part 1 treats of the position, discovery and general physical features, including climate; part 2 considers the Dominion by natural regions; part 3 is a study of environments as related to man—a careful consideration of occupations and population problems. The whole is illustrated by a wide range of sketch maps and diagrams; many of which show great ingenuity.

Proximity to the North Polar regions has been a certain disadvantage to Canada in the past; but with the advent of aerial navigation may prove an asset, since air traffic is not restricted by ice-bound seas or lands. Great-circle routes are thus becoming of increasing importance. Prof. Taylor admits that he is somewhat of a determinist, that man can accelerate or retard the progress of a country's development, but would be unwise if he attempts to depart widely from the directions indicated by natural conditions. Thus he reaches the conclusion that, keeping to the standards of a rich new country, the population potentiality of Canada is some fifty million, or on general European standards twice that figure. These figures are reached by close reasoning which merits careful attention. The book is a valuable study and indispensable to students.

Surrey

By Eric Parker. (County Books Series.) Pp. viii+256+49 plates. (London: Robert Hale, Ltd., n.d.) 15*s.* net.

THE County Books aim at giving "a true and lively picture of each county and its people set against the background which has made it what it is". The present volume is one of the first of the series and its author is well chosen, being a field naturalist of repute and author of the well-known "Highways and By-ways of Surrey".

It is not a topographical work in the usual sense but contains much of the kind of information not found in guide-books. Without losing sight of his home county, the writer discourses pleasantly on themes which often carry him beyond it. He ranges from ancient camps to women's institutes and from the Pilgrims' Way (which he exposes as a fraud) to Brooklands. In separate chapters he discusses folklore, dialect, the economics of farming in 1850 and the vanished industries. He deals broadly (geologists might say summarily) with soil and structure, and generously with the scanty materials of Surrey archæology. Architecture he leaves to the photographer, and, except for museums and roads, ignores everything urban and suburban.

The greater part of the book is concerned with the author's own study of the life of the countryside. For so accessible a county Surrey has a surprising variety of wild life. Mr. Parker, from personal observation over many years, states that in 1939 it was richer in water birds than at any time in living memory, and he believes there are signs of recovery from the setback due to war-time defence measures. With much first-hand evidence he discusses the habits of nuthatches, crossbills, bullfinches, wrynecks and other rare birds, and, in controversial mood, propounds a theory of the drumming of woodpeckers. The red squirrel, he thinks, has been completely ousted by the grey, but many less familiar mammals—among them water-shrew, badger, polecat, pine marten and hare—still flourish. In similar vein he dilates upon butterflies, moths, dragonflies and the living population of woodland, garden and pond. These chapters contain much of interest for the naturalist and many suggestions to stimulate further inquiry.

The book is well printed and produced, with a good index and many fine photographs of landscape and architectural subjects. To conclude it with a featureless sketch-map dominated by roads and railways is anti-climax. W. E. S.

Introduction to Modern Physics

By F. K. Richtmyer and E. H. Kennard. (International Series in Pure and Applied Physics.) Fourth edition. Pp. xvii+759. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 36*s.*

THERE must be very few students of advanced physics who are unaware of the contents and scope of Richtmyer's important book. The appearance of the fourth edition is indeed most welcome and a matter of hearty congratulation to Dr. Kennard, who has kept the work so well up to date. The additions to the latest edition cover the more important advances of the last five years, and mainly take the form of extensive new sections on the properties of the nucleus, including details of the meson, fission and the transuranic elements, and on cosmic rays. Some basic portions of the chapter on atomic structure and optical spectra have been rewritten, with much advantage.

In the concluding paragraph of the final chapter we find the interesting statement that it will be a dramatic day when mesons are for the first time generated in the laboratory. It appears from recent notes that the announcement of this dramatic discovery was somewhat accidentally delayed, and the reviewer now awaits the announcement that someone with access to a cyclotron is attempting to measure the magnetic moment of a meson by a modification of the Alvarez and Bloch resonance method which was so successful with the neutron. L. F. BATES

Practical Biology for Medical and Intermediate Students

By C. J. Wallis. Second edition. Revised, enlarged and re-set. Pp. ix+396. (London: William Heinemann (Medical Books), Ltd., 1947.) 21*s.* net.

THE second edition of this book has been extensively revised and contains much new material which will, no doubt, add to its usefulness. More than a hundred of the illustrations are new and others replace some which were present in the first edition and which were taken from other text-books. Apart from those taken from other books, the illustrations are very rough sketches which are not improved by crude shading such as one would not welcome in the work of the students for whom the book is intended. They are by no means always accurate, especially in the section on embryology, in which two transverse sections appear to have been drawn upside down, and in which Fig. 197 will do little but mislead. This is not a book which the reviewer would be happy in recommending to students. P. D. F. MURRAY

EFFECT OF PRESENT-DAY WHALING ON THE STOCK OF WHALES

By J. E. HAMILTON
Stanley, Falkland Islands

IN November 1946, the *Norsk Hvalfangst Tidende* (*Norwegian Whaling Gazette*), which is an authoritative journal, published an article on Antarctic pelagic whaling in the season 1945–46. This article contains the ominous statement[1] that although the proportion of mature females taken in the catch shows an increase on the seasons immediately preceding the War, the percentage of mature females which were pregnant shows a marked decline. In blue whales, this percentage was only 20·7 per cent and in fin whales 23·2 per cent. Percentages of pregnant females are also given for five pre-war seasons, the lowest figure appearing in 1934–35 and being 28·7 per cent for blue whales and 33·1 per cent for fin whales.

It is generally believed that the cows become pregnant in alternate years, and therefore one might expect about 50 per cent of the adult females to be in calf; or since the newly mature are, in theory at least, pregnant, the percentage might be somewhat higher. How much higher would depend on the proportion of newly mature cows to those which had already established the breeding rhythm. A drop in this percentage must be the result of three factors: (1) killing of young mature females before they have had time to be impregnated; (2) depletion of the stock of adult females in previous seasons; and (3) depletion of the total stock of adult whales so that a perceptible number of females are not fertilized.

The 1930–31 season was a record in the annals of pelagic Antarctic whaling, and 28,000 blue whales were taken. Succeeding seasons showed an increasing decline in the quality and quantity of the catch, and consequently in 1937 the minimum lengths at which whales were to be killed were fixed by international agreement. These lengths should be compared with the lengths at which whales become sexually mature; Mackintosh and Wheeler[2] published the following figures in 1929, and Mackintosh[3] produced revised lengths in 1942.

			1929	1942	
Blue	whales,	male	74 ft. 2 in.	74 ft. 2 in.	(no change)
,,	,,	female	77 ft. 9 in.	77 ft. 1 in.	(reduced 8 in.)
Fin	,,	male	63 ft. 8 in.	63 ft. 0 in.	(,, 8 in.)
,,	,,	female	65 ft. 7 in.	65 ft. 3 in.	(,, 4 in.)

Matthews[4] gives the following lengths for the humpback whale:

Males	39 ft. 4 in.
Females	41 ft. 0 in.

Now the figures decided upon by international agreement as the minimum for permissible killing are:

Blue whales	70 ft.
Fin whales	55 ft.
Humpback whales	35 ft.

In every case the length is well below that at which the animal attains sexual maturity, and consequently the young cows will not have had time to reproduce.

Since the period of gestation is stated to be just over ten months for blue whales and eleven and a half months for fin whales, and the addition of the suckling period of six or seven months gives a total of about eighteen months from conception before the calf can fend for itself[2], it is obvious that the legal size limit has been fixed too low to be effective in preserving the stock. In fact, the habitual killing of immature whales of both sexes is a particularly and obviously efficient way of exterminating a species, although the effect may not be noticeable until a fair proportion of adults are dead, either naturally or by modern whaling methods.

The season 1940–41 was the last of the 'pre-war' series and the catch was comparatively small; eleven factory ships taking 12,744 blue and fin whales. A number of ships were captured or destroyed, but some of the records, at least, have survived; one factory ship went to the Antarctic whaling grounds in each of the seasons 1943–44 (837 whales) and 1944–45 (1,595 whales). However, speaking generally, there was a 'rest' from the depletion of the stock for four and a half years during 1941–45. In this period, mature females could each have produced two calves and could have become pregnant again by 1945–46, when whaling was resumed on a large scale. Now, in spite of this 'rest', the percentage of blue whales in the 1945–46 catch was only 30·7 per cent, "the lowest hitherto met in pelagic whaling in the Antarctic"[1].

The practice of the whalers is to try to catch the largest whales—the gunner who does this gains in reputation; but any whale is better than none, since the factory ships have to be filled with oil. Since the average length of the whales killed is decreasing, it must be concluded that either the larger whales are becoming more difficult to catch or that they have been pretty well killed off. The former assumption cannot stand, for against powerful modern catchers the bolting whale stands no chance. It must take frequent breaths while travelling at speed, remaining practically at the surface all the time, and so can be easily followed and run down. With regard to the latter assumption, the remarks made to me after the last Antarctic season by a very experienced whaler are pertinent. He told me that blue whales were not what they used to be, and that the enormous animals of past years were either extremely scarce or non-existent. I can remember one day in South Shetland when five or six whales were brought in, one male of 89 ft., the rest being females all 90 ft. or more. The inevitable conclusion is that the larger animals have been killed off, and that the survivors do not live long enough to attain the great size of former years. Absence or rarity of the largest examples of a wild species which is habitually hunted is a sign of a diminishing stock[5].

In making returns in the whaling industry it is customary to express the catch in 'blue whale units'. This is a deceptive practice, and does not give a true summary of the whales taken. At no time in the history of Antarctic whaling has there been a pure blue whale catch. Two principal species, the blue and fin whales, are hunted and contribute to the catch; and at one time a third species, the humpback, was also caught, but now seems to be thoroughly reduced in numbers. In the 'blue whale unit' system, the following equivalents are used:

1 blue whale = 2 fin whales = 2½ humpbacks = 6 sei whales.

These are valid equivalents; but the important point is this—the agreed figure for the last two whaling seasons of 16,000 'blue whale units' for the contracting parties may well mean that a full catch involves the killing of many more than 16,000 animals. For example, in 1945–46 the Antarctic catch was returned[6] as 8,304·8 'blue whale units', but was, in fact, made up of 13,381 whales (3,604 blue, 9,184 fin, 238 humpback and 81 sei whales, as well as 239 sperm whales and 35 "sperm and others"). This last might include some bottlenose or *Berardius*. The catch for 1946–47 has been returned[7] as 15,230·7 'blue whale units'. This represents 8,870 blue, 12,857 fin and 2 sei whales, a total of 21,729 whales[8].

There is obviously a serious danger of losing sight of the reality of the position by continued contemplation of the 'blue whale unit' value of a catch, since the number of animals killed will always be greater than the number of units allowed. An industry of this sort cannot be regulated by reference to abstractions, when it depends entirely upon a stock of wild animals, over the lives and breeding habits of which there is no control.

In the presence of vast and unestimated numbers of animals which it is desired to exploit commercially, nothing is easier than to persuade oneself that the stock is so great that it is impossible to injure it, still less to destroy it. But it is my opinion that the stocks of blue whales are showing clear signs of reduction: (1) in the rarity or absence of the huge animals of earlier seasons; (2) in the reduced proportion in the total catch of this species; and (3) in the reduced percentage of mature females which were pregnant. It is also certain that a parallel reduction of the stock of fin whales is now in progress.

The position with regard to sperm whales is somewhat different. These animals are polygamous, and there are therefore spare bulls which can very well be utilized. The sperm whales occurring outside the warm waters of the breeding grounds are almost invariably large males, which have not been able to keep their place in the herds. There is, however, no information as to the size of this stock of spare bulls, or whether they are resident in the Antarctic. Hence, the present increased killing may simply be using up the accumulation of years, either of a resident male stock, or of an annually visitant herd. The appropriate literature is not available here; but I have the clearest recollection that in the days of the old sperm whalers, certain solitary bulls were known to haunt particular areas of the sea, and continued to do so for years. Such whales, like the authentic 'Moby Dick' and 'Paita Tom', attacked boats at sight.

Finally, it may not be out of place to recall to memory the fate of the North American bison and the passenger pigeon. The former was brought to the verge of extinction and the latter completely exterminated by man for commercial purposes, in spite of the almost incredible numbers in which they both existed a little more than a century ago.

[1] *Norst Hvalfangst Tidende*, No. 11, 278 (1946).

[2] Mackintosh, N. A., and Wheeler, J. F. G., "Southern Blue and Fin Whales", Discovery Reports, 1, 417 (1929).

[3] Mackintosh, N. A., "The Southern Stock of Whalebone Whales", Discovery Reports, 22, 217 (1942).

[4] Matthews, L. H., "The Humpback Whale", Discovery Reports, 17, 93 (1937).

[5] Laurie, A. H., "The Age of Female Blue Whales", Discovery Reports, 15, 265 (1937).

[6] *Norst Hvalfangst Tidende*, No. 11, 277 (1946).

[7] *Norst Hvalfangst Tidende*, No. 3, 83 (1947).

[8] *Norst Hvalfangst Tidende*, No. 9, 322 (1947).

THE ENZYME-SUBSTRATE COMPOUNDS OF CATALASE AND PEROXIDES

By BRITTON CHANCE*

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CATALASE is a hæmatin enzyme found in relatively large concentrations in erythrocytes, liver, kidney, etc. Its extremely efficient catalysis of the destruction of hydrogen peroxide and its ability to catalyse the oxidation of alcohols by hydrogen peroxide have been recognized for some time, but very little direct evidence for the mechanisms of these reactions in terms of the theory of enzyme-substrate compounds has hitherto been obtained.

Using a micro form of the method of Hartridge and Roughton[1] and Millikan[2] for rapid spectrophotometric studies[3] of the reaction kinetics and equilibria of the unstable compounds of catalase with hydrogen peroxide and methyl or ethyl hydrogen peroxide, the catalytically active enzyme-substrate compounds of catalase with these substances have been discovered. In addition, corresponding inactive forms of the compounds of catalase with hydrogen peroxide and methyl hydrogen peroxide have been revealed. The catalase – ethyl hydrogen peroxide complex which had previously been studied by Stern[4] is shown to be one of these inactive enzyme-substrate compounds. The three active enzyme-substrate complexes share a common property of oxidizing substances such as alcohols, and in this case catalase functions as a peroxidase. But the active catalase – hydrogen peroxide complex has the unique property of acting 'catalatically', that is, of decomposing hydrogen peroxide directly into water and oxygen. These studies have shed some light on the mechanisms of these reactions.

Spectra of the Primary and Secondary Compounds

The colour of the three active or primary (I) enzyme-substrate compounds of catalase is pale green, and they have an absorption band at about 670 mμ. The Soret band is decreased in intensity and is slightly shifted towards the visible region of the spectrum, giving an isobestic point at about 435 mμ[5]. At 405 mμ the decrease of extinction coefficient per mole of hæmatin iron bound by peroxide is the same for the three primary complexes. Under suitable conditions the green compounds change into inactive or secondary (II) red compounds having two bands, at 536 and 572 mμ, approximately in the positions found by Stern[4] for catalase – ethyl hydrogen peroxide. The green-red shift of the hydrogen peroxide compounds superficially resembles that found by Theorell[6] for horse-radish peroxidase and hydrogen peroxide. By analogy with his views, the green primary compounds are ferric iron peroxide complexes with ionic bonds, and the red secondary compounds are ferric iron peroxides with covalent bonds.

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Molecular Composition of Catalase – Hydrogen Peroxide

In the primary compound of erythrocyte catalase and hydrogen peroxide three out of four hæmatin-iron groups of catalase can still react with cyanide ion or alkyl hydrogen peroxide. Thus the maximum concentration of catalase – hydrogen peroxide found under any condition corresponds to only one of the total number of hæmatins present in the catalase molecule. But the alkyl hydrogen peroxides combine with all four hæmatins, as is shown by the inability of their catalase compounds to combine with cyanide. This difference in composition of the primary hydrogen peroxide and alkyl hydrogen peroxide compounds causes a four-fold difference in the decrease of the intensity of the Soret band of catalase when these compounds are formed.

While a catalase in which all four hæmatin groups are combined with alkyl hydrogen peroxide is relatively stable except in the presence of alcohols, the attachment of more than one molecule of hydrogen peroxide to catalase results in an as yet undetected complex which rapidly decomposes. It is this 'catalatic' activity which limits the saturation value of the primary catalase – hydrogen peroxide complex to one hydrogen peroxide molecule per catalase molecule. This complex is the enzyme-substrate compound concerned in the decomposition of hydrogen peroxide, but it does not exhibit the properties of a Michaelis intermediate compound because the hydrogen peroxide not only unites with catalase to form the enzyme-substrate complex but also reacts again with this complex to cause the decomposition of hydrogen peroxide. Therefore, no Michaelis saturation effect is to be expected, and the velocity of destruction of hydrogen peroxide by strong catalase solutions is directly proportional to the hydrogen peroxide concentration, at least up to 0·3 *M*[7]. The previous evidence for a Michaelis constant of 0·025 *M* appears to be an artefact due to the inactivation of catalase.

Kinetics of Formation and Decomposition and the Enzyme-substrate Affinity

Of the three primary complexes, that with hydrogen peroxide forms the most rapidly ($k_1 \sim 3 \times 10^7$ M^{-1} sec.$^{-1}$ (see ref. 5), that is, in a 1 *M* hydrogen peroxide solution the complex would be half-formed in about $\frac{2\cdot3 \log 2}{3 \times 10^7}$ sec.) and the larger the peroxide molecule, the slower the reaction ($\sim 1 \times 10^6$ and $\sim 1 \times 10^4$ $M.^{-1}$ sec.$^{-1}$ for methyl and ethyl hydrogen peroxide respectively). This decrease is much greater than could be expected solely upon the basis of diffusion velocities and must be attributed mainly to a steric effect, due possibly to restricted accessibility of catalase hæmatin to these substances. In these three reactions, the kinetics of the formation of the primary complexes clearly represent the direct combination of catalase with peroxide without the formation of any detectable intermediates. The primary complexes are not stable ; they decompose spontaneously into free catalase with a velocity constant of about 0·02 sec.$^{-1}$ (the half-time for the reaction is $\frac{2\cdot3 \log 2}{0\cdot02}$ sec.) even in the complete absence of alcohols.

Catalase shows the highest affinity for hydrogen peroxide 10^{-9} *M* (that is, a steady-state concentration of about 10^{-9} *M* hydrogen peroxide is required for half-saturation of the primary catalase – hydrogen peroxide complex). This high affinity is not obtained when hydrogen peroxide 'from the bottle' is added to catalase, for then the value is $1\cdot6 \times 10^{-6}$ *M* (at a $3\cdot4 \times 10^{-6}$ *M* catalase concentration[5]), due to the partial destruction of hydrogen peroxide during formation of the primary catalase – hydrogen peroxide complex. Catalase has an affinity equivalent to about 10^{-8} *M* for methyl hydrogen peroxide and about 10^{-6} *M* for ethyl hydrogen peroxide. These values are all increased in the presence of substances such as alcohols which cause the decomposition of these complexes.

The secondary compounds of catalase and these peroxides are formed from the primary compounds comparatively slowly, are much more stable than the primary compounds, and do not appear to react directly with alcohols. They are thus inhibitors of the catalytic activity of the primary complexes.

Reactions of the Primary Complexes with Alcohols, etc.

Keilin and Hartree[9,10] have demonstrated that catalase and hydrogen peroxide or ethyl hydrogen peroxide can oxidize alcohols. These studies show that the primary catalase peroxide complexes are the active agent in these oxidations and are true Michaelis compounds since they fulfil the tests applied to the peroxidase – hydrogen peroxide complex[8]. The reaction-velocity constants for the reaction of the primary compounds with alcohols, etc. (calculated from the formulæ developed for peroxidase[8]), are very nearly independent of whether hydrogen peroxide or methyl or ethyl hydrogen peroxide is bound to catalase, and have values which decrease with the increasing size of the alcohol molecule, as is the case with the increasing size of the peroxide molecule. The velocity constant with ethanol or methanol is $k_4 \sim 1000$ M^{-1} sec.$^{-1}$ (the turnover of the primary compounds in the presence of 0·001 *M* ethanol is $1000 \times 0\cdot001$ times per sec.). The reactions of these three catalase peroxides with alcohols are not inhibited by carbon monoxide.

Direct spectroscopic measurements of the primary compound of catalase and hydrogen peroxide have been obtained in the presence of notatin, glucose, and oxygen. The absolute spectrum of the compound has been obtained with the Beckman spectrophotometer in the region 370–460 mμ and completely confirms the spectrum obtained using 'bottle' hydrogen peroxide and the rapid flow technique[5].

The direct spectroscopic studies of the turnover number of the catalase peroxides in presence of different alcohols agree with Keilin and Hartree's data obtained in coupled oxidations[10]. In such coupled oxidations the saturation of the catalase – hydrogen peroxide complex is found to be small in spite of the extremely high affinity of catalase for hydrogen peroxide. Therefore, the steady state hydrogen peroxide concentration during efficient coupled oxidations is only about 10^{-9} *M*. Only under these conditions is all the hydrogen peroxide utilized for alcohol oxidation and no molecular oxygen is evolved.

Two other biologically important substances have been found to react with catalase peroxides just as rapidly as do ethanol or methanol. These are formaldehyde (probably as methylene glycol) and formate. By a combination of the chromotrophic acid method[11] for formaldehyde production or disappearance and an acidimetric method using brom-cresol purple for formic acid production and disappearance, the conversion of methanol to formaldehyde and formic acid, and the destruction of the latter, have been determined using ethyl hydrogen peroxide as the substrate. Similarly, carbon dioxide production from formate can be demonstrated in 'coupled oxidations' in which hydrogen peroxide is the substrate (Keilin and Hartree, personal communication).

The reaction of catalase – ethyl hydrogen peroxide with ethanol apparently gives acetaldehyde from ethanol and ethanol from ethyl hydrogen peroxide; the supply of ethanol is not at all depleted during the oxidation, and a small initial ethanol concentration may cause the reduction of a large amount of ethyl hydrogen peroxide. The destruction of strong ethyl hydrogen peroxide solutions by catalase studied by Stern[4], in which catalase is almost completely converted into the secondary compound, can be explained on the basis of a small percentage of the primary compound in equilibrium with the secondary compound. This primary compound reacts rapidly with ethanol present in ethyl hydrogen peroxide, and a small initial ethanol concentration will therefore cause the reduction of all the ethyl hydrogen peroxide. Thus the normal reactions of the primary compound were masked by the presence of Stern's inactive red complex.

The fact that catalase has a high affinity for ethyl hydrogen peroxide appears to contradict the results obtained by Stern[13], who failed to find appreciable inhibition of the destruction of hydrogen peroxide by catalase until about 0·1 *M* ethyl hydrogen peroxide solutions were used. However, these spectroscopic measurements show the 'stripping off' of alkyl hydrogen peroxide groups bound to catalase hæmatin upon the addition of hydrogen peroxide, with the result that only the catalase – hydrogen peroxide complex remains. In experiments in which hydrogen peroxide is continuously generated by notatin, glucose and oxygen, the rapid turnover of a large amount of catalase-bound alkyl hydrogen peroxide is observed spectroscopically. Thus hydrogen peroxide can take the place of an alcohol and can react with catalase alkyl peroxides. It does so with about the same velocity as it reacts directly with catalase. Therefore hydrogen peroxide has a reactivity of about 30,000 times $\left(\frac{3 \times 10^7}{10^3}\right)$ that of ethanol.

By a comparison of the activity of catalase-peroxides towards methanol, methylene glycol, and formic acid (all three are equally active) and ethanol, acetaldehyde, and acetic acid (the latter two are nearly inactive), it is concluded that both a hydroxyl group and a hydrogen atom attached to the one carbon atom are required of a suitable oxygen acceptor. The acceptor action of hydrogen peroxide constitutes an exception to this rule. Since the reaction velocity of both substrate and acceptor decreases with increasing size of the acceptor or substrate molecule, the acceptor molecule may have to pass through the same 'hole' as the substrate and may momentarily become attached to or near the catalase iron peroxide complex.

Secondary Compound of Catalase and Hydrogen Peroxide

When catalase is continuously supplied with hydrogen peroxide by means of notatin, glucose, and oxygen, the slow conversion of the primary to the secondary complex ensues, and the two-banded spectrum (536 and 572 μ) may be seen in the hand spectroscope. Since these bands are close to those reported by Lemberg and Foulkes[14] for a compound of catalase and ascorbic acid, and since hydrogen peroxide formed by autoxidation of ascorbic acid has already been shown to give rise to the primary complex[5], there appears to be little evidence for the existence of this catalase – ascorbic acid complex.

The secondary complex has not yet been observed spectroscopically by adding 'bottle' hydrogen peroxide to catalase owing to the decomposition of the hydrogen peroxide in a fraction of a second. Under the conditions used in the determination of Kat *F*, catalase is in contact with 'bottle' hydrogen peroxide for ten minutes or more. The observed slow decrease of activity during this time has been proved to be due mainly to the formation of the secondary complex, since after the secondary complex has been formed by notatin, glucose, and oxygen, the diluted solution has only half the Kat *F* of the untreated solution. Furthermore, at *p*H 3·5 the rate of decrease of activity[7] and the rate of formation of the secondary complex in the presence of notatin, glucose, and oxygen are both accelerated. The extent of inactivation of catalase depends upon the number of catalase hæmatins converted to the secondary complex, and this varies with the experimental conditions.

This explanation of the inactivation of catalase by hydrogen peroxide justifies the new method for the determination of catalase activity, in which strong enzyme solutions are used so that the reaction is complete in a few minutes[7]. In this procedure there is insufficient time for the formation of the secondary complex and a nearly constant activity is therefore observed.

Reaction Mechanisms

The nature of the reaction velocity constants obtained in these experiments suggests the following overall equations. The symbol "Cat" represents the four ferric-iron atoms of catalase hæmatin to which the peroxides become attached. The hydroxyl group found by Agner and Theorell[15] is considered to be replaced by the peroxide group. The equations are written in terms of methyl hydrogen peroxide and ethanol for simplicity, but similar reactions have been measured with ethyl hydrogen peroxide as substrate, and with several lower alcohols, formaldehyde, and formate in place of ethanol.

$$\begin{aligned}\mathrm{Cat(OH)_4} + \mathrm{4CH_3OOH} &\xrightarrow{1 \times 10^6\ M^{-1}\ \mathrm{sec.}^{-1}} \mathrm{4H_2O} + \\ \mathrm{Cat(-OOCH_3)_4} - \mathrm{I}^* &\xleftrightarrow{<0{\cdot}01\ \mathrm{sec.}^{-1}} \mathrm{Cat(-OOCH_3)_4} - \mathrm{II}. \quad (1)\end{aligned}$$

$$\begin{aligned}\mathrm{Cat(-OOCH_3)_4} - \mathrm{I} + \mathrm{4C_2H_5OH} &\xrightarrow{1100\ M^{-1}\ \mathrm{sec.}^{-1}} \\ \mathrm{Cat(OH)_4} + \mathrm{4CH_3OH} &+ \mathrm{4CH_3CHO}. \quad (2)\end{aligned}$$

Thus the oxidation of alcohols by the primary catalase alkyl hydrogen peroxide complexes follows the simple theory of Michaelis and Menten, where $\mathrm{Cat(-OOCH_3)_4-I}$ is the Michaelis compound. The conversion of this primary compound into the secondary compound is negligible when the alcohol concentration is large and the peroxide concentration is small.

In Stern's experiments[4] the ethyl hydrogen peroxide concentration exceeded the ethanol concentration, and catalase was mainly in the form of the secondary complex which he mistook for the active enzyme-substrate complex.

The oxidation of alcohols by the primary catalase hydrogen peroxide complex may also be regarded as following the Michaelis theory if proper allowance is made for the reactions of this complex with hydrogen peroxide (see equation 5) and for the fact that only one of the four catalase hæmatins is bound to hydrogen peroxide in this complex.

$$\mathrm{Cat(OH)_4 + H_2O_2} \xrightarrow[<0{\cdot}02\ \mathrm{sec.}^{-1}]{\sim 3 \times 10^7\ M^{-1}\ \mathrm{sec.}^{-1}} \mathrm{H_2O} +$$
$$\mathrm{Cat(OH)_3(-OOH) - I^*} \longleftrightarrow \mathrm{Cat(OH)_3(OOH) - II.} \qquad (3)$$

$$\mathrm{Cat(OH)_3(OOH) - I + C_2H_5OH} \xrightarrow{1000\ M^{-1}\ \mathrm{sec.}^{-1}}$$
$$\mathrm{Cat(OH)_4 + CH_3CHO + H_2O.} \qquad (4)$$

The overall mechanism for the destruction of hydrogen peroxide by catalase is represented:

$$\mathrm{Cat(OH)_4 + H_2O_2} \xrightarrow[<0{\cdot}02\ \mathrm{sec.}^{-1*}]{\sim 3 \times 10^7\ M^{-1}\ \mathrm{sec.}^{-1}}$$
$$\mathrm{Cat(OH)_3(-OOH) - I^*} \longleftrightarrow \mathrm{Cat(OH)_3(OOH) - II.} \qquad (3)$$

$$\mathrm{Cat(OH)_3(OOH) - I + H_2O_2} \xrightarrow{\sim 3{\cdot}5 \times 10^7\ M^{-1}\ \mathrm{sec.}^{-1}}$$
$$\mathrm{Cat(OH)_4 + H_2O + O_2.} \qquad (5)$$

Although similar equations were previously proposed (for a summary see Sumner[16]), it is only now that they find experimental support. First, each step in equation 3 has been observed spectroscopically, and kinetic data have been obtained. Secondly, the reactions of $\mathrm{Cat(OH)_3(-OOH)-I}$ with alcohols according to equation 4 have been followed spectroscopically, as has the following reaction of catalase-bound alkyl hydrogen peroxide with hydrogen peroxide:

$$\mathrm{Cat(-OOCH_3)_4 + 4H_2O_2} \xrightarrow{3 \times 10^7\ M^{-1}\ \mathrm{sec.}^{-1}}$$
$$\mathrm{Cat(OH)_4 + 4CH_3OH + 4O_2.} \qquad (6)$$

It is therefore concluded that the second step of 'catalatic' activity is a second-order reaction of $\mathrm{Cat(OH)_3(-OOH)-I}$ with a second molecule of hydrogen peroxide according to equation 5. Thirdly, equations 3 and 5 indicate that, prior to the formation of appreciable amounts of the secondary complex, the overall velocity of decomposition of hydrogen peroxide will increase linearly with initial hydrogen peroxide concentration over a wide range. This is true at least up to 0·3 M, since the Michaelis constant of 0·025 M is an artefact[7]. In addition, the rapid and slow phases of catalase activity found by George[17] probably represent catalase activity in the absence and in the presence of the secondary complex.

In efficient coupled oxidations, the steady-state concentration of hydrogen peroxide is so low that the reaction velocity according to equation 5 is negligible compared with that according to equation 4. Therefore no molecular oxygen is evolved and hydrogen peroxide is utilized quantitatively in the oxidation of alcohol to aldehyde.

The reactions 1 and 2, 3 and 4, and 1 and 6, representing the 'peroxidatic' activities of catalase, can be analysed according to the Michaelis theory; but equations 3 and 5, representing the 'catalatic' destruction of hydrogen peroxide, cannot, since consecutive reactions of hydrogen peroxide with catalase and catalase–hydrogen peroxide are involved, and the saturation value of the catalase–hydrogen peroxide complex depends upon the relative velocities of these reactions. The formation of a catalase hydrogen peroxide complex containing one hydrogen peroxide molecule per four catalase hæmatins can be explained in two ways:

A purely 'kinetic' explanation is that the ratio of the velocity constant for the hydrogen peroxide reaction of equation 5 to that of equation 3 is 3 : 1; hence the maximum concentration of the catalase–hydrogen peroxide complex is a quarter the enzyme concentration. In this mechanism for equation 5, the hydrogen peroxide molecule may collide directly with the peroxide group attached to hæmatin or may collide with one of the three free catalase hæmatins to give, in either case, oxygen, water and free catalase. In the latter case, a catalase with only one hæmatin group would be 'catalatically' inactive (for a more detailed discussion see Theorell[18]). A second explanation assumes 'special properties' of the catalase–hydrogen peroxide complex. The existence of this complex is necessary for the decomposition of hydrogen peroxide into free oxygen and water or into radicals at the free catalase hæmatins, but the complex itself is not decomposed by these reactions. The complex may, however, decompose spontaneously or on reaction with alcohols, etc. In this case also a one-hæmatin catalase would be 'catalatically' inactive. These two mechanisms give very nearly identical mathematical solutions over the ranges of experimental conditions that can now be investigated with accuracy, and therefore a final conclusion on the exact mechanism for 'catalatic' activity is not yet possible.

A comparison of equations 2, 4 and 6 with equation 5 indicates that there is no fundamental difference between the 'peroxidatic' and 'catalatic' reactions; 'catalatic' activity appears to be the special case of peroxidatic activity when the substrate and acceptor are identical.

Complete papers on these experiments will be published elsewhere.

I wish to acknowledge my gratitude to those who have taken an active interest in the progress of this research and who have made many useful criticisms and suggestions: Profs. H. Theorell, L. Pauling, D. Keilin and F. J. W. Roughton, and Dr. E. F. Hartree. I am indebted to Dr. R. K. Bonnichsen for supplying the bulk of the catalase preparations used in these experiments.

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* The kinetics of this reaction do not follow first or second order kinetics with accuracy.

THE TELECOMMUNICATIONS RESEARCH ESTABLISHMENT, MALVERN

AN exhibition of the work carried out at the Telecommunications Research Establishment of the Ministry of Supply was held at Great Malvern during May 25–27. This was the first occasion on which this well-known establishment has been open to the public. The Telecommunications Research Establishment, or T.R.E. as it is generally called, became famous during the war years on account of the pioneering research on radar carried out there. It developed from the small research group at Bawdsey originally under Sir Robert Watson-Watt to become one of the largest Government research establishments and attracted many of the leading scientific workers in Britain.

During the War, T.R.E. was responsible for research and development of most of the radar equipment for the Royal Air Force. The story of this work is now very well known. At the close of hostilities many of the leading scientific workers at T.R.E., as was indeed expected, returned to academic life. A considerable number of war-time recruits, however, stayed on in the Government Scientific Service and have carried on the tradition of T.R.E. After the War the activities of the Establishment were broadened in scope and a considerable part of the effort on military problems was turned to civil problems and to fundamental research.

The Establishment is now divided into three Departments—Physics, Radar and Engineering. The Physics Department is mainly concerned with fundamental research on the properties of extremely short radio waves, on infra-red radiation and on various fundamental problems in electronics. It includes a theoretical physics group. Some research on supersonics is also being carried out and the application of radar techniques to various problems in meteorology is being studied. A considerable part of the work of the Physics Department is supported and financed by the Department of Scientific and Industrial Research. The Radar Department is responsible for research and development of radar equipments for the Royal Air Force, the Naval Air Arm and the Ministry of Civil Aviation. Examples of projects on which research is taking place are the location by radar of bombing targets, the location and attack of enemy aircraft, radio navigational aids and the use of radar for the control of air traffic. The Engineering Department is responsible for the design and construction of apparatus to the requirements of the scientific staff and for investigating new materials, finishes and component techniques to meet the wide variations of temperature and humidity encountered at high altitudes and in various parts of the world. It includes the Engineering Unit, which is one of the largest and best equipped workshops in Britain.

The Ministry of Supply School of Electronics is situated within T.R.E. Technical instruction is provided in the School for craft and engineering apprentices. Radar courses are arranged for all classes of new entrants, and advanced refresher courses for internal staff. A department of the Atomic Energy Research Establishment is also at present situated at T.R.E. It is concerned with the development of high-energy particle accelerators for nuclear physics and medical research work, and with electronic instrumentation for measuring all forms of radiation in the field of nuclear physics.

The exhibition was opened on May 25 by the Right Hon. G. R. Strauss, Minister of Supply. On that day leading representatives of the Fighting Services, the Civil Service, universities and industry, together with representatives of the Press, were shown a selection of the work of the Establishment. On May 26, about 1,400, representing other Government establishments, industry, and the universities and technical colleges, attended the exhibition. On May 27, senior science scholars from local schools and members of the public from Malvern and nearby towns attended the exhibition. This was made an occasion for the formal opening of the Ministry of Supply School of Electronics by Mr. J. Freeman, M.P., Parliamentary Secretary to the Ministry of Supply.

It was clearly possible to show only a selection of the work of T.R.E. This selection was representative of that carried out in all departments, and items were chosen which were free from any security restrictions. A few of the more interesting exhibits are described below.

Application of Radar to Meteorology

A number of exhibits illustrated the application of radar techniques to meteorology. Photographs of rain clouds and of the radar echoes obtained from them were shown. A light-weight microwave radar equipment, for installation in large civil aircraft, was demonstrated. This equipment is to enable aircraft to avoid dangerous clouds, particularly those of the cumulo-nimbus type. Fortunately this type of cloud gives an excellent radar echo at a wave-length of 3 cm. at which the equipment operates. An interesting problem in the study of rain is the determination of the size of raindrops, particularly immediately below precipitating clouds. A method of making this kind of measurement by use of a specially designed microphone in an aircraft was exhibited. An interesting application of pulsed light to the measurement of the height of the cloud base was also shown. Another application of radar techniques is the radar sonde. Radar is used to locate the position of the sonde carried on a balloon. Thus observations of wind speed can be made from a single station. Meteorological information as determined by the instruments carried in the sonde is transmitted to the ground by the train of radar pulses.

New Developments in Microwave Technique

A number of exhibits illustrated the development of microwave technique for wave-lengths near 3–10 cm. These included demonstrations showing the improvement of receiver performance and the development of very high power transmitters, both aimed at increasing the range of detection by radar equipment. The development of techniques to enable even shorter wave-lengths to be used was illustrated. One exhibit, for example, showed the method of construction of valves for wave-lengths of the order of 8 millimetres and of the associated microwave components.

D.C. Amplifier using Magnetic Modulator

The amplification of small direct currents is much more difficult than that of small alternating currents, and the technique generally adopted is to turn the direct current into alternating current before amplification. A new type of amplifier which uses a magnetic modulator to effect this conversion was exhibited. The apparatus is particularly suitable for amplification of small signals from low-impedance sources such as thermocouples.

Electronic Digital Computing Techniques

An electronic 'memory' for a computing system was demonstrated. This is based on the storage of an electrostatic charge distribution produced on the fluorescent screen of a cathode ray tube by a bombarding beam of electrons. Many binary numbers of 32 digits can be simultaneously remembered by this system, which has been developed in association with Prof. F. C. Williams of the University of Manchester. A binary number arithmetical unit was also shown which will add together two 32 digit binary numbers in a time of the order of 350 microseconds.

Infra-red Research

A number of exhibits illustrating the use of infrared radiation for the detection of temperature differences were shown. For radiations in the range of 1–3 microns the very rapid response of the lead sulphide type of cell makes it useful for the detection of temperature changes which are very short-lived. One exhibit illustrated its use for the detection of hot spots caused by friction. These may last only a small fraction of a millisecond but are clearly shown by the lead sulphide detector. The use of an electronic A.C. amplifier operating at a frequency of 5 cycles per second in conjunction with a thermocouple of special design was shown as an example of an extremely sensitive detector of radiation arising from bodies having only a small difference in temperature from their surroundings. The amplifier is thought to be the best of its type designed so far and is capable of showing the Johnson noise from a 1-ohm resistance in a band-width of 1 cycle per second.

Automatic Recording Spectrophotometer

An automatic recording spectrophotometer which has been designed for the Medical Research Council was exhibited. This instrument enables an ultraviolet absorption spectrum of a substance in liquid solution to be obtained as a trace on photographic paper. The wave-length scale and absorption are simultaneously recorded on the photographic paper so that on development complete information is obtained without further calibration. This enables specimens to be examined with extreme ease and rapidity. The instrument provides an excellent example of the use of electronic servo mechanisms.

Automatic Following Telescope

A working model of an astronomical telescope locked by electronic means to a star at which it is pointed was shown. The telescope contains a device capable of determining the position of a star in its field of view, and any deviation of the star from the centre of the optical system produces correcting signals which drive the telescope to keep the star centrally aligned.

Air Traffic Control

By means of radar equipments sited at Malvern and near London airport a display showing the position of air traffic in the southern half of England was shown. The exhibit illustrated the control of aircraft arriving at a busy airport using radar information.

Airborne Radar

A number of exhibits showed the latest improvements in a number of radar navigational aids developed during the War. Another exhibit showed the radar equipment used in a modern bomber. This included the *H2S* equipment for obtaining a radar map of the ground over which the aircraft is flying, and the automatic gun-laying equipment used in the rear turret. The latter equipment enables a rear gunner to open fire at an approaching fighter which he cannot see visually. Some recent developments in the radar equipment for night fighters were also shown. The equipment enables the fighter to locate and follow an enemy bomber in the dark and to manœuvre into such a position that the pilot can see the enemy aircraft and attack it. A device was also shown which enables the radar information to be projected on to the pilot's windscreen so that he can at the same time view it and look out for the enemy aircraft.

Suppressed Aerials

As aircraft speeds increase, the drag of external aerials becomes more and more intolerable, and as sonic speeds are approached it is impossible to have external aerials at all. Methods of suppressing aerials by use of plastic fittings to the aircraft and by the use of slot aerials were illustrated. These methods represent considerable advances in aircraft aerial technique.

Ultrasonic Research

A number of applications of ultrasonics were illustrated, such as the measurement of ultrasonic absorption in metals as a means of determining the grain size, and the detection of obstacles and flaws by means of ultrasonic technique. The methods used were based on radar principles and employed pulses of ultrasonic energy.

Electronics for Atomic Energy

The exhibitions of the Atomic Energy Electronics Group included an electron accelerator operating on the synchrotron principle and producing electrons having an energy of 15 million electron volts. Various instruments were also demonstrated which are used for the measurement of radiations met with in nuclear physics research. In particular, a number of instruments called 'health monitors' were shown which are used to ensure that workers are not being exposed to an amount of radiation sufficient to cause appreciable bodily harm.

The Ministry of Supply School of Electronics gave a display of equipment illustrating the historical development of microwave technique. An exhibition arranged by the Engineering Department illustrated the development of new types of radio components designed to withstand extreme climatic conditions and also showed some of the latest types of miniature radio components which have been developed with the view of reducing the size and weight of airborne radio equipment. In addition, a number of films, including "RDF to Radar", were shown.

OBITUARIES

Mr. J. J. Shaw, C.B.E.

The death on May 23 of Mr. John Johnson Shaw at the age of seventy-four severs yet another link with the pioneers of the study of earthquakes in Great Britain.

J. J. Shaw was born at Gornal, near Dudley, educated at King Edward's School, Birmingham, and then apprenticed to an engineer. During the latter part of his engineering studies, he designed some gas and some steam pumps, and although he soon forsook his engineering to become a pawnbroker, he never lost his love for engineering. It was in the year 1908 that he read a newspaper article on the recording of earthquakes, and this encouraged him to visit Dr. John Milne, who, having retired from his professorship at Tokyo Imperial University, had settled in the Isle of Wight and set up a seismological observatory there. John Milne and J. J. Shaw became friends, and Shaw, on returning home, set up his first seismograph, which included as components an old treacle tin as drum, a wheat straw as pointer and a driving mechanism taken from an old German clock costing 1*s.* 11*d.* This instrument recorded some violent, world-shaking earthquakes, including the Messina earthquake of December 28, 1908, and with this early success and John Milne's encouragement, Shaw set about improving his instrument. The task became a life study, and in each Milne-Shaw seismograph made under Shaw's personal supervision some improvement on the previous one was embodied. Milne–Shaw seismographs are now working in many observatories throughout the world and are excellent for recording strong distant earthquakes.

Microseisms are now thought to be largely due to storms at sea. They gave ever-recurring trouble to the early observers, and Shaw suggested that data concerning them could best be obtained by the use of the tripartite seismograph station (British Association Seismological Committee Report, 1920), a method which in the hands of Father J. E. Ramírez at St. Louis, U.S.A., and later workers has given such good results.

Shaw, like John Milne, never lost an opportunity to make a friend for seismology. He fitted an electric bell to the seismograph system at his home in West Bromwich, so that he could be ready with instrumental results when any newspaper reporter rang him up about an earthquake. Reporters were often surprised at his perpetual cheerfulness over the telephone at any time of the day or night, and at the fact that his seismograph and his reference files often gave earlier information than their own telephone systems. A few years before the Second World War, Shaw was particularly pleased to set up one of his instruments in Selfridges' Store in London, so that any passer-by could see an earthquake being recorded should one occur at the instant he happened to be near the instrument. This instrument was suspended from one of the main structural steel pillars of the building, and since the steel went deep into the ground the pendulum recorded waves from distant earthquakes but was unaffected by street traffic or the movement of people in the store. This instrument is now in the Science Museum at South Kensington.

Shaw first became a member of the British Association Seismological Committee in 1914, probably having been proposed by his friend John Milne just prior to the latter's death in July 1913. John Milne had been honorary secretary of the Committee for many years, and Prof. J. Perry had taken over the duties of secretary as a temporary measure on John Milne's death. At Manchester on September 8, 1915, Prof. Perry resigned the secretaryship and J. J. Shaw took over. He continued as honorary secretary until July 26, 1946, and was a member of the Committee until his death. As a member of the Seismological Committee of the British Section of the International Union of Geodesy and Geophysics, J. J. Shaw took part in many international meetings and established a world-wide reputation as an instrumental seismologist. He was also a popular scientific lecturer of considerable renown in the Birmingham district, having an infectious enthusiasm for popular science in general and instrumental seismology in particular; being a kindly, forthright man, he made many friends. He was made C.B.E. in 1931, and awarded an honorary M.Sc. by the University of Birmingham a year later.

Mr. Shaw had suffered from knee trouble for some years, and on May 22 one leg was amputated; the operation was successful, but he had a relapse and died the next day. He will be missed by many people not only in his home town and district, but also by a wide circle of friends and acquaintances throughout the world. His son, Mr. Harold V. Shaw, is expected to continue the observatory.

ERNEST TILLOTSON

Dr. J. M. Dalziel

Dr. J. M. Dalziel, whose death was recently reported, was educated in Edinburgh and spent the first years of his career in South China as a medical missionary with the English Presbyterian Mission. His interest in natural history was evident even then. He eventually transferred to the West African Medical Service, where his work during many years took him to all the British West African Colonies. His greatest love was for Northern Nigeria in general, and the Hausas in particular. He was a good Hausa scholar, and also had a considerable knowledge of Fulani. He was a keen observer, and collected a number of new species, especially of Northern Nigerian plants, although he collected animals as well, and recorded their vernacular names. He tried to record the vernacular names and the uses of every plant he encountered, and his field notes were always most thorough and painstaking. His Hausa names of plants, with scientific equivalents, and often with derivations of the names, were published in 1916 as "A Hausa Botanical Vocabulary", an invaluable work, unfortunately now out of print, and in which the majority of the information given is still accurate. During that period Dalziel helped, with his field notes, in J. H. Holland's monumental "Useful Plants of Nigeria".

In zoology Dalziel was a keen bird watcher, as his little booklet "Bird Life round Accra" testifies. He also collected insects of importance as vectors in tropical medicine, and presented his carefully prepared specimens to the University of Edinburgh.

On his retirement from the West African Medical Service, Sir Arthur Hill, then director of the Royal Botanic Gardens at Kew, secured his services to help Dr. J. Hutchinson in the production of the "Flora of West Tropical Africa", a work which occupied the years 1923–36. It was a fortunate choice, for Hutchinson had a great knowledge of the African material in the Kew Herbarium, and Dalziel had a wide field knowledge in West Africa.

But it was the appendix to this flora, entitled "The Useful Plants of West Tropical Africa" (1937), which came to be Dalziel's *magnum opus*. The amount of information and local names he collected was amazing; there were 10,000 vernacular names from Nigeria alone. His information covered all the West African Colonies, including much information from the French West African Colonies. His thorough recording of the medicinal uses, for example, could only be done effectively at that stage by one who, like Dalziel, combined a thorough knowledge of both the plant life and the tropical diseases of the area, together with the necessary persistence and thoroughness in recording his own observations and those supplied to him by others. His correspondence during these many years of compilation must have been immense, and his critical faculty in dealing with it adequately must have been exceptional.

His work is a sound basis for all future work on the uses of West African plants, and he quotes all the authorities he used. This work was his main scientific work, done with endless care, at financial loss to himself, and with inadequate recognition in his life-time. Dalziel has put into the hands of educated Africans, as well as into those of European research workers, the requisite means for further research in the subject, which is of vital importance for the future welfare of West Africans themselves. In his work of recording the medicinal uses in particular, he has laid a foundation on which those of us who follow him can build with confidence.

F. R. IRVINE

Mr. G. L. Overton

MR. GEORGE LEONARD OVERTON, who had been keeper of the Department of Air and Water Transport at the Science Museum during 1926–35, died at his home in London on May 15. Born at Coventry on May 18, 1875, he was educated at Bradford Technical College and passed to the Royal College of Science, London, where in 1897 he graduated in physics and for a year held the post of assistant in the Astronomical Department.

In 1898 Overton was appointed to the then South Kensington Museum by competitive examination—in which he figured with high distinction—and was concerned with the presentation of various scientific subjects, notably time measurement, which for him was a hobby as well as a serious study. He was a fellow of the British Horological Institute and of the Physical Society, and in 1922 published a book on clocks and watches.

Overton had the analytical type of mind that is appropriate to museum work. He was a purist; not only in choice of words, but also in all matters pertaining to the restoration and preservation of exhibits. His regard for accuracy was so great that it tended to limit his output; but the official publications of which he was the author evinced a standard of precision rare even in technical literature.

A serious operation during the latter years of his service handicapped him, but it made his admirable custodianship of the collections for which he was responsible even more praiseworthy. He was one of the very few officers surviving who constituted the higher technical staff of the Science Museum on its separation from the Victoria and Albert Museum in 1909 and inception as a separate entity. The tradition so ably established by Overton and his contemporaries is the foundation upon which that national museum of science and industry is to-day erected. All who knew him, admired his knowledge, and experienced the kindness and generosity of his personal relationship, will deeply regret his passing.

M. J. B. DAVY

NEWS and VIEWS

Royal Society of London: New Foreign Members

ON May 27, Prof. D. W. Bronk, Prof. L. E. J. Brouwer, Prof. M. J. G. C. Caullery and Prof. L. C. Pauling were elected foreign members of the Royal Society of London.

Prof. D. W. Bronk is known not only for his own researches in biophysics but also as the director of the Eldridge Reeves Foundation for Medical Physics since its foundation in 1929. This Foundation forms a part of the University of Pennsylvania, and has acquired an international reputation under his direction and become a flourishing centre of research under his genial and skilled guidance and produced many distinguished pupils. In his own work, his early physical training shows in the precision and definition which he has brought to many biological problems. His particular contributions have been on electrical phenomena in nerve, following his work with Adrian in 1929 on the mode of discharge of impulses by motor nerve cells; he elucidated the functions of the carotid sinus and brought light to many problems of sensory physiology and of synaptic transmission. His work during the War was concerned with many applications of science to the Services, especially those relating to night vision. He was indefatigable in travelling to theatres of war and across the Atlantic as a co-ordinator of research between the laboratory and the field.

L. E. J. Brouwer, professor of mathematics in the University of Amsterdam, may be regarded, along with Cantor and Poincaré, as one of the founders of modern topology if only on account of his proof in 1911 that dimensionality is a topological invariant. Brouwer's life work has, however, been concerned with a theory of the nature of mathematics, which he put forward in its first state in 1907. This theory, known as intuitionism, denies in particular the universality of the law of the excluded middle, and has aroused much controversy.

Prof. Maurice Caullery is the most distinguished of French zoologists. During his long and active career, his students have included many of the present holders of zoological chairs in France and many other well-known biologists, including some in Great Britain. Until 1939, he held the chair of biology at the Sorbonne. He is a member of the Institut de France, member of the Belgian Royal Academy, foreign member of the American Academy of Arts and Sciences, LL.D. of St. Andrews, and has been exchange professor of Harvard University. He was president of the Société de Zoologie and of the Société de Biologie of France. He is president of the Permanent Committee of the International Zoological Congress, and honorary fellow of the Zoological Society and foreign member of the Linnean Society, which awarded him its Gold Medal in 1947. Caullery's 'Jubilé Scientifique' on his seventieth birthday in 1939 was the occasion of remarkable tributes to him and his work paid by many distinguished men of science. His contributions to zoology and general biology are remarkable for their positive and fundamental nature, their wide range and their stimulating character. He has made great contributions to parasitology in a variety of distinct groups of animals. It was he who discovered the Haplosporidia, a new order of Sporozoa. He worked out the life-cycles and relationships of parasites in many groups, particularly Crustacea, Turbellaria and Orthonectidæ. His studies have thrown much light on the biological relations of a parasite to its host.

Prof. L. C. Pauling, professor of chemistry in the California Institute of Technology, is distinguished for his researches on valency and on structural organic and inorganic chemistry. Through his profound knowledge of physics and mathematics he has been able to apply quantum mechanics to problems of chemical valency bonds. His comprehensive work is embodied in his book, "The Nature of the Chemical Bond" (1939), which is now recognized as a classic in chemistry. For this, and other cognate researches, Prof. Pauling was awarded the Davy Medal of the Royal Society in 1947.

Pontifical Academy of Science: New Members

The following have been appointed members of the Pontifical Academy of Science: Prof. J. M. Albareda-Herrera, professor of geology and director of the Institute of Edaphology, Ecology and Plant Physiology, University of Madrid; Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, London; Prof. E. Cruz-Coke, professor of physiological and pathological chemistry, University of Santiago; Prof. A. De Castro, professor of clinical medicine, University of Madrid; Prof. Edward A. Doisy, professor of biochemistry, St. Louis University School of Medicine; Prof. Herbert S. Langfeld, Stuart professor of psychology and chairman of the Department of Psychology, Princeton University.

Physiology at St. Andrews: Prof. P. T. Herring

The retirement of Prof. P. T. Herring from the Chandos chair of physiology in the University of St. Andrews brings to a close a long term of office, for he has occupied the chair for forty years. Prof. Herring was educated in New Zealand and later at the University of Edinburgh, where he came under the influence of Sir Edward Sharpey-Schafer, with whom he later collaborated. His first researches, published in 1908, concerning the development and structure of the pituitary gland, quickly gained recognition and gave the histological background for many of the earlier investigations on the function of this body. The colloid bodies he described are still referred to as 'Herring's bodies', and illustrations of his original preparations demonstrating the vascular bed of the pituitary are to be found in current textbooks. Later, the structure and function of the thyroid claimed his interest, and again he was responsible for contributing much valuable knowledge. Prof. Herring went to St. Andrews in 1908 with a reputation as a lecturer of great distinction, and during his tenure of the Chandos chair he has systematically developed the Department of Physiology and the teaching courses in accordance with current physiological thought. He himself has invariably undertaken the greater part of the teaching in his Department, and there will be many at this time who will recall his clear and stimulating lectures. In addition to his other duties, Prof. Herring has taken a large and vital part in the administration of the University of St. Andrews. He acted as dean of the Faculty of Science during 1921–39 and served as an assessor of the Senatus on the University Court for four periods. His colleagues and the many students who have gained so much from his kindly interest and help will wish him long years of quiet and happiness in his retirement.

Dr. A. E. Ritchie

Dr. A. E. Ritchie, who has been appointed to the chair of physiology in the University of St. Andrews in succession to Prof. P. T. Herring, has had a wide training, having graduated M.A. and B.Sc. in mathematics, zoology and physiology at the University of Aberdeen, and later, in 1940, obtained the M.B., Ch.B. in the University of Edinburgh. In 1945 he was awarded the Gold Medal for his M.D. thesis on the electrical diagnosis of nerve injury. His postgraduate work began when he was holding a Carnegie Scholarship in the Physiology Department of the University of Edinburgh. In that Department he has stayed, combining varied teaching experience with original research. His most important contribution, both to physiology and medicine, has been to design a reliable and relatively simple and compact electronic apparatus for the determination of strength-duration curves, thus converting a laboratory procedure into a practical clinical one. This apparatus is valuable in the diagnosis of nerve injury. Thus Dr. Ritchie's interests lie in the fields both of physiology and of clinical medicine. He has published a number of papers on muscle and nerve reactions both in health and disease, and has contributed an article on muscle reactions in the forthcoming "Encyclopædia of British Surgical Practice".

Proposed Central Publication of Scientific Papers

Mrs. Lucia Moholy, of 127 Sloane Street, London, S.W.1, writes: "In describing American methods of auxiliary publication in *Nature* of June 5 (p. 896), Mr. Watson Davis speaks with authority on the practical value of certain organised measures adopted in the United States to a larger extent than in some other countries. If corresponding methods have not yet attained comparable popularity in Great Britain, it does not follow that the question of systematically using and organising photographic reproduction to assist science and learning has not been taken care of. Not only have suggestions for extensive uses been put forward on many occasions, but also a specific study has been made of the part photographic reproduction can play in relation to Prof. J. D. Bernal's project. With the Royal Society's Scientific Information Conference in sight, a formal statement setting out the merits of these methods for alternative and supplementary services was drafted and, upon Prof. Bernal's request, submitted to the appropriate quarter. This followed an outline of these methods and their potential uses for the publication and distribution of scientific papers, at a meeting on Apr. 21, at the Society for Visiting Scientists. An earlier approach, also with specific reference to Prof. Bernal's project, was made at the Conference on the Publication and Classification of Scientific Knowledge, held at Trinity College, Cambridge, on October 25, 1947.

"The use of documentary reproduction for auxiliary publication, and its eminent suitability as an aid to science and learning in general, were the subject of two articles in *Nature* (157, 29, 38; 1946), where a new type of service was forecast to 'keep men of science currently informed of all the literature published on their respective subjects'. It was there, also, that the setting up of central agencies was suggested and interchange of services and close co-operation with bibliographical centres and scientific institutions was advocated. A memorandum to this effect was also submitted to Unesco (through the offices of its predecessor, the Conference of Allied Ministers of Education, 1945). In a paper read to the Royal Society Empire Scientific Conference, 1946 (Report, vol. 1, pp. 717–721), and another put before the Co-operation Committee of the Library Association in the same year, the setting up of a Central Office of Documentary Reproduction was recommended to act as a co-ordinating centre for Great Britain and the British Commonwealth and Empire; while a renewed appeal for the co-ordination of policy in Documentary Reproduction on a world scale was made to the Sixteenth Conference of the International Federation of Documentation in Paris, November 1946 (F.I.D. Communicationes, 13, Fasc. 4, 60; 1946). For the furtherance of these ideas, Mr. Watson Davis' letter has provided valuable evidence which should bring closer to realization some of the services for which the plans have been prepared in former years."

British Commonwealth of Nations Scientific Liaison Offices

The British Commonwealth of Nations Scientific Liaison Offices (London) have been opened on the third floor of Africa House, Kingsway, W.C.2. This is one of the measures to facilitate co-operation in the civil aspects of science within the Commonwealth decided on by the British Commonwealth Scientific Official Conference held in London in 1946. For a number of years several of the Commonwealth countries have maintained scientific liaison offices in London, and these, together with the ones now being established, will have their headquarters in Africa House. Each of these offices will continue to operate as in the past, retaining complete independence of action; but the convenience of occupying adjacent premises will facilitate co-operation between them on matters of common interest. For ease of reference to the group of independent offices as a whole, the title given above has been chosen, with the abbreviation B.C.S.O. (London) for common use. The offices taking part in the scheme are those of Australia, Canada, Central African Council, India, New Zealand, South Africa and the United Kingdom. Pakistan and the Commonwealth Agricultural Bureaux will be represented, and the Overseas Liaison Division of the U.K. Department of Scientific and Industrial Research will work in Africa House. In Washington the scientific liaison offices of the Commonwealth countries are associated under a similar scheme.

British Seismological Observatories

The Stonyhurst College Observatory has now ceased to record earthquakes, as has also the Royal Observatory at Edinburgh. Mr. E. W. Pollard has moved from the Isle of Wight to Dorking, Surrey, and hopes to set up his seismograph at his new home. He has presented a seismograph with mass 40 lb. to the County Secondary Grammar School at Newport, Isle of Wight, where the instrument has been set up and is being standardized. It is hoped to install good time-keeping apparatus shortly.

International Seismological Summary

Since the British Association meeting in September 1947, the United Nations Educational, Scientific and Cultural Organisation has given a substantial grant-in-aid to the International Union of Geodesy and Geophysics for the International Seismological Summary (see *Nature*, April 17, p. 616). The staff of the I.S.S., consisting of Mr. J. S. Hughes and two assistants, have been at work at Kew for more than a year now, and the full issue for the year 1936 has been produced and partly distributed. In addition, much work has been done on the Summary for 1937, portions of this being in the hands of the printers. We are informed by Dr. Wang Ging-Hsi, of the Natural Sciences Section of Unesco, that the Organisation will assist similarly with another grant in the present year.

Natural History Journals

One by one some of the journals whose light flickered and went out in 1939 are being revived. The latest is the *Scottish Naturalist* which now enters on its fifth stage under the joint editorship of Prof. V. C. Wynne-Edwards and Dr. J. W. Campbell. The first volume of the new series is mainly devoted to birds of Scotland. That country has also produced a new journal, *Scottish Zoo and Wild Life*; this has been inaugurated by the Zoological Society of Scotland for the benefit of its fellows and all who are interested in animal life. Cordial wishes for their success are extended to both these journals while naturalists everywhere will also wish to congratulate the *North-Western Naturalist* on reaching its twenty-first anniversary under the able editorship of Mr. A. A. Dalliman.

National Advisory Council for Education in Industry and Commerce

The following have been elected to serve on the Standing Committee of the National Advisory Council for Education in Industry and Commerce: Lieut.-General Sir Ronald Weeks (chairman), Sir Samuel Gurney-Dixon (vice-chairman), Sir Graham Savage, Mr. E. L. Russell, Mr. A. Ballard, Dr. Percy Dunsheath, Prof. F. H. Garner, Prof. R. G. Batson, Sir Robert Wood, Dr. T. J. Drakeley, Dr. H. Schofield, Mr. J. Wilson, Dr. J. E. Myers, Sir Charles Tennyson, Sir Arthur Smout, Mr. G. S. Heaven, Sir Arthur Fleming, Mr. B. J. Ewing, Mr. G. H. Lowthian, Mr. W. T. Mainwaring, Mr. M. F. Titterington, M.P., Mr. E. G. Gooch, M.P., Dr. F. C. Toy, the Hon. Josiah Wedgwood, Captain A. M. Holbein. Sir Samuel Gurney-Dixon was also elected vice-chairman of the Council.

Institution of Mining and Metallurgy: Awards

The Gold Medal of the Institution of Mining and Metallurgy, the highest distinction which the Council of the Institution has power to grant, has been awarded to Mr. G. Carleton Jones, resident director in South Africa of New Consolidated Gold Fields, Ltd., in recognition of his distinguished services to the gold mining industry of South Africa, and in particular to the development of the West Rand. Honorary membership of the Institution has been conferred on Dr. William Cullen, Dr. T. A. Rickard and Prof. S. J. Truscott, in recognition of their long and valued services to the mining and metallurgical profession and to the Institution. The "Consolidated Gold Fields of South Africa, Ltd." Gold Medal has been awarded jointly to Dr. Anthony Caplan and Mr. J. K. Lindsay, for their work on the effect of high temperatures on working efficiency in deep mines.

Institution of Civil Engineers: Officers

The following have been elected officers of the Institution of Civil Engineers for the Session 1948–49: *President*, Sir Jonathan Davidson; *Vice-Presidents*, Sir Reginald Stradling, V. A. M. Robertson, Dr. W. H. Glanville, A. S. Quartermaine; *Other Members of Council*, H. E. Aldington, Sir Stanley Angwin, Sir Donald Coleman Bailey, Prof. J. F. Baker, G. Baxter, W. S. Cameron, J. Chambers (India), H. F. Cronin, E. L. Everatt (Pakistan), A. Gray (Canada), A. C. Hartley, Prof. Douglas Hay, G. H. Humphreys, Sir Claude Inglis, L. Leighton, L. A. Mackenzie (South Africa), G. M. McNaughton, H. J. B. Manzoni, W. L. Newnham (New Zealand), Prof. A. J. S. Pippard, J. Rawlinson, W. P. Shepherd-Barron, T. H. Silk (Australia), J. C. L. Train, D. M. Watson, Sir Arthur Whitaker.

University of London: Appointments

The following appointments in the University of London have been announced: Prof. J. W. S. Blacklock, professor of pathology in the University of Glasgow, to the University chair of pathology tenable at St. Bartholomew's Hospital Medical College as from October 1; Mr. James Whillis, reader in anatomy in Guy's Hospital Medical School, to the chair of anatomy tenable at the School as from October 1; Dr. Hugh Ford, technical director, Paterson Engineering Group, to the University readership in applied mechanics tenable at the Imperial College of Science and Technology as from May 1.

The following titles have been conferred in respect of posts at the Colleges mentioned: professor of social studies in the University on Mrs. Barbara Wootton (Bedford College); reader in biochemistry in the University on Dr. H. W. Buston (Imperial College of Science and Technology); reader in biochemistry in the University on Mr. Wilfrid Lawson (Middlesex Hospital Medical School); reader in morbid anatomy in the University on Dr. D. M. Pryce (St. Mary's Hospital Medical School).

The degree of doctor of science has been conferred on Mr. B. H. Crawford, of University College.

Thirteenth International Congress of Zoology

The Chief Cashier, Exchange Control, Bank of England, states that a special allotment of the equivalent of £36 in foreign exchange will be provided to approved persons to enable them to attend the International Congress of Zoology in Paris during July 21–27. Anyone wishing to obtain this special allotment should submit an application on Form *T.2*, quoting the reference *I*/392 *EC* 902, through the medium of their own bankers, from whom the necessary forms may be obtained. The Bank of England authorities state that they would only be prepared to consider names sponsored by the Zoology Section, International Union of Biological Sciences, and therefore any applicants are advised also to notify the president of the Section, Dr. Edward Hindle, Zoological Society, Regent's Park, N.W.8.

Announcements

The Lord President of the Council has appointed the following to be members of the Chemistry Research Board of the Department of Scientific and Industrial Research for a period of four years: Mr. A. L. Bacharach, head of Nutrition Unit, Glaxo Laboratories, Ltd.; Prof. H. J. Emeléus, professor of inorganic chemistry, University of Cambridge; Prof. D. M. Newitt, professor of chemical engineering, Imperial College of Science and Technology, London.

The following have been appointed to the Advisory Council on Scientific Research and Technical Development, Ministry of Supply, which advises on the important scientific and technical problems with which the Ministry is concerned: Sir Howard Florey, professor of pathology, University of Oxford; Prof. J. L. M. Morrison, professor of mechanical engineering, University of Bristol; Prof. L. Rosenhead, professor of applied mathematics, University of Liverpool.

The Royal Astronomical Society wishes to direct the attention of authors to the fact that arrears of papers accepted for the *Geophysical Supplement* of the *Monthly Notices of the Royal Astronomical Society* have now been published. It is anticipated that in future the average delay between the acceptance and publication of geophysical papers will only be a few months. The arrears of papers accepted for the *Monthly Notices* are now all in print and will be published and distributed in the near future; after which the average delay between acceptance and publication should not be more than three or four months.

The Animal Health Trust has made a research grant to Mr. J. Steele, of Australia, for work at the Trust's Canine Research Station near Newmarket. Mr. Steele's work will be in connexion with the fundamentals of electro-cardiography as applied to domestic animals and with nervous diseases of dogs.

The Council of the Institution of Mining and Metallurgy is arranging a symposium on the "Refining of Non-ferrous Metals" to be held in London on July 7 and 8, thus preceding the Fourth Empire Mining and Metallurgical Congress. The papers to be presented will be issued as preprints, so that most of the time available at the meeting may be devoted to discussion. Further information can be obtained from the Secretary, Institution of Mining and Metallurgy, Salisbury House, London, E.C.2.

The third annual Electronics Exhibition organised by the North-West Section of the Institution of Electronics will be held in the College of Technology, Manchester, during July 20–22. There will also be an exhibition of scientific films arranged by the Manchester Scientific Film Society. Admission to the Exhibition will be by ticket only, obtainable from Dr. J. A. Darbyshire, 'Melandra', 1 Kershaw Road, Failsworth, Manchester.

A summer school for youth leaders is being held at Haywards Heath, Sussex, during July 26–August 1, under the auspices of the National Association of Girls' Clubs and Mixed Clubs. The theme of the conference will be "The Club Programme and Informal Education" and it will be directed by Dr. J. Macalister Brew. Further information can be obtained from the Education Secretary, National Association of Girls' Clubs and Mixed Clubs, 30–32, Devonshire Street, London, W.1.

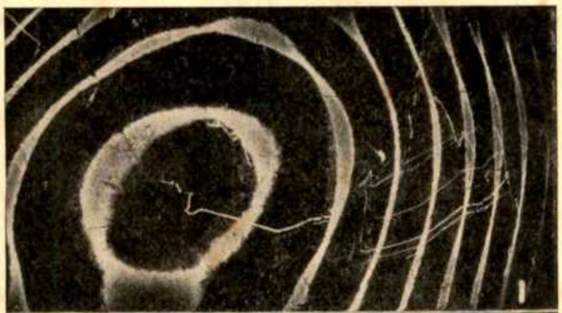
LETTERS TO THE EDITORS

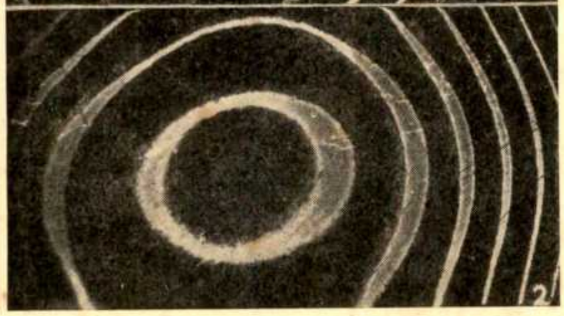
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Application of Multiple-Beam Interferometry to the Study of Oscillating Quartz Crystals

WE have succeeded in applying multiple-beam interference methods to the study of the surface movements of oscillating quartz crystals, and the striking results obtained indicate that this has opened up a considerable field for investigation. The technique is simple. The quartz crystal (kindly prepared for us by Dr. W. G. Radley of the Post Office Research Laboratory) was polished to a slightly higher degree than that usually adopted for oscillators, in order to give sharp interference fringes. It was silvered very lightly on one side, and on the opposite face with a high reflecting silver layer. The high reflecting face was placed resting in contact with a silvered optical flat, and electrical connexion made (by gentle contact) between the lightly silvered face of the crystal and the silver layer on the flat. The two connecting leads were taken to an oscillator circuit. There were no constraints on the crystal.

On illumination with correctly collimated monochromatic light (5461 A.), sharp multiple-beam Fizeau fringes form in the air film between the surfaces of the crystal and the flat, providing the crystal is not oscillating. The particular crystal used was rectangular, 3 cm. × 1 cm., and about 3 mm. thick. The final optical polish was such that the face in contact with the flat had a slight curvature, as a result of which the field of view, when the crystal was not oscillating, was covered by a few sharp, yet highly dispersed approximately circular fringes. When oscillations are excited, the fringes take on the remarkable appearance shown in the accompanying reproductions. Fig. 1 shows about three-quarters of the crystal surface, the remainder (the left-hand quarter) being obscured by the particular microscope stage available. One can see in a striking manner the whole distribution of oscillation on the crystal surface. More than one type of oscillation can, of course, be excited, and in that illustrated in Fig. 1 it can be clearly seen that there exist clear-cut nodal lines which are roughly the diagonals of the rectangular crystal face, forming a St. Andrew's cross. Other secondary features are readily interpreted from the interferogram, the fringe-width at any point being an exact measure of the local amplitude of oscillation. In Fig. 2, an oscillation of another type is illustrated, different nodal regions being readily discernible. Under the particular excitation conditions employed here, observed amplitudes vary from zero to a maximum of about 750 A.





A remarkable feature is the extreme sharpness of the fringes in the nodal positions. It is evident that in these regions the fringes remain quite undisplaced over the length of the time of exposure (several minutes), and indeed from visual observation they appear to remain quite still indefinitely. An amplitude of oscillation of only λ/100 can certainly be detected even with the relatively imperfectly surfaced crystal used here. This quantity is about 50 A.; hence the nodal regions have certainly less amplitude than this small amount, if any at all, and may quite possibly be at rest to within the dimension of the crystal lattice spacing. It should be possible to test this conjecture by using the high-dispersion crossed fringe technique already in use in this laboratory; but such an approach requires a higher surface finish than that of the crystal used. When sufficiently well-worked surfaces become available, this sensitive technique will be adopted.

A surprising feature is the complete stability of the fringe pattern given by the oscillating surface, particularly when the sensitivity of the multiple-beam fringes is recalled. It is clear to us that an intensive programme of investigation is called for, and this is being undertaken. We intend also to attempt to extend the technique by the application of stroboscopic methods of illumination. We note here that some earlier attempts in this direction have been reported, using two-beam interference methods (see Vigoureux, "Quartz Oscillators and their Applications" (1939)), but of course, as is always the case, the sensitivity of a two-beam interference method is not to be compared with that of the far more powerful multiple-beam technique.

A fuller report, including details of measurements, will be communicated elsewhere at an early date.

S. TOLANSKY
W. BARDSLEY

Royal Holloway College,
Egham, Surrey.
Feb. 20.

Transfer Rates in Liquid Helium Films

THE superfluidity of liquid helium II can be very conveniently studied by making observations on the flow of the thick mobile films ('Rollin films'[1]) which cover all surfaces in contact with the liquid. In previous investigations of these films by Daunt and Mendelssohn[2], the rate of flow was observed to be almost independent of such factors as the pressure head or the height of the film, and varied only with the temperature, rising from zero at the λ-point to $7 \cdot 5 \times 10^{-5}$ cm.^{3}/sec. per cm. width of film below 1·5° K. We have extended these investigations and

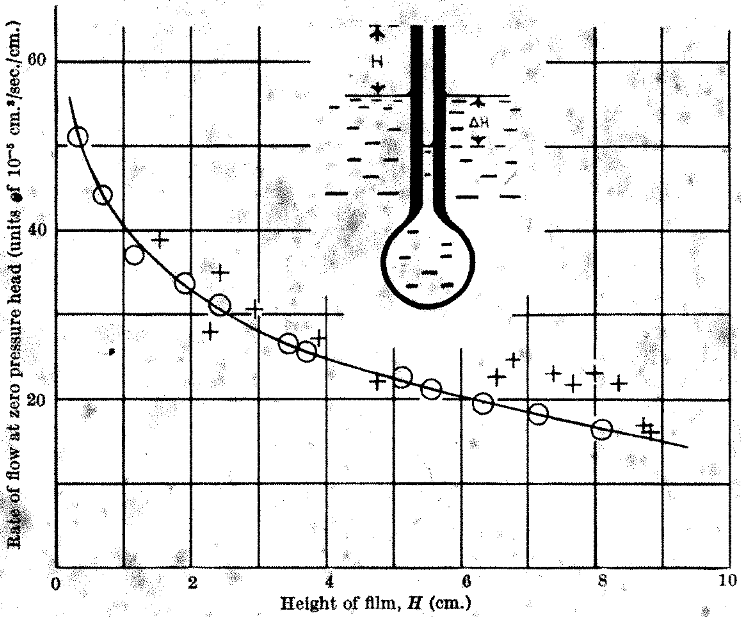


Fig. 1. ○, filling; +, emptying; temperature, 1·347° K.

have observed: (*a*) that with some experimental arrangements the rate of flow varies considerably with the height of the film; (*b*) that there is an effect which simulates a dependence upon the pressure head; and (*c*) that much higher rates of flow, up to 10^{-3} cm.^{3}/sec./cm., can occur.

In the first type of experiment an apparatus such as that shown in Fig. 1 was used. It consisted of a straight glass capillary of internal diameter 0·54 mm., open at its upper end and blown out into a closed bulb of diameter 3 cm. at its lower end. The capillary was partially immersed in a bath of liquid helium II, and that part of the glass surface protruding above the bath became covered with the film. When the vessel was raised or lowered, transfer took place through the film until the inner meniscus returned to its equilibrium position very close to the bath-level. The rate of filling was independent of the difference in height, ΔH, between the two levels, but the rate of emptying decreased as ΔH decreased in such a way as to suggest that the determining factor was not the pressure head but the height H of the top of the capillary above the higher of the two levels. During a filling the higher level was, of course, the bath-level which remained stationary so that H remained constant; but during an emptying the higher level, being the inner level, was falling rapidly and H was increasing as ΔH was decreasing. The rate of emptying extrapolated to $\Delta H = 0$ was approximately the same as the rate of filling; but both quantities varied rapidly with the height of the film, H, as will be seen from Fig. 1. This variation with H might be an effect depending upon the length of the film as in the case of viscous flow through tubes, but it is also possible, as suggested by Bijl, de Boer and Michels[3], that the thickness of the film is a function of height. The rate of transfer for a particular value of H varied in a complicated way with the radius of the capillary and even with the volume of the bulb, which suggests that the driving force was not a hydrostatic pressure but a temperature difference arising from the various thermal effects which are known to occur in liquid helium II.

It was, in fact, possible to initiate these high rates of transfer thermally, using the apparatus shown in Fig. 2. The small glass Dewar flask had a ground lip against which was pressed a glass cap with a ground flange. The only communication between the helium bath and the inside of the Dewar flask was via this ground joint, but the width of the gap was much greater than the thickness of the film. Heat was supplied electrically to the inside of the Dewar flask, so that the temperature there rose above the bath temperature and consequently liquid flowed into the flask via the film because of the thermomechanical effect[4]. The temperature difference associated with this flow was measured by means of two phosphor-bronze resistance thermometers, one inside the Dewar flask and the other in the bath. A set of readings was taken for a constant value of the film height, H, and the rate of flow was always measured when the flask was filling and the inner level was within a few millimetres of the bath-level. Fig. 2 shows such a set of readings for a film height of 0·9 cm. It will be seen that the flow became saturated

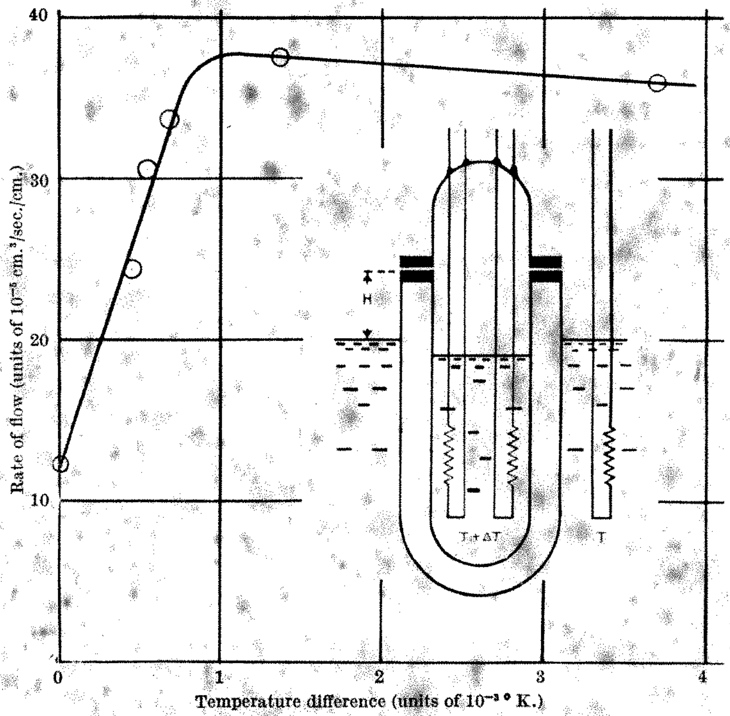


Fig. 2. Height of film, H, 0·9 cm. Temperature, 1·49° K.

at about 38 × 10^{-5} cm.^{3}/sec./cm. and then began to decrease slowly, presumably because evaporation of the liquid inside the Dewar flask was not entirely prevented by the ground joint. Preliminary measurements have shown that the maximum rate of flow is a function of the height of the film, being only about 26 × 10^{-5} cm.^{3}/sec./cm. for a film of height 4 cm. In order of magnitude these rates of flow agree satisfactorily with the data of Fig. 1.

It is worth noticing that saturation occurs at a temperature difference of approximately 10^{-3} ° K. which, according to H. London's[5] thermodynamic formula, corresponds to a thermo-mechanical pressure head of only 3 cm. of helium at this temperature. When no electrical power was supplied, a transfer of 12 × 10^{-5} cm.^{3}/sec./cm. was observed and was probably caused by unwanted heat inflow to the system. It was not possible, however, to decide whether this transfer took place under zero temperature difference or whether it required a temperature difference of the order of 10^{-4} ° K.

I should like to thank Prof. J. F. Allen for valuable help and discussion.

K. R. ATKINS

Royal Society Mond Laboratory,
Cambridge.
April 28.

[1] Rollin, B. V., Actes du 7e Cong., intern. du Froid. La Haye—Amsterdam, 1, 187 (1939).

[2] Daunt, J. G., and Mendelssohn, K., *Proc. Roy. Soc.*, A, **170**, 423, 439 (1939).

[3] Bijl, A., de Boer, J., and Michels, A., *Physica*, **8**, 655 (1941).

[4] Daunt, J. G., and Mendelssohn, K., *Nature*, **143**, 719 (1939).

[5] London, H., *Proc. Roy. Soc.*, A, **171**, 484 (1939).

Diffraction of Light by Very High Frequency Ultrasonic Waves

IN two recent notes[1], we reported that ultrasonic waves of frequencies as high as 100 Mc./sec. were generated. The diffraction patterns produced by such waves were found to exhibit interesting features. Since then, by using a tourmaline plate and specially designed circuits, we have been able to push up this frequency to nearly 180 Mc./sec., and to study the diffraction effects produced when progressive waves of such high frequencies are maintained in a column of water. Results for the velocity of sound, measured at two different frequencies, are given below. In obtaining these, it has been assumed that the velocity in water is 1,504 metres per second at 15 Mc./sec. and 26·5° C. If the slightly higher temperature of the medium when the highest frequency is used is taken into account, it will be noticed that there is no dispersion of ultrasonic velocity.

It is well known that the first-order lines on both sides are easily obtained at normal incidence when low frequencies are used, and we have found in our earlier work that this feature persists even at 50 Mc./sec. Moreover, when the crystal is tilted, the line on the appropriate side increases in intensity and attains a maximum at the corresponding reflexion angle. The line on the opposite side decreases in intensity but generally does not vanish altogether, showing that if we regard the phenomenon as a reflexion, the angular region in which it occurs when moderate frequencies are used is not at all sharp. In the present experiments, we have made special arrangements to reduce the power supplied to the crystal at moderate frequencies to such an extent that the first-order diffraction lines obtained are as weak as those obtained at 177·2 Mc./sec. Even under such conditions, both lines appear at normal incidence and they exist simultaneously over practically the entire range as the tilt of the sound wave-front is varied from the reflexion position on one side to the reflexion position on the other.

Order of harmonic	Frequency, ν (megacycles per sec.)	Fringe width, d (cm.)	ν/d	Velocity (metres per sec.)	Temp. (° C.)
9	15·29	0·1237	123·6	1504	26·5
83	140·9	1·140	123·6	1504	26·5
107*	177·2	1·441	122·9	1511	27·9

* The plate distance in this case is slightly different from that adopted in the other two.

On the other hand, the diffraction patterns at the very high frequencies employed disappear altogether when the sound wave is exactly normal to the incident light. The crystal holder has to be tilted to the correct angle on one side or the other so that the first-order diffraction line on that side may appear. At these high frequencies, the first-order lines on both sides are never present simultaneously. It may even be said that the appearance of the first-order line is quite critical. The tilt angle measured in our experiments with different frequencies has been found to be in agreement with the value derived from the equation $\lambda/\lambda^* = 2\mu \sin \theta$. In accordance with this formula, we find that the sound wave-front has to be tilted from the normal position by 1° 29′ in the case of 177·2 Mc./sec. in order that the first-order line on one side may appear. So small a deviation as about 8′ from this position results in complete disappearance of the line. The wave-length of sound in water corresponding to 177·2 Mc./sec. employed in the present investigation is 0·000849 cm., which is only about fourteen times as large as the wave-length of sodium light.

S. BHAGAVANTAM
B. RAMACHANDRA RAO

Andhra University,
Waltair, India.
Feb. 15.

[1] *Nature*, **158**, 484 (1946); **159**, 266 (1947).

A New Hot-Wire Vacuum Gauge

IT is known that the range of a hot-wire vacuum gauge may be extended to 10 mm. mercury pressure or above, if by some means the current supplied to

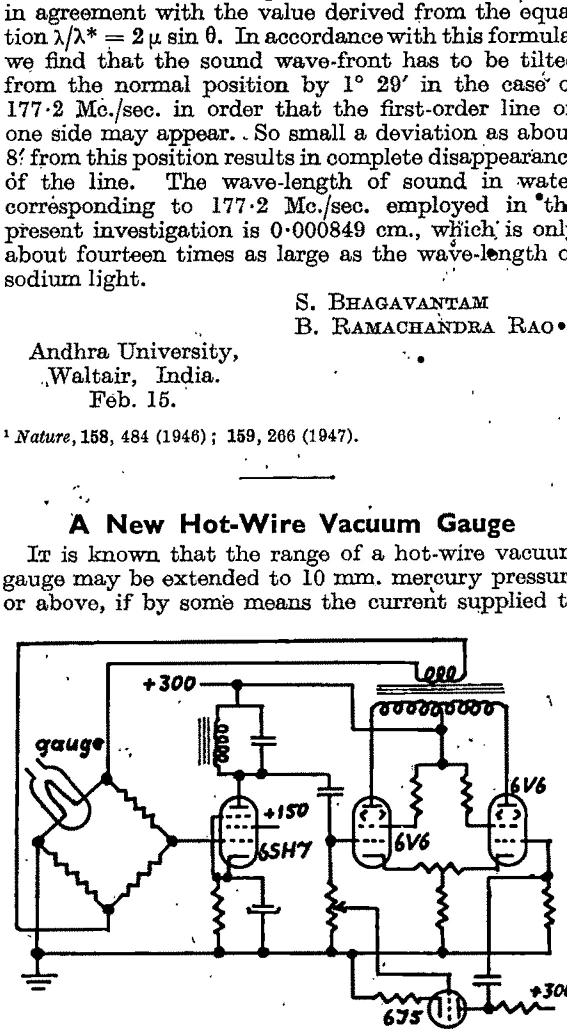


Fig. 1

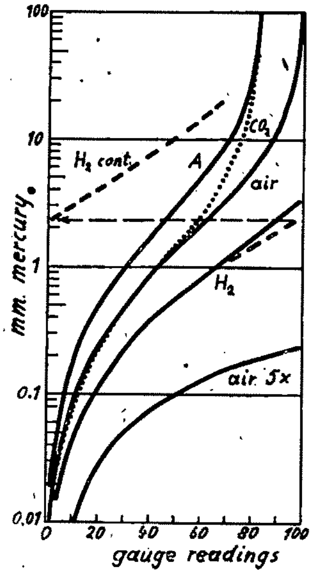


Fig. 2

the wire is increased with increasing pressure[1,2]. Attempts have been made to do this with the aid of automatic devices. Such a gauge becomes easier to handle, and there is then no danger of overloading. One of these circuits (suggested in principle by Mr. G. von Dardel) (Fig. 1) consists of an amplifier tuned on 800 c.p.s. A regenerative feed-back is provided by a bridge containing the hot wire. The amplitude of oscillations adjusts itself to keep the temperature of the wire approximately constant at all pressures. The amplitude is read by a diode circuit. Two ranges of sensitivity are provided. The output meter is protected from dangerous overloading by a rectifier which, however, distorts the readings slightly.

It is essential to use a very thin wire. An extended spiral of 0·01 mm. tungsten wire is employed here. The length is approximately 5 cm., cold resistance 90 Ω, working resistance about 120 Ω. The heating current ranges from 4 to 35 mA. The spiral is mounted inside a capillary in order to save space. Calibration curves are plotted in Fig. 2.

The gauge responds immediately to changes in pressure. In cases where for some reason it is not suitable to use a gauge with a fluid, the hot-wire gauge can be used.

H. von Ubisch

Chemical Department,
Karolinska Institutet,
Stockholm.
Feb. 14.

[1] Knudsen, M., *Ann. d. Phys.*, 34, 593 (1911).

[2] Rittner, E. S., *Rev. Sci. Instr.*, 17, 113 (1946).

Electron Tracks in Photographic Emulsions

Electron range. In a recent note[1], R. W. Berriman reported on a new photographic emulsion with which electron tracks can be recorded. Attempts have been made to relate energy and range of electron tracks in this type of photographic material, referred to as the *NT2a* plate. The electron tracks were obtained by exposing the plates to heavily filtered X-rays generated at increasing kilovoltages. The tracks were scanned under the microscope, and the number of grains of each track counted was plotted against the frequency of tracks. The curves so obtained show a shift of the maximum frequency towards greater numbers of grains with increasing kilovoltage. In a few cases where the tracks were at almost glancing angle to the plane of the plate, length measurements of the curved path of tracks were made. The maximum number of grains and lengths of tracks for each kilovoltage are shown in the accompanying table (columns 2 and 3).

1 kV.	2 Max. number of grains	3 Range in microns (curved path)	4 Schonland and Varder (calc. in microns)	5 Column 3 × 1·4 (curved path in microns)
35	13	8	6·1	8·4
50	18	14	10·6	14·8
65	16	—	16·7	23·4
69*	18	—	18·6	26·0
80	—	—	23·1	32·0
100	18	—	—	—
130	28	35	—	—
200	27	—	—	—

* This refers to monochromatic radiation (K_α of platinum).

It will be seen from this table that the maximum numbers of grains counted between 50 and 100 kV. are almost identical. A possible explanation might be the rising proportion of Compton recoil electrons, which have on the average a considerably shorter range than the photo-electrons. The range quoted in column 3 refers to the curved path of the electron tracks. The thickness of various metals necessary to stop electrons of different velocities was determined by Schonland[2] and Varder[3]. This was found to be dependent only on the mass per unit area. The range values of Schonland and Varder were converted into lengths in microns for the mass per unit area of *NT2a* emulsion, and these values are quoted in column 4. The curved paths in the metal should be on the average some 40 per cent greater than the thickness of the foil[4]. Column 5 shows the values of column 4 multiplied by 1·4.

From the values in column 4 and from the explanation regarding the constancy of grain numbers between 65 and 100 kV., it can be concluded that the maximum energy of electrons which can be recorded with the *NT2a* emulsion will be at about 80 kV. This figure might serve as a guide until more accurate measurements have been made by means of an electron spectrograph.

Fig. 2

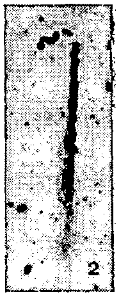


Fig. 1

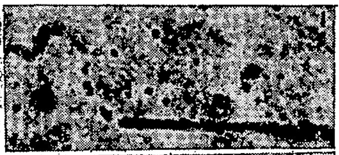
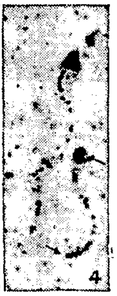


Fig. 4



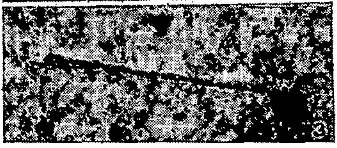


Fig. 3

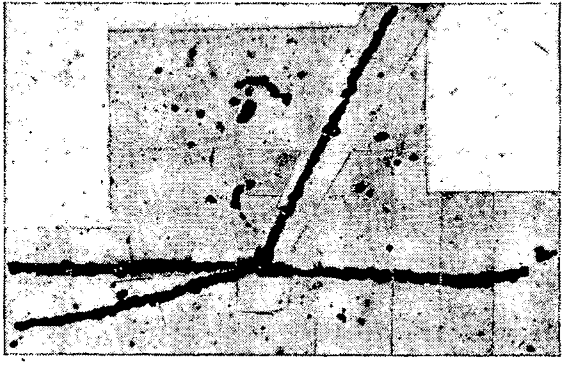


Fig. 5

Electron track records in radioactive decay. *NT2a* emulsions were soaked in dilute thorium and uranium nitrate solutions, and electron tracks were recorded at the origin of alpha-tracks. Figs. 1 and 2 show photomicrographs of alpha-tracks of uranium I with beta-tracks probably due to the decay of uranium-X_1. The beta-ray energy (Fig. 1) should, according to the table, correspond roughly to 35 kV. Fig. 3 represents an alpha-track due to thorium-C, and the beta-particle is due to the parent element thorium-B, which has been ejected before the alpha-emission. A second beta-particle is believed to be seen as being ejected from the same origin. This may be attributed to the beta-emission from thorium-C$''$. Fig. 5 is a photomicrograph-mosaic of a plane-projection of a three-dimensional radiothorium star at the origin of which an electron track is seen. The second electron track visible in this photograph may be the end of a track of an electron of higher energy arising from the same origin.

Auger tracks. While scanning the electron tracks it was observed that some tracks show clumping of grains at the beginning and at the end of tracks (see arrows in Fig. 4). This phenomenon can probably be attributed to the Auger effect. Although the specific ionization is greater at the end of the tracks, in some cases branching of short secondary tracks will be recorded in the emulsion by heavier ionizations at the beginning of the tracks.

I am indebted to Messrs. E. B. Kennedy and G. P. Cooke for their assistance in this work.

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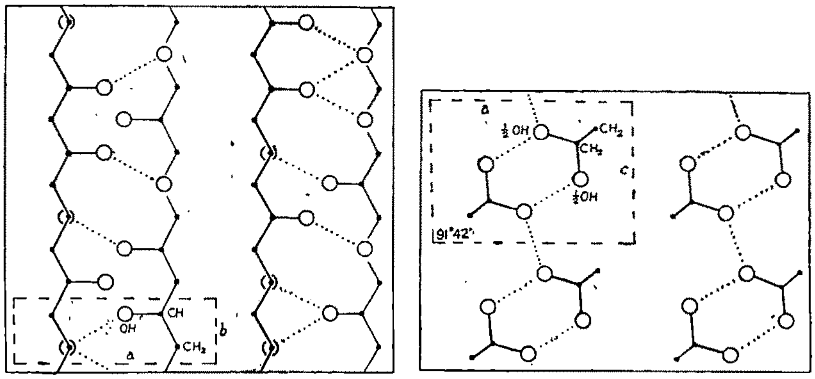
Crystal Structure of Polyvinyl Alcohol

IT has often been said (by me[1] as well as by others) that the molecular repeat distance (from X-ray diffraction photographs) of polyvinyl alcohol—2·52 A.[2]—indicates not only that the chain has a simple plane zigzag configuration, but also that all the hydroxyl groups (in the section of a molecule in one crystallite) lie on the same side of the zigzag plane. This is not necessarily true; so far as X-ray diffraction is concerned, the observed repeat distance is equally compatible with a molecular structure in which hydroxyl groups are randomly placed in left- and right-hand positions. This possibility was not considered until recently; it was assumed that the high degree of crystallinity of polyvinyl alcohol implied regularity of molecular structure. Recently, however, it has been found[3] that interpolymers of ethylene and vinyl alcohol are crystalline; thus hydroxyl groups may replace hydrogen atoms at random on a carbon chain without destroying crystallinity; the high crystallinity of polyvinyl alcohol cannot, therefore, be regarded as evidence against the idea of stereochemical irregularity in this molecule.



c-Projection *b*-Projection

DOTTED LINES, HYDROGEN BONDS

To determine whether the hydroxyl groups are randomly or regularly placed, the interpretation of X-ray diffraction patterns of polyvinyl alcohol fibres has been considered in detail. In agreement with Mooney[2], a two-molecule monoclinic unit cell is found to account for the positions of X-ray reflexions; this cell has $a = 7\cdot 81$ A., $b = 2\cdot 52$ A., $c = 5\cdot 51$ A., $\beta = 91^\circ\ 42'$; these figures agree fairly well with those of Mooney, who, however, gives $\beta = 90^\circ$. No structure embodying regular molecules gave correct relative intensities for the X-ray reflexions; all possible arrangements (including that proposed by Mooney) and all possible molecular parameters were considered. But a particular arrangement of molecules with hydroxyl groups randomly placed in left- and right-hand positions accounts in a highly satisfactory way for the entire X-ray diffraction pattern: calculated intensities agree very well with those observed. This arrangement has the symmetry $P2_1/m$ with C (of CH_2) at $0\cdot 190\ a$, $0\cdot 250\ b$, $0\cdot 806\ c$, C (of CH) at $0\cdot 277\ a$, $0\cdot 750\ b$, $0\cdot 708\ c$, half the oxygen atoms at $0\cdot 451\ a$, $0\cdot 750\ b$, $0\cdot 782\ c$, and the other half at $0\cdot 267\ a$, $0\cdot 750\ b$, $0\cdot 450\ c$. The arrangement, which is illustrated in the accompanying projections, may be described as a layer structure; a double layer of molecules is held together by hydroxyl bonds; between one double layer and the next the weaker Van der Waals forces operate. The hydroxyl bond distances (2·8 and 2·9 A.) are greater than in pentaerythritol[4] and resorcinol[5] (2·7 A.) and therefore the bonds are presumably weaker than in those substances; this is perhaps connected with the fact that owing to the random positions of the OH groups, some of the possible bonds are not made at all, while in other cases an OH group is faced with too many possibilities (up to four) of hydroxyl bond formation.

This is an example among high polymers of the sort of randomness which has been reported recently by Clews and Cochran[6] in a monomeric crystal (2-amino-4-methyl-6-chloro-pyrimidine); but in view of the difference of size of the hydroxyl group and the hydrogen atom, polyvinyl alcohol is a more extreme case. The implications in the theory of crystallization (or non-crystallization, as the case may be) of high polymers have been referred to in an earlier communication[3]. Here, I need only remark that polyvinyl acetate, from which polyvinyl alcohol is prepared, probably has a corresponding (stereochemically random) molecular structure, but, unlike polyvinyl alcohol, does not crystallize; this is presumably because the difference of size between acetate groups and hydrogen atoms is much too great for them to occupy equivalent positions in a crystal structure.

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The Tollens Naphthoresorcinol Reaction for Uronic Acids

The mechanism of colour production in the Tollens test[1] for glucuronic acid is not definitely known, and since this reaction is frequently used for the determination of glucuronic acid in biological materials[2], an attempt should be made to understand its chemistry. Some of our preliminary results to this end are now reported here.

Since the reaction is carried out by heating naphthoresorcinol (1 : 3-dihydroxynaphthalene) and glucuronic acid in 5–6 *N* hydrochloric acid, furfural may be formed which may condense with naphthoresorcinol to give a pigment. We find, however, that furfural gives a different and less intense colour than glucuronic acid.

Mayer, Bloch and Chaffee[3] in a brief abstract suggested that the pigment of the Tollens test may be a xanthene derivative. Our observations (see below) appear to support this view, and the following mechanism is suggested for the Tollens reaction (cf. the formation of pyronine and phthaleine dyes).

Some of our observations were:

(*a*) Heating naphthoresorcinol, m.p. 119°, and *d*-glucurone, m.p. 176° (or *d*-galacturonic acid), together in the dry state at a low temperature, 100–120°, yields the same dark-blue solid as obtained in the Tollens reaction. In ethanol the blue solid obtained either way shows spectral absorption bands at 595, 335, 302 and 243 mμ.

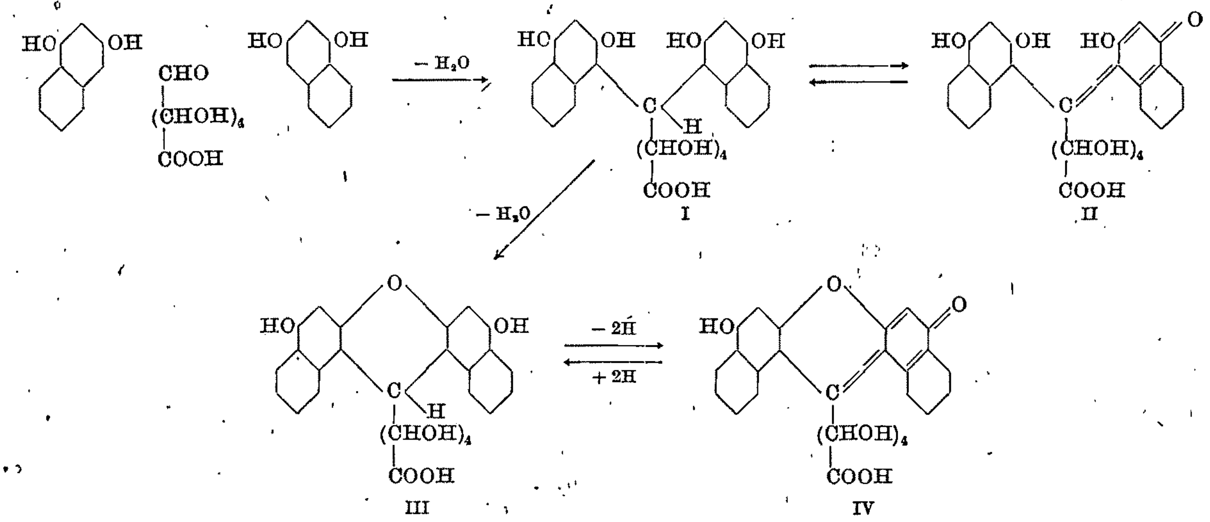
(*b*) If dry naphthoresorcinol and *l*-menthylglucuronide are heated together, no blue solid is obtained unless crystalline oxalic acid is added to the melt. This experiment suggests that the aldehydic group of the uronic acid must be free for pigment formation.

(*c*) The solid pigment is soluble in dilute alkali, from which it is precipitated by acid as dark-blue flocks, that is, it is acidic.

(*d*) A solution of the pigment is readily decolorized by sodium hydrosulphite, forming the leuco dye I or III, and the colour can be restored (to the quinones II or IV) by an oxidizing agent such as chloramine-*T*.

(*e*) If naphthoresorcinol is replaced in the Tollens reaction by monocyclic *m*-dihydric phenols such as resorcinol or orcinol, only very weak colours are obtained unless an oxidizing agent is also present. Thus if orcinol and glucurone are heated in 5–6 *N* hydrochloric acid, on extraction with amyl alcohol a weak green colour is obtained; but if the reaction is carried out in the presence of chloramine-*T*, a very intense green results. To obtain an intense colour with naphthoresorcinol an external oxidizing agent does not appear to be necessary, although Mayer, Bloch and Chaffee[3] state that the colour intensity is increased by potassium persulphate. It should be noted that the two possible formulæ, II and IV, suggested for the naphthoresorcinol pigment could form several resonance structures; these would tend to stabilize the pigment and render its production from the leuco-form relatively easy. This suggests that *m*-diols of polycyclic hydrocarbons such as anthracene-1 : 3-diol may be even better than naphthoresorcinol for detecting uronic acids, for in such compounds more resonance structures are possible.

We believe that the pigment of the Tollens reaction could be either a dinaphthylmethane (II) or a xanthene derivative (IV). We have found the isolated pigment difficult to purify, and we cannot as yet rely on elementary analyses for confirmation of the structures suggested. Analysis of a partially purified



sample gave C, 63·4; H, 3·8 per cent; $C_{26}H_{22}O_{10}$ (II) requires C, 63·2; H, 4·45 per cent; and $C_{26}H_{20}O_9$ (IV) requires C, 65·55; H, 4·2 per cent.

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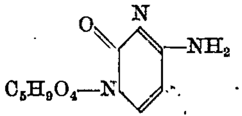
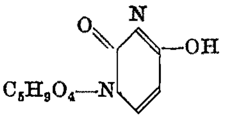
Separation of Pyrimidine Nucleosides by Synthetic Resin Ion-Exchangers

Four nucleosides—guanosine, adenosine, cytidine and uridine—are formed in the hydrolysis of yeast ribonucleic acid by aqueous pyridine, and Bredereck *et al.*[1] have described a method of isolating the nucleosides from the hydrolysate. Although this method is adequate for the production of guanosine and adenosine, we have been unsuccessful in isolating the pyrimidine nucleosides in the pure state and in good yield by this method, and believe this to be due to the method of isolation adopted by Bredereck.

In consequence, a technique has been developed for the separation of cytidine and uridine using a cation-exchange resin.



Cytidine



Uridine

Cytidine would be expected to be retained by a cation-exchange resin due to the basic amino-group ($pK'_b = 9{\cdot}78$)[2]. Uridine, on the other hand, would be expected to have little or no tendency to remain on the resin as the enolic hydroxyl group is acidic ($pK'_a = 9{\cdot}17$)[2]. 'Zeo-Karb 215' was selected for trial because of its strong proton-donating sulphonic acid groups and because of its stability to alkaline solution (*v. infra*). The above expectations were realized when aqueous solutions of cytidine and uridine were separately percolated down columns of 'Zeo-Karb 215'. In the former case, cytidine was afterwards eluted from the column by dilute aqueous ammonia.

A mixture of cytidine and uridine in aqueous solution (0·05 *M* with respect to each nucleoside) was therefore passed down a column of the same resin.

The percolate and aqueous washings were evaporated to dryness, giving crystalline uridine (*c*. 99 per cent recovery), m.p. 162–165° C. The column was eluted with *N*/10 aqueous ammonia and the eluate evaporated to dryness, giving crystalline cytidine (71–78 per cent recovery), m.p. 208–211° C.

An attempt is being made to obtain the pyrimidine nucleosides from deoxyribonucleic acid using the above technique. A fuller account of this work will be published elsewhere.

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Isolation and Separation of the Pyrimidine Nucleosides of Yeast Ribosenucleic Acid

Improved methods have been sought for the isolation and preparation of the purine and pyrimidine nucleosides of yeast ribosenucleic acid as a preliminary to the study of the constitution of the nucleic acids of normal and malignant tissues.

Bredereck *et al.*[1] were able to prepare adenosine and guanosine by enzymatic or aqueous pyridine hydrolysis of the acid, and claimed to have separated cytidine and uridine. The yields of these latter were low and no characterization data were given. Gulland and Smith[2] failed to obtain cytidine by Bredereck's method, and the yield of uridine was augmented by deamination of any cytidine present. Isolation of the four nucleosides from the same nucleic acid sample has not hitherto been satisfactorily achieved even from hydrolysates of as much as 100 gm. nucleic acid.

Preliminary experiments showed that cytidine and uridine could be satisfactorily isolated and separated in one operation, not only from artificial mixtures, but also from the pyrimidine nucleoside fraction of the nucleic acid hydrolysate. Cytidine, having a basic amino group ($pK = 4{\cdot}22$)[3], is retained from dilute aqueous solution on percolation through a column of ion-exchange resin 'Zeo-Karb 215', activated by hydrogen ions. Uridine, on the other hand, with an acidic hydroxyl group ($pK = 9{\cdot}17$)[3] is not so retained.

Hydrolysis of 20 gm. yeast ribosenucleic acid (Pharmaco-Chemical Products Co.) with 50 per cent aqueous pyridine, by the method of Bredereck *et al.* (*loc. cit.*), gave comparable yields of guanosine (m.p. and mixed m.p. 237–240°) and adenosine (m.p. and mixed m.p. 228–229°). The residue was hydrolysed with 2 per cent sulphuric acid, and the liberated purine bases removed with silver sulphate. Excess silver ions were precipitated as silver sulphide, and sulphate ions as barium sulphate. Percolation of the solution (1 l.) through a column containing the minimum quantity of prepared resin and concentration *in vacuo* of the effluent and 1 l. water washings gave 2·4 gm. uridine, as colourless needles (m.p. and mixed m.p. 165–166°; α_D^{21} + 10° ± 2°; *c*, 1·6245 in water). Elution of the exchanger with 2 per cent aqueous pyridine gave 150 mgm. cytidine (crystallized as sulphate, m.p. and mixed m.p. 224–225° (dec.); α_D^{21} + 37·5 ± 2°; *c*, 1·498 in 1 per cent aqueous sulphuric acid).

A volumetric procedure has been developed for the estimation of dilute aqueous solutions of uridine and/or cytidine which may be used to determine the extent of elution or degree of exhaustion of the exchanger.

These experiments are described in detail in a paper submitted and accepted for publication in the *Journal of the Chemical Society* on January 20, 1948.

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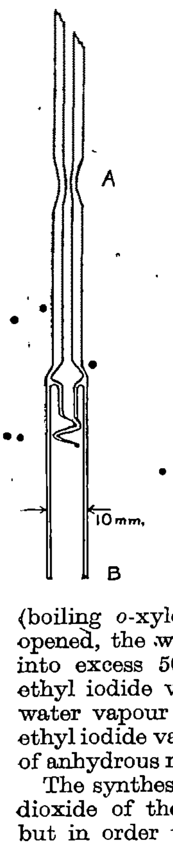
Microsynthesis of C^{14}-Labelled Ethyl Iodide

CARBON dioxide labelled with C^{14} can be converted in good overall yield to ethyl iodide by way of acetylene and ethylene on the scale of about 10 micromoles. Acetylene can be produced from carbon dioxide[1] in 90–95 per cent yield, and it may be reduced almost quantitatively to ethylene by the method of Traube[2,3], in which it is shaken for an hour with a large excess of freshly prepared chromous chloride solution at room temperature. The chromous chloride solution is prepared by the rapid reduction of a solution of 1 part green chromic chloride hexahydrate in 2 parts 25 per cent hydrochloric acid with zinc wool, until the solution turns almost a copper sulphate blue. About 0·4 ml. of this solution is pipetted into a glass reaction vessel (see diagram), frozen in liquid nitrogen and evacuated. The acetylene is condensed into the tube which is then sealed off at *A* and allowed to warm to room temperature. After agitation for an hour, carried out by intermittent rotation about its axis of the reaction vessel held horizontally, the vessel is sealed on to the high vacuum apparatus at *B* and the break-seal opened. All the dissolved gas is boiled from the chromous chloride solution, and ethylene condensed at liquid nitrogen temperature into a trap connected with a McLeod gauge, water and any residual acetylene being held back in a U-tube at liquid oxygen temperature. The yield in terms of standard gas volume is 96–98 per cent in this stage, and the remaining few per cent of acetylene can be recovered from the oxygen-cooled trap.

The direct addition of hydrogen iodide to ethylene is not easy, but can be carried out with about 90–95 per cent yield on the 10-micromole scale by sealing up ethylene with a few drops of saturated hydriodic acid in a tube similar to that used for reduction of acetylene but of about half the internal volume. The closed tube is then heated for one hour at 144° C. (boiling *o*-xylene). After the break-seal has been opened, the whole contents of the tube are distilled into excess 50 per cent caustic soda, from which ethyl iodide vapour can be recovered, most of the water vapour being held back at −78° C., and the ethyl iodide vapour finally dried over about 100 mgm. of anhydrous magnesium perchlorate for five minutes.



The synthesis is intended for use with radiocarbon dioxide of the highest obtainable specific activity; but in order to obtain a preliminary check on the yield in terms of radioactivity, several samples of C^{14}-labelled carbon dioxide of exceedingly low activity were converted to ethyl iodide by the method, this ethyl iodide being burnt and the carbon dioxide from it introduced into a Brown and Miller type β-counter[4]. It was found that whereas overall yields for $CO_2 \rightarrow C_2H_5I$ were about 80 per cent in terms of gas volume measurements, in terms of radioactivity they were generally some 10 per cent lower. About half the loss in radioactivity was found to occur in the stage $CO_2 \rightarrow C_2H_2$, and the other half in the stage $C_2H_4 \rightarrow C_2H_5I \rightarrow CO_2$. No loss of activity at all occurred in the stage $C_2H_2 \rightarrow C_2H_4$. In two particular experiments, the overall volume yields were 83·5 and 84 per cent, and the yields calculated from radioactivity measurements, 72 and 75 per cent. The activities of C^{14} available in each experiment were only about three times the background of the counter and were insufficient to pursue further the small losses, the first of which was probably due to an unidentified exchange reaction. In fact, the total amount of C^{14} available was 2×10^{-3} microcuries, of which half had to be used for calibration of the counter.

Catalytic reduction of acetylene to ethylene has been found to be possible on this scale, and yields are about 75 per cent. The method of preparation of the palladized palladium catalyst is critical, however, and it is easily poisoned. Chromous chloride reduction is much to be preferred.

We wish to acknowledge grants from the Therapeutic Research Corporation, the Royal Society and the Central Research Fund of the University of London, and to thank the Medical Research Council for grants and for a specimen of radioactive barium carbonate. One of us (R. G.) is a Keddey Fletcher-Warr student of the University of London.

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Effect of Insulin on Intestinal Glucose Absorption in Alloxan Diabetic Rats

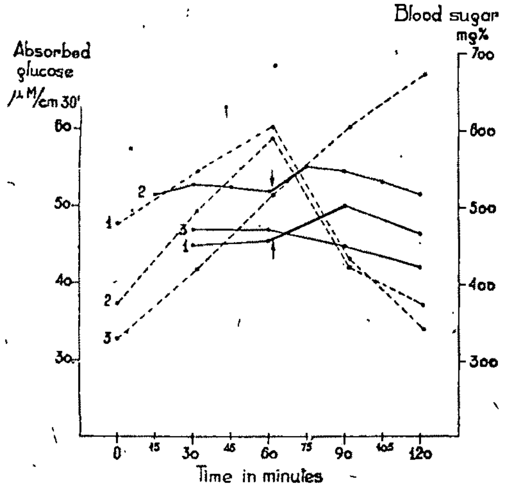
INTESTINAL absorption of glucose is increased in the diabetic rat[1,2]. According to Laszt and Vogel[2], this increase is not observed when alloxan diabetic rats are submitted to insulin treatment, suggesting that insulin has an inhibiting action on intestinal glucose absorption.

In the diabetic animal, as a consequence of the lack of insulin, changes are produced in the enzymatic systems, some of which might themselves modify absorption. To determine whether insulin has a direct influence on the mechanism of absorption, we have investigated the intestinal glucose absorption in alloxan diabetic rats before and after intravenous injection of insulin in the same animal, by the Sols and Ponz method of successive absorptions[3].

Diabetes was produced by intravenous injection of 5 mgm. of alloxan per 100 gm. body-weight. The animals were tested four to eight days after this injection. Previous to testing, a blood-sugar level greater than 300 mgm. per cent was recorded.

Within a period of 2½–3 hours, two or four absorption experiments (of 30 and 15 min. duration respectively) were done; then an intravenous injection of 2 units of insulin per 100 gm. body-weight was given, and immediately afterwards further absorption experiments, all other circumstances being kept constant. By way of control, the blood-sugar level was estimated periodically, usually once after each absorption experiment.

As a control of the absorption capacity in diabetic rats during the experimental period (about three



CURVES OF ABSORPTION (———) AND OF BLOOD-SUGAR LEVEL (– – –) IN ALLOXAN DIABETIC RATS.
(1) FOUR ABSORPTION EXPERIMENTS OF 30 MIN. DURATION.
(2) EIGHT ABSORPTION EXPERIMENTS OF 15 MIN. DURATION.
IN BOTH SETS AN ARROW MARKS INSULIN INJECTION. (3) CONTROL ANIMAL WITHOUT INSULIN INJECTION
THE INTERVALS BETWEEN ABSORPTION MEASUREMENTS (ABOUT 5 MIN. EACH) ARE NOT RECORDED

hours), several animals were examined in the same way, without insulin injection.

The accompanying figure shows three typical cases. These show that the immediate effect of insulin[1,2] is not to produce a decrease of intestinal absorption of glucose in diabetic rats, but rather a slight increase during the first half-hour; this contrasts with the tendency to decrease, with time, shown by diabetic animals[3]. In twelve animals, this increase showed an average value of 8 per cent.

We would emphasize that the maximal absorption does not correspond to a minimal blood-sugar value: one hour after insulin, the blood-sugar level is lower than after half an hour, whereas absorption is already returning to original values.

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Respiratory Quotient of the Mammary Gland

DETERMINATIONS by the arterio-venous method of the respiratory quotient of the lactating udder of the goat[1,2] and cow[3,4,5] have given mean values greater than unity, which have been interpreted[1,2] as evidence of the formation of fat from carbohydrate. A feature of these studies, commented upon in at least one instance[5], has been the excessive variability of arterio-venous differences in oxygen and carbon dioxide and in the corresponding respiratory quotient values. No undue variability was, however, observed in a small series of determinations carried out on lactating cows in this laboratory[6], in which the blood samples were collected over mercury; in eight experiments in which no detectable hæmo-concentration occurred, the mean respiratory quotient was 1·25 ± 0·12 (95 per cent fiducial limits). Variance has also been diminished by working on anæsthetized goats[2], for which a mean respiratory quotient of 1·09 was obtained. This mean quotient can scarcely be regarded as significantly greater than unity; but it was raised to 1·18 by application of a correction (incidentally slightly incorrect[7]) for the carbon dioxide supposedly used for the synthesis of urea by the mammary gland. By contrast, values obtained on anæsthetized cows[4] could scarcely be considered as satisfactorily uniform.

The high mammary gland respiratory quotient indicated for the lactating gland by the arterio-venous technique is of obvious interest; but in view of the criticisms which this technique has to face[8,9], and since the high value has not always been confirmed by studies on perfused glands[3,5], it seemed desirable to investigate the question by the tissue slice method, which hitherto has not, so far as we know, been applied to the mammary gland. Accordingly we report below some preliminary results on the respiration and respiratory quotient of mammary gland slices from the lactating rat.

Satisfactorily reproducible slices of this difficult tissue were cut by the microtome of Stadie and Riggs[10], and the respiratory quotient determined by the method of Dickens and Šimer[11] in 3-hr. experiments in bicarbonate-Ringer (pH 7·4) containing 0·2 per cent glucose as substrate. The results of twenty-six determinations on slices from ten rats, given in the accompanying table, are satisfactorily consistent and in all cases much greater than unity. Taken together, they are appreciably higher than any of the mean (but not the extreme) values reported for the arterio-venous method. A few determinations by the direct Warburg method in phosphate-Ringer-glucose also gave results well above unity. On the other hand, six experiments (five rats) in bicarbonate medium in which no glucose was present gave a mean quotient of 0·78, so that it seems possible that fat and perhaps protein are being oxidized under these conditions.

The respiration figures are much higher than those reported for pieces (not slices) of rat mammary tissue by Kleiber, Smith and Levy[12] in so far as they are comparable; but our results, like theirs, indicate a tendency for the Q_{O_2} to increase as lactation advances and therefore as the milk yield increases[13] (mean values of $-Q_{O_2}$ (glucose) for slices from the three of our rats killed at three to six days and the remaining

RESPIRATORY QUOTIENTS OF RAT MAMMARY GLAND SLICES

Substrate	No. of rats	No. of determinations	$-Q_{O_2}$		R.Q.	
			Mean	Range	Mean	Range
0·2 per cent glucose	10	26	7·6 ± 0·4	3·5–11·5	1·54 ± 0·03	1·30–1·86
None	5	6	5·0 ± 0·4	4·1–6·3	0·78 ± 0·03	0·71–0·87

Rats: Hooded Norway. Medium: bicarbonate-Ringer (pH 7·4). Temperature: 37° C. Gas mixture: 95 per cent oxygen, 5 per cent carbon dioxide.

seven killed at 15–21 days *post partum* were respectively 5·6 and 8·4; $P = 0{\cdot}03$).

The validity of determinations of respiratory quotient on tissue slices extending over 3-hr. periods has been questioned[14], but we have evidence which indicates that the quotient is high from the outset, so that there is no reason to suppose that our values are far from the truth.

Our results point with satisfactory consistency to a quotient for lactating rat mammary tissue which is clearly much greater than unity, and thus lend needed support to the high values claimed for the lactating bovine udder on the basis of a technique which suffers from many disadvantages. Speculation in detail about the interpretation of these results in terms of postulated reactions occurring in the active mammary gland must await further work, but it seems reasonable to conclude that mammary tissue is noteworthy in its ability to effect considerable synthesis of oxygen-poor substances from carbohydrate *in vitro*. The interesting possibility, thus opened up, of using mammary gland slices for the study of fat synthesis *in vitro* is being further investigated.

We are indebted to the Agricultural Research Council for a research grant to one of us (T. H. F.).

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Influence of Solvent Movement on Sedimentation

Due to the fact that in sedimentation the hydrodynamic volume of the particles moves towards the bottom of the vessel, the medium is caused to flow in an opposite direction. The sedimentation volume is the sum of the volume of the sedimenting particles and the volume of the medium which accompanies the particles.

In calculating the rate of sedimentation we use the following symbols: M_{I}, the molecular weight or particle weight of the sedimenting substance I; v_{I}, the partial specific volume of I; c_{I}, the concentration of I in gm./cm.³; Φ_{I}, the specific sedimentation volume of I in cm.³/gm. substance I; v_1, the partial specific volume of the solvent 1; x, the distance from the axis of rotation; ω, the angular velocity; $s_{\text{I}} = \frac{1}{\omega^2 x} \times \frac{dx_{\text{I}}}{dt}$ = the sedimentation constant relative to the walls of the vessel; $\sigma_{\text{I}} = \frac{1}{\omega^2 x} \times \frac{dX_{\text{I}}}{dt}$ = the sedimentation constant relative to the free solvent; A, the cross-sectional area of the cell. (These magnitudes should be corrected for the shape of the cell so that they hold for a vessel with parallel walls, and for the changes in density and viscosity with pressure, and for the change in the centrifugal force with x.) The sedimentation volume per second is $c_{\text{I}}\Phi_{\text{I}} \frac{dx_{\text{I}}}{dt} \times A$, and the cross-sectional area for the stream of solvent is A minus the area $c_{\text{I}}\Phi_{\text{I}} \times A$ of the sedimenting particles on this level. Therefore

$$\frac{dX_{\text{I}}}{dt} = \frac{dx_{\text{I}}}{dt} - \left(- \frac{c_{\text{I}}\Phi_{\text{I}}}{1 - c_{\text{I}}\Phi_{\text{I}}} \cdot \frac{dx_{\text{I}}}{dt}\right) = \frac{1}{1 - c_{\text{I}}\Phi_{\text{I}}} \cdot \frac{dx_{\text{I}}}{dt}. \qquad (1)$$

The centrifugal force per mol is $M_{\text{I}}\left(1 - \frac{v_{\text{I}}}{v_1}\right)\omega^2 x$ if the accompanying solvent has the same density as the free solvent, which generally, and particularly with pure solvents, is very nearly correct. The frictional force per mol is $f \frac{dX_{\text{I}}}{dt}$. Equating these two forces we get,

$$M_{\text{I}}\left(1 - \frac{v_{\text{I}}}{v_1}\right)\omega^2 x_{\text{I}} = f_{\text{I}} \cdot \frac{dX_{\text{I}}}{dt}, \qquad (2)$$

$$M_{\text{I}} = \frac{f_{\text{I}} \cdot s_{\text{I}}}{\left(1 - \frac{v_{\text{I}}}{v_1}\right)(1 - c_{\text{I}}\Phi_{\text{I}})}. \qquad (3)$$

In certain circumstances, Φ_{I} does not change with c_{I} and the concentration in front of the boundary is constant, σ_{I} is independent of c_{I}. Then we have from (1)

$$s_{\text{I}} = \sigma_{\text{I}}\,(1 - c_{\text{I}}\Phi_{\text{I}}). \qquad (4)$$

In this case s_{I} is a linear function of c_{I}, and the value extrapolated to infinite dilution is σ_{I}. From the slope of the graph of s_{I} against c_{I} we can calculate Φ_{I}. In Table 1 values of Φ_{I} are given for some proteins.

TABLE 1

Protein	Φ_{I}	Calculated from measurements made by
Serum albumin (horse)	14	v. Mutzenbecher[1]
,, ,, ,,	10	McFarlane[2]
,, ,, ,,	10	Johnston and Ogston[3]
Serum globulin (horse)	12	v. Mutzenbecher[1]
,, ,, ,,	9·6	McFarlane[2]

The stream of liquid causes the sedimentation peak (dc/dx as a function of x) to have a steeper slope towards the solution than towards the solvent when the diffusion is normal and the substance monomolecular. This means that the sedimenting boundary, obtained from the first moment of the peak, does not correspond to the maximum. If $c_{\text{I}}\Phi_{\text{I}}$ is smaller than about $0{\cdot}1$, dx_{I}/dt can be calculated from the maximum point and c_{I} put equal to half the concentration of I in that part of the solution where the concentration is unaffected by the diffusion.

The sedimentation volume also has an effect upon the areas of the sedimentation peaks. Let c_{I}° and c_{II}° be the original concentrations of two macromolecular substances, of which I moves faster than II, and $\varphi_{\text{I}}^{\text{II}}$ the volume of 1 gm. of substance I and the solvent, which moves together with it and which is not combined with II. Behind the faster boundary $c_{\text{I}} = 0$ and

$$c_{II} = \frac{c_{II}^{\circ}}{1 - c_I^{\circ}\varphi_I^{II}} \quad (5)$$

in the part between the two boundaries where the concentration is constant. Hence $c_{II} > c_{II}^{\circ}$. If we take the amount of I before the faster sedimenting boundary as the difference $\Delta c_I = c_I^{\circ} + c_{II}^{\circ} - c_{II}$, as is usually done in the determination of concentrations from sedimentation diagrams, we get a smaller value than c_I°. From (5) or Δc_I, it is possible to calculate φ_I^{II}.

The same conditions are also obtained if II is a low molecular substance, 2, and this is the explanation for the fact that c_I as calculated is smaller than c_I° in many protein sedimentations. In this case we get the inner solvation, while $\varphi_I^{II} - v_I$ is the total solvation in cm.³ per gm. of substance I. The inner solvation of cellulose nitrate has been determined by H. Sihtola and T. Svedberg[4] by sedimenting cellulose nitrate in a mixture of a solvent and an indifferent liquid.

If the molecules are dissociated into ions, we must also allow for the electric forces. If there are more than two substances dissolved, the calculations are made in the same way but are more laborious.

In Table 2 some values of φ_I^{II} are given.

TABLE 2

Protein I	Protein II	φ_I^{II}	Calculated from measurements made by
Serum albumin	Lactoglobulin	11	Pedersen[5]
" "	"	11	Johnston and Ogston[3]
Serum globulin	"	7	"
" "	Serum albumin	10	"
" "	" "	12	McFarlane[2]

Every value is the mean of at least three determinations at different concentrations. From Tables 1 and 2 it is seen that Φ_I is nearly the same as φ_I^{II}, but the values are not good enough for the formulation of definite conclusions. New measurements and a more detailed discussion will be published later.

To Prof. The Svedberg I wish to express my thanks for the privilege of working at this Institute. I am indebted to Prof. Ole Lamm for his interest in this work; I also wish to thank Mr. Evald Hellman for many stimulating discussions.

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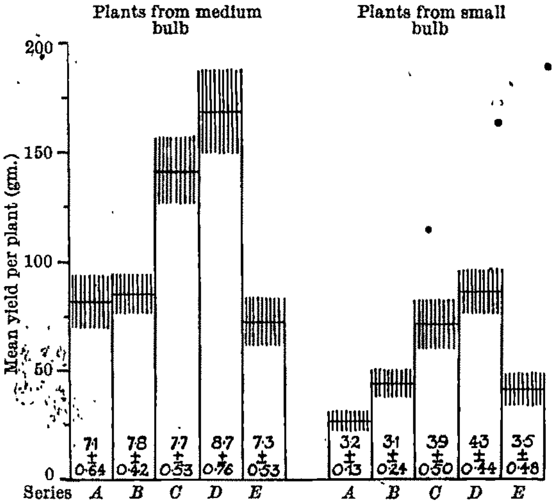
Bulb Formation in the Shallot

As a medium for studying the process of bulb formation, the shallot has certain advantages. It is normally grown from sets, and provided a suitable non-flowering strain is chosen any possible confusion between the effects of treatments used on flowering and bulbing is avoided. In our experiments shallot bulbs of two sizes (medium, mean weight 10·59 gm., and small, mean weight 3·12 gm.) were subjected to the following storage treatments during the winter preceding planting: (*A*) ordinary (laboratory) storage; (*B*) low temperature (0–4°) storage; (*C*) high (88 days at 30°) followed by ordinary temperature; (*D*) low (88 days at 0–4°), followed by ordinary temperature; (*E*) ordinary (88 days), followed by low temperature (71 days at 0–4° C.).

Plants of series *C* were noticeably slow to come into growth, and the plants from the medium-sized bulbs were always more vigorous than those derived from small bulbs. By mid-June the plants of series *C* and *D* were beginning to bulb (the 'low-temperature plants' being slightly more advanced than the 'high-temperature' ones), while all other series were in an advanced state of bulbing. The plants of series *C* and *D* continued to carry vigorous green upright foliage, and were not fit to harvest until August 26, 1946, whereas the other plants were fit to harvest five weeks earlier. Yield data are shown below. It was noticeable that the produce of series *C* and *D* included many very asymmetrical bulbs. These consisted either of one large and one or more smaller bulbs, or of two or more bulbs almost equal in size, invested in a common set of scales.

With both sizes of planted bulbs the treatments have affected bulb growth, but there is some divergence between the results for the plants from the small- and medium-sized bulbs. In both sets of material, series *C* and *D* have given the highest yields. This increased yield is effected by an increase in the weight of the individual bulbs. Treatments *B* and *D* had no effect on the plants from the medium-sized bulbs, but an appreciable effect on those from the small bulbs.



COLUMNS REPRESENT MEAN YIELDS PER PLANT AND THE VERTICAL HATCHING THE STANDARD ERRORS OF THE MEAN. FIGURES IN THE COLUMN REPRESENT THE MEAN NUMBER (WITH STANDARD ERRORS) OF BULBS PER PLANT

In a subsidiary experiment in which bulbs were stored at high temperature throughout the whole winter, a similar increase in yield and individual bulb-weight was obtained; although in this case the treatment caused an increase in the number of bulbs per plant—probably because common investing scales rubbed off many of the asymmetrical bulbs after drying, so that two or three separate bulbs resulted.

Bulbing in onions is a phenomenon the initiation of which is to a large extent controlled photoperiodically[1], but depending also on the temperature[2–5] and nitrogen supply[6] as well as on the variety. The critical photoperiod differs according to whether the plants have been derived from sets or seeds, and in the former case the growth and bulbing of the plant are affected by the storage treatments to which the sets have been subjected. Heath and his co-workers[2-5], concerned especially with the effects of storage treatments of onion sets on the 'bolting' of the resulting plants, and confirming and extending the results of earlier workers[1,7], found that high-temperature storage given throughout the winter, or for the last eight weeks, delays ripening, and gives larger yields, whereas high-temperature storage for the first eight weeks has no such effect. These treatments also reduced the incidence of 'bolting', as did storage at 0° either for the whole or the first eight weeks of the winter. The effects of storage treatments on bolting and bulbing were difficult to disentangle; but Heath and Holdsworth[4] concluded that the high-temperature treatments suppress bolting and affect bulbing separately.

So far as the treatments given here parallel those used by Heath in the treatment of onion sets, the results are similar; but with a non-flowering strain of shallot, there is no possibility of any confusion between the effects of the several storage treatments on flowering and bulbing. With the shallot, therefore, we can be sure that we are dealing with a primary effect on bulb initiation and swelling, and not with some secondary effect on these phenomena that operates through the suppression of flowering. If, in the shallot, as in the onion, bulbing is controlled photoperiodically, the effects of these storage treatments would be at least partially explained if their primary effect was in some way to increase the critical photoperiod necessary for bulb initiation. The shallots are grown during a period of lengthening days (April–June), and the effect of an increase in this critical photoperiod would be to delay the onset of bulbing. Further[1], with onions, the greater the excess of the photoperiod experienced over the critical photoperiod required for bulb initiation, the more rapid are the ripening processes. Hence, if the critical photoperiod is increased, but is still less than the photoperiods experienced after bulbing has begun, the difference between the critical and the experienced photoperiods will be reduced, and the processes of bulb ripening retarded, that is, the period of bulb-swelling extended. Delayed bulb initiation, a prolonged period of bulb swelling and delayed ripening are the precise effects on the resulting plants of storage throughout the winter, or for the first part of the winter at 30° C., or for the first part of the winter at 0–4° C. (or for the whole storage period at 0–4° C. with small bulbs) of shallot bulbs before planting. The data available do no more, however, than permit the suggestion that the storage treatments operate on the lines indicated, affecting in some way the critical photoperiod required for the initiation of bulbing in the resulting plants.

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Streptococcus fæcalis in *E. histolytica* Infections

BACTERIOLOGICAL studies conducted upon a series of cases of relapsing amœbiasis showed that changes occurred in the relative distribution of organisms in the fæces during the active stages of the disease[1]. One particular change was the abnormal prevalence of enterococci in dysenteric exudates. In most cases, these enterococci were identified as *Streptococcus fæcalis*.

When a 1 per cent glucose-broth culture or culture-filtrate of certain strains of *Streptococcus fæcalis* was added to a phosphate-buffered suspension of *E. histolytica* in equal volume, the amœbæ were observed to disintegrate in one or two hours. This effect was a specific result of the growth of *Streptococcus fæcalis* in peptone media containing glucose, and was due apparently to some substance or substances formed during the fermentation of glucose. When glucose was fermented by growing cultures of coliform organisms or staphylococci, no such action was observed.

The complete identity of the metabolites which are toxic to *E. histolytica* has not as yet been ascertained, but the properties are consistent with a heat-stable, water-soluble substance not readily adsorbed on surfaces. Lactic acid[2] shows a similar type of activity against *E. histolytica in vitro* in concentrations of $0{\cdot}05\,M$; this concentration is readily attained in glucose-broth cultures of *Streptococcus fæcalis*, and removal of lactic acid from such cultures by ether-extraction almost eliminates their activity. The effect is not a direct consequence of changes in the hydrogen ion concentration of the media, though the action of lactic acid increases as the *p*H falls, and lactates, which are inactive at *p*H 7, show activity at *p*H 5. It is probable, therefore, that the principal toxic metabolite is lactic acid.

An effect was also observed *in vivo* when young rats, experimentally infected with *E. histolytica* by the method of Jones[3], were fed with living cultures of the appropriate strains of *Streptococcus fæcalis*. The degree of amœbic infection was consistently lowered, and when cultures of the two organisms were mixed before inoculation of the rats *E. histolytica* lost its infectivity within one hour.

Enterococci of the *Streptococcus fæcalis* group are normal members of the intestinal flora of man and certain animals, especially in the small intestine. Their prevalence in the colon becomes increased during the 'hurry' of the small intestine caused by diarrhœa. As a result of this, *E. histolytica* becomes more closely associated with *Streptococcus fæcalis* in the colon during the active stages of amœbiasis. It is possible, therefore, that the process described above plays a part in the natural history of an amœbic infection.

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Sex Reversal in Copepods

BETWEEN February and June 1947, 20·5 per cent of the males, 3·7 per cent of the females and 0·3 per cent of the copepodids of *Pseudocalanus elongatus* Boeck, collected from six stations between Flamborough Head and the Dogger Bank, were found to be parasitized by *Blastodinium contortum hyalinum* Chatton. Almost all the observed parasites were found to be in the tetrablastic or a later stage, with a length of 440–560 μ. They occurred singly in the vast majority of cases, but very rarely two individuals were found in the same *Pseudocalanus*. As the material was unstained, it is likely that most of the earlier stages of the parasite were overlooked, particularly in the younger stages of the copepodids, and that the proportion of infected individuals was really higher than that given.

Chatton[1] states that the presence of *Blastodinium* causes the castration of the host without, however, this affecting its external structure; on the other hand, it brings about a comparative reduction in its maximum size. He did not find any parasitized adult males, and thought that the parasite arrested the development of the last copepodid by inhibiting the final moult. Chatton recorded infection of *Pseudocalanus* sp. from the North Sea.

In the parasitized material dealt with here, while the stage V male and female copepodids and the mature females had normal external features, there were present abnormal individuals. Some of these showed a full development of the female abdomen, vulva and all other characters such as antennæ, but with the presence of a fifth pair of legs. The legs were in a state of development corresponding with that in one of the male copepodid stages. Contrary to Chatton, I have found these infected copepods to be, if anything, slightly larger than the comparable non-parasitized individuals. I have recorded to date three individuals in this category which had an attached spermatophore (Fig. 1).

I have found also several infected individuals such as that shown in Fig. 2, in which the female type of abdomen is not fully formed, showing the presence of the vulva, but with the abdominal segments 1 and 2 not completely fused together. The proportions of the remaining segments are typical of the male sex. These individuals possess, moreover, a pair of fully formed male fifth legs. The contained parasite measures about 310 μ in length and is in either the di- or triblastic stage.

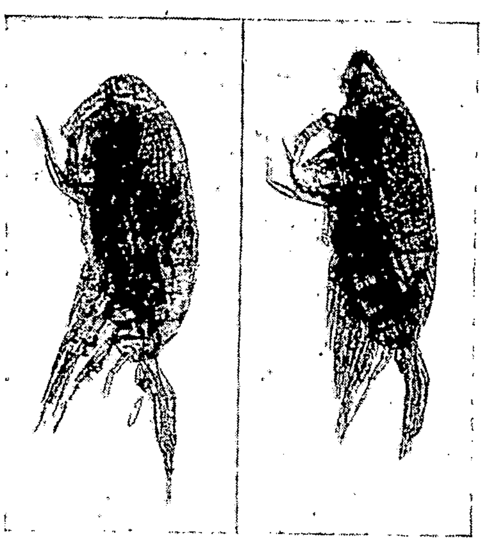

Fig. 1 Fig. 2

Pseudocalanus elongatus BOECK FROM THE SOUTHERN NORTH SEA, PARASITIZED BY *Blastodinium contortum hyalinum* CHATTON. PHOTOMICROGRAPHS OF TWO UNTREATED AND UNMOUNTED INDIVIDUALS PRESERVED IN FORMALIN. LENGTH OF CEPHALOTHORAX: FIG. 1, 950 μ; FIG. 2, 920 μ. MAG. × 40

These observations suggest that the parasite exercises no effect on the morphology of the female sex of the host, and that the last copepodid stage passes on to the fully formed but castrated individual. In the male sex, however, the parasite at some stage in its growth is able to arrest the development of the male characters of the copepodid (externally the fifth pair of legs), while in the final ecdysis it causes the copepod to undergo sex reversal and become a superficially mature but sterile female. The presence of the fifth pair of legs remaining in a state of development comparable to that in the animal's previous stage is the only indication of the original male sex.

It appears most likely that the individual of Fig. 2 became parasitized first at a later stage in its development than usual, and that it was able to reach the fully mature male stage before the parasite could exercise control over its morphology. Whether the individual could show the complete external sex change described when the parasite approaches its maximum size remains to be seen.

It is apparent that the abnormal 'females', under the influence of the parasite, have undergone complete sex reversal, for it has been shown that males find them as attractive as normal females and effect copulation (*vide* Fig. 1). The sex reversal is, however, virtual, not absolute, as according to Chatton the copepods are castrated.

Although the incidence of infection has been shown to be considerable, the castration which occurred does not seem to have caused any substantial drop in the population of *Pseudocalanus*, as large numbers of uninfected juvenile forms were found in June at the end of the period.

I am indebted to Colonel Seymour Sewell for suggesting the possible identity of my parasite and also for referring me to Chatton's paper.

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Evaluation of Herbage for Grazing

IN the numerous published accounts of digestibility trials with cut herbage, the assumption has been made[1] that the herbage fed represents that which grazing animals would eat. It is known, however, that animals select grass and clover leaf in preference to stem when grazing[2,3]; these are the more nutritious constituents of the sward, so that by feeding the whole cut from the sward, the nutritive value of the portion stock would eat in the field is underestimated. Thus we need to measure the feeding value of a portion of the sward that we cannot actually analyse, namely, that taken off by the grazing animal. This problem is being investigated at the Grassland Improvement Station.

During May–October 1947, fæces were collected daily from a group of sheep on rotational grazing, and analysed for dry matter, nitrogen and ash.

Fæcal dry matter figures from these sheep indicated that the amount of the daily feed intake was almost independent of the grazing available, but increased steadily with increase of body size. This was at variance with consumption estimated by a mowing machine technique (sampling grazed and protected areas of the sward) which appeared proportional to the amount of feed available[4]. This is because, especially when keep is short, stock obtain much of their feed below the level at which most mowing machines can cut. At times when much growth was available, the mowing machine over-estimated consumption, due to the protected sward growing more rapidly than the grazed sward[5]. The results of these experiments suggest that the usual mowing machine techniques at present used by agronomists may be valueless as methods of measuring with precision the herbage consumed by the grazing animal.

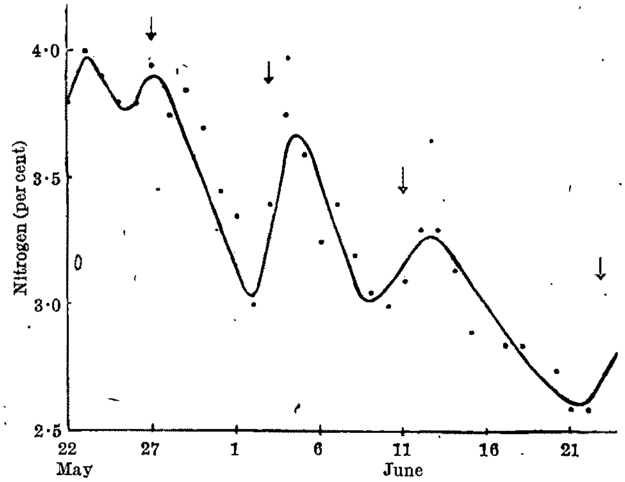
Results of experiments in which mown herbage was fed to sheep in cages[6], together with those from a large number of similar experiments, conducted at Jealott's Hill Research Station[7], have shown the following relation between the nitrogen content of the dry matter of grass fed and of the oven-dried fæces produced:

$$\text{per cent N in feed} = 0\cdot795 \times \text{per cent N in ash-free fæces} + 0\cdot14 \ (t = 17).$$

The grass fed varied from that cut for hay or silage to closely grazed pasture grass; but different constants may apply for other feeds such as lucerne, mountain pasturage, etc.

Considering the process of selective grazing by sheep, it is likely that, day by day, the nitrogen content of their feed from a single plot will decrease, because they are progressively removing the leafiest, nitrogen-rich growth available, and leaving the stemmy part of the growth for subsequent grazing. A move to fresh herbage will make feed of higher nitrogen content available, and the nitrogen in the feed should thus exhibit a periodicity with movement from plot to plot. If, as is suggested by the regression formula given above, the fæcal nitrogen bears a direct relationship to feed nitrogen, the former should show a similar periodicity, with the time-lag of approximately two days normally assumed for the feed to pass through the gut. Analysis of the daily fæcal nitrogen from the grazing sheep has shown this to be so (see accompanying graph) and suggests that in fact the nitrogen content of fodder grazed from one plot does decrease day by day. As the nutritive value of herbage is roughly proportional to its nitrogen content[8], the feeding value of the grazing on this plot decreases daily, and the average percentage starch equivalent depends on the overall intensity of grazing.

Thus the fæcal nitrogen from grazing sheep gives a figure for nitrogen in feed grazed which is probably more accurate than that obtained by analysis of cut herbage. Experiments are now in progress at this Station to find whether analysis of fæces for other constituents (for example, lignin, as suggested by Maynard *et al.*[9], but making due allowance for the factor of selective grazing) together with nitrogen estimations will give a direct measure of the quality of the feed intake. Such analyses could be made on fæces collected from the sward, and need not demand the harnessing of stock. If it is confirmed that the main factor controlling dry matter intake is body-weight, then we should have available a method for measuring the daily intake of nutrients by the grazing animal.



AVERAGE DAILY PERCENTAGE OF N IN ASH-FREE FÆCES FROM TEN SHEEP ON ROTATIONAL GRAZING. ARROWS MARK DAY OF ENTRY OF STOCK ON TO A NEW PADDOCK: THE EFFECT OF INCREASING MATURITY OF HERBAGE DURING THE PERIOD IS SHOWN BY LOWER FÆCAL-N FIGURES ON THE LATER PADDOCKS

I should like to thank Mr. W. S. Ferguson for permission to use figures from the Jealott's Hill experiments and my colleagues at this Station for their considerable help in the present investigations.

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Perithecia of Oak Mildew

FORMATION of perithecia of the oak mildew is a rare occurrence in Britain, the only record known to me being that of Robertson and Macfarlane[1], who found one leaf with six perithecia at Bricket Wood, Hertfordshire, on October 6, 1945. It is therefore of some interest to note that a few perithecia were found on leaves of *Quercus robur* at Aberystwyth on October 2, 1947. The identification of the fungus as *Microsphæra alphitoides* Griff. and Maubl. was kindly made by Mr. S. J. Hughes, Imperial Mycological Institute, who compared the Aberystwyth material with a slide of Robertson and Macfarlane's specimen deposited in the Herbarium of the Royal Botanic Gardens, Kew.

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March 12.

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RIBOFLAVIN ENHANCEMENT OF RADIOACTIVE PHOSPHATE EXCHANGE BY YEASTS

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AND

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It has recently been suggested by von Hevesy[1] that processes occurring at the cell surfaces or just inside cell boundaries play an important part in phosphorus metabolism in yeast. We have obtained evidence that we interpret in a similar vein, and suggest the existence of a 'P-complexing factor' at the cell surface.

We have found it possible to increase the radioactive phosphate (P^{32}) exchanged by yeast in the presence of glucose by the addition of trace amounts of riboflavin to the suspending medium. The increases observed range from 20 to 200 per cent over the phosphate exchanged by controls in glucose alone. This effect has been found in two widely different species of yeasts.

The organisms used were *Candida albicans*, a pathogenic non-sporulating yeast, and *Saccharomyces cerevisiæ* (Carlsberg No. 237). Cells were grown in wort or in a medium (*GGY*) consisting of: glucose, 2·0 gm.; glycine, 1·0 gm.; yeast extract ('Difco'), 0·1 gm.; and distilled water, 100 ml., and incubated for 24 hours at 20° C. with constant agitation. The yeast crop was harvested by centrifugation, washed twice with glass-distilled water, and suspended in glass-distilled water to a known density. The P^{32} was usually introduced at this time. Aliquots of the suspension were placed in flasks (with a fritted glass aeration tube leading to the bottom of the flask) in the following medium: yeast suspension, $M/5{,}000$ potassium dihydrogen phosphate, $M/15$ glucose, water or riboflavin (50 µgm./c.c.). The flasks were aerated with washed and filtered compressed air, or with 95 per cent nitrogen with 5 per cent carbon dioxide (passed through a heated copper coil). After the experimental period, the yeast cells were removed by centrifugation, washed twice with glass-distilled water and the yeast cream placed in aluminium dishes adapted for Geiger–Müller counting, and measured automatically[2]. The results obtained in the two experiments reported here are typical of those we have obtained in many other experiments.

Addition of riboflavin (1 µgm./c.c. final concentration) to suspensions of *Saccharomyces cerevisiæ* or *Candida albicans* metabolizing glucose aerobically or anaerobically prompted a marked increase in P^{32} exchange. As shown in Table 1, this addition of riboflavin more than doubled the P^{32} exchanged aerobically by *S. cerevisiæ* with either glucose or sucrose as source of carbohydrate. In the same experiment, 2,4 dinitrophenol in a concentration of 10^{-3} *M* inhibited P^{32} exchange approximately 40 per cent; this is in agreement with the inhibitory action of this substance on phosphate uptake by *S. cerevisiæ* reported by Hotchkiss[3].

If a P-complexing factor is formed at the cell surface, it is possible that, once formed, it might act in the absence of the energy-yielding processes apparently necessary for its formation[4]. An experiment was conducted along these lines wherein *C. albicans* was incubated aerobically at 20° C. in the presence of riboflavin and glucose, then equilibrated at + 4° C. and exposed to P^{32}. Table 2 shows that the starved suspension of the yeast exchanged twice as much P^{32} as the unstarved suspension (both suspensions were prepared from the same culture of yeast). It is also seen that riboflavin prompted a nearly four-fold increase in the exchange of P^{32} by the starved cells, but was without effect on the unstarved yeast. The occurrence of phosphate exchange at a very slow rate by yeast at + 4° C. has been reported by Lindahl *et al.*[5].

TABLE 1. *S. cerevisiæ*, GROWN AEROBICALLY IN *GGY* MEDIUM FOR 24 HR. AT 25° C.
Not starved; exposed aerobically to P^{32} at 25° C., for 5 hr. with treatments as listed (40 mgm. yeast dry wt. per vessel)

Vessel	Treatment	Counts/min./mgm. dry wt. (standard units)
1	glucose + glycine	13·6
2	sucrose + glycine	12·5
3	glucose + glycine + 2,4 dinitrophenol	7·9
4	sucrose + glycine + 2,4 dinitrophenol	7·5
5	glucose + glycine + riboflavin	30·7
6	sucrose + glycine + riboflavin	32·8

TABLE 2. *C. albicans*, GROWN AEROBICALLY IN 'TULAUF' WORT AT 20° C. FOR 26 HR. WITH AGITATION.
Half the suspension not starved (stored at 4° C. for 18 hr.), the other half starved by agitating aerobically in water for 18 hours at 25° C. Both suspensions treated as below for 2½ hr. at 25° C. aerobically with constant agitation (50 mgm. yeast dry wt. per vessel), then placed at − 4° C. for 45 min. P^{32} was then added and flasks held at + 4° C. in presence of P^{32} for 5 hr. Cells separated by centrifugation and washed in the cold

Vessel	Treatment	Counts/min. (standard units)	Counts/min./mgm. dry wt.
	Cells starved		
1	glucose + riboflavin	100	2·2
2	glucose	33·2	0·6
	Not starved		
3	glucose + riboflavin	15·4	0·3
4	glucose	19·5	0·3

The increase in rate of uptake of P^{32} in the residual-phosphorus fraction (presumably metaphosphate[11]) of yeast brought about by cyanide[6] might be considered in the light of the present data on riboflavin in view of the action shown by Pett[7] for the increase in riboflavin synthesis by yeast treated with cyanide. Among the several compounds examined, yeast nucleic acid, uracil, and fructose 1,6 diphosphate proved without detectable effect on phosphorus exchange by *C. albicans* metabolizing glucose aerobically.

Yeasts are well known to be relatively rich in riboflavin, so it is rather surprising to find that added riboflavin exerts such marked effects as we have noted. An average value for the riboflavin content of baker's yeast may be taken from Pett[7] as 20–30 µgm./gm. dry wt., of which 80–90 per cent exists as bound riboflavin. In our experiments usually 30–50 mgm. dry weight of yeast was placed in each flask containing 50 ml.; thus a total of approximately 1 µgm. of riboflavin was introduced into each flask with the yeast. If all this riboflavin were to have been released from the yeast (not possible under our conditions) a concentration of 0·02 µgm. riboflavin per ml. would have resulted. The quantities of riboflavin introduced into each flask as impurities in the sugars and glycine (reagent quality, but not especially purified) are undoubtedly minute. While some species of the genus *Candida* are known[8] to produce sufficient riboflavin on controlled low-iron media to colour the medium, we have never succeeded, using the strains of *Candida albicans* employed here, in obtaining more than very small yields of riboflavin with similar, purified, known-iron media.

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While it is well known that the presence of external phosphate is not essential for the oxidation and assimilation of glucose by yeast suspensions[9], it is also known that phosphate exchange[4,6] and polymerization (as measured by the increase in basophily[11]) are dependent on the presence of external metabolizable substrate.

In view of the correlation which has been pointed out[3] between the action of 2,4 dinitrophenol on the assimilation of carbon sources by micro-organisms and its action on the uptake or exchange of inorganic phosphate by micro-organisms, it is of interest to compare the action of riboflavin with that of other agents on these two processes. Such a comparison has been made in Table 3 (references noted). It appears there is a decided 1 : 1 correlation between the processes of phosphate uptake and assimilation of carbon by micro-organisms. At the concentrations stated, the agents listed in Table 3 are without effect on the rate of aerobic or anaerobic breakdown of carbon sources. The effect noted[10] for riboflavin on assimilation was observed with the two organisms reported on in this paper. From concomitant investigations[10] on the variation in basophily of yeasts (see Wiame[11]), it is believed that the 1 : 1 correlation between assimilation and phosphate uptake results from the, possibly coupled, simultaneous polymerization by yeasts of inorganic phosphate (to polyphosphates) and of carbon sources (to carbohydrate polymers).

TABLE 3

Substance	Concentration	Assimilation of carbohydrate	Uptake or exchange of inorganic phosphate
2,4 Dinitrophenol	10^{-4} *M*	inhibited[9]	inhibited[3]
Sodium azide	10^{-4} *M*	inhibited[9]	inhibited[3,13]
Gramicidin*	40 μgm./ml.	inhibited[3]	inhibited[3]
Glucose	10^{-3} *M*	a substrate	enhanced[4,6]
Riboflavin	$2 \cdot 5 \times 10^{-6}$ *M*	enhanced[10]	enhanced

* Acting on *Staphylococci*, other agents acting on yeast.

The observation of Malm[12] that phosphate exchange by yeast is sensitive to the *p*H of the medium can be taken as evidence that a surface reaction, easily affected by external *p*H, is involved in phosphate exchange (see Myrbäck and Vasseur[14] for an extended discussion of the considerations underlying this line of reasoning). It is unlikely that phosphate enters the yeast cell in an ionized form, and it seems reasonable that phosphate is brought through the cell barrier by uniting with some 'complexing substance' existing at the cell surface. The compound of this substance with phosphate may then dissociate, or in other manner lose phosphate to the cell (possibly to coenzyme I; see Lindahl *et al.*[5]), and free 'complexing substance' to act again. From our observations we believe that such a role as postulated for the 'complexing substance' may be filled by riboflavin. Combined roles of phosphorus and hydrogen transference for trace-active substances may assume importance in considerations of *in vivo* processes.

We wish to thank Prof. Ø. Winge for facilities at the Carlsberg Laboratorium, Prof. G. Hevesy for most helpful discussion and for reading the manuscript, and Mr. K. Zerahn for his aid in carrying out the activity counts.

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FACTORS INVOLVED IN THE DEACTIVATION OF PENICILLIN SOLUTIONS BY RUBBER TUBING

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COWAN[1] in 1945 demonstrated that aqueous solutions of penicillin could lose up to 50 per cent of their antibiotic activity by simple passage through the rubber tube of a continuous-drip apparatus. These results were confirmed by Huelsbusch, Foter and Gibby[2], who showed that certain samples of both natural and synthetic rubber could inactivate completely the penicillin in solution in twenty-four hours; and also by Hughes[3], who showed that no improvement was obtained by repeated washing of the tubes before use.

At the request of the Medical Research Council through the Ministry of Supply Advisory Service on Rubber, we have been investigating this problem in the hope that we should be able to throw some light on the mechanism of inactivation and on possible methods of improving the quality of rubber supplies. The main technological details will be published elsewhere, and the purpose of this communication is to give a summary of the results relevant to medical practice.

The Effect of Compounding Ingredients and of Vulcanization. Unfortunately, none of the early workers was in a position to supply information on the compounding ingredients other than rubber which were present in the tubes which they tested. These ingredients may well represent quite a large proportion of the total weight, and as some of them are highly active substances it was thought possible that the trouble might be due to one or more of these rather than to the rubber itself. On testing singly a number of such substances, including natural rubber, sulphur, zinc oxide, stearic acid, paraffin wax and a number of accelerators of vulcanization—mercaptobenzthiazole, dibenzthiazyl disulphide, tetramethylthiuram disulphide, zinc diethyldithiocarbamate and diphenylguanidine—no loss in penicillin potency was observed with any of these materials. However, when these ingredients were compounded together in various proportions to give products suitable for rubber tubing and then subjected to vulcanization, the resulting rubber tubes were found to be very active towards penicillin. Thus a rubber tube vulcanized with sulphur and 1·0 per cent of mercaptobenzthiazole reduced the potency of penicillin by 80 per cent in 24 hours at room temperature, and in no case was the loss less than 60 per cent in this period.

Causes of Penicillin Deactivation. It is clear from the above that the active agents in penicillin degradation by rubber must be produced during the complex chemical changes occurring during vulcanization. The major reaction which results in the cross-linking of the rubber molecules with sulphur is unlikely to leave the latter in an active form; but in the process of heating with sulphur, it is not improbable that mercaptan compounds could be produced from any non-rubber components present. This is particularly likely in the case of vulcanization accelerators, many of which decompose during vulcanization with the production of mercaptan compounds. It is known that cysteine is effective in the deactivation of penicillin, and indeed it has been suggested by Cavallito[4] and others that penicillin and other antibiotics inhibit the growth of micro-organisms by reaction with mercaptan compounds within the organism.

In the first instance, therefore, the effect of a reduction in the proportion of accelerators from 1·0 per cent to 0·1 per cent was studied. In each case a substantial corresponding reduction was achieved in the activity of the rubber towards penicillin. Thus in the case of dibenzthiazyl disulphide, the loss of potency of the penicillin was reduced from 80 to 40 per cent, while with a diphenylguanidine-accelerated mix reduction was from 74 to 20 per cent. By the omission of accelerators altogether, a still further reduction was obtained. In some cases the rubber showed no deactivating effect whatever, whereas in others varying effects up to a maximum of 20 per cent were observed.

Confirmation of this finding was obtained by the simple heating of an accelerator—in this case tetramethylthiuram disulphide—to vulcanization temperature for ten minutes. After this treatment the product was found to be highly active towards penicillin, in contrast to its initial inert behaviour. It is therefore clear that accelerators play a major part in the deactivation of penicillin by rubber, and it is clearly desirable that the amounts used should be as small as possible.

The smaller, and variable, activity of vulcanized rubbers containing no accelerator would appear to be due to the reaction of sulphur with impurities rather than with the rubber itself, as otherwise it would be difficult to explain the preparation of some mixes which are entirely inert towards penicillin. Impurities which could react to form mercaptan compounds are often present in small amounts in natural rubber in the form of the so-called 'rubber resins', and some evidence that these may play a part in penicillin deactivation was obtained by testing acetone extracts of vulcanized rubbers prepared without accelerators. Rubber resins and their reaction products with sulphur are largely soluble in this solvent whereas the rubber complex is not, and such extracts were found to be active towards penicillin in those cases in which the vulcanized rubber itself showed activity.

Methods of Minimizing the Degradation of Penicillin. It has already been shown by Yudkin and Pulvertaft[5] that vulcanized rubber is without action upon penicillin in the presence of phosphate buffer, and we have found this to be true even with the most active rubbers which we have been able to prepare. However, where the use of phosphate buffer is impracticable, the potential destructive action of mercaptans will constitute a danger in any form of vulcanized rubber, whether natural or synthetic. In studying possible methods of minimizing this effect, we have obtained some success by the use of a suitable grade of carbon black as an inert filler in the compounding of the rubber tubes. Thus, the incorporation of carbon black in an accelerated mix resulted in the rubber tube showing 27 per cent loss of penicillin potency in 24 hours, whereas an exactly similar rubber tube, containing the same volume proportion of barytes, resulted in a loss of potency of 78 per cent. Comparable results were obtained with a variety of different accelerators. The effect is due presumably to the absorption of active substances and the prevention of their migration to the surface.

The second method examined was the treatment of vulcanized rubber tubes with reagents which are active towards mercaptan groups. This aspect has not yet been studied extensively, but promising results have been obtained by treatment for a few hours with 40 per cent formaldehyde at 38° C., whereby the destructive power for penicillin of a highly active rubber tube was considerably reduced (from 91 to 68 per cent loss of potency in 24 hours). Similar results have been obtained on a variety of different mixes, suggesting that this method of treatment would be worthy of further study, while at the same time lending some support to the view that it is the mercaptan groupings in the vulcanizate which are the active principles concerned in the destruction of penicillin.

Effect of Repeated Sterilization and of Ageing. Small chemical entities such as simple mercaptans are known to migrate to the rubber surface. This suggested a danger that the destructive power of rubber for penicillin would increase with age, and this aspect has also been examined. No alteration in the deactivating power of rubber tubes could be observed by repeated sterilization; but tubes which have been subjected to normal storage for a period of six months were found to show a marked increase in their activity towards penicillin. These tubes were deliberately prepared without the usual antioxidant in order to accelerate any effects due to ageing; but this finding does suggest the desirability of occasional checks upon rubber tubing during its period of use or storage.

Alternative Materials. In view of the obvious difficulties in the preparation of rubber tubes which can be relied upon to be completely without action upon penicillin, we have investigated the effect of a number of alternative materials. Of those which we have studied, polyvinyl chloride, with the plasticizers normally used in its manufacture, and polyethylene, have no action whatever upon penicillin. Polyethylene has the disadvantage that it shows a tendency to kink when used in long lengths, and both materials present difficulties in sterilization as their softening points are below the temperature of the normal steam autoclave. However, polyvinyl chloride can be made in a form resistant to boiling water and is already finding uses in surgery, so that it may prove to be superior to rubber for the purpose of the drip-feed injection of penicillin.

We wish to thank the Chief Scientific Officer, Ministry of Supply, for permission to publish this communication.

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LONDON'S TRANSPORT SYSTEM

THE fourteenth annual report, recently issued by the London Passenger Transport Board, makes interesting reading. Since the undertaking is now vested in the British Transport Commission, this is the Board's final report, and it has therefore devoted one section to a review of the way in which it has discharged its functions since July 1933.

Here is an example of the operation of a very large centralized concern run on lines similar, from many points of view, to those which must be adopted in the even larger organisation of nationalized industries or utilities. There can be no doubt that in this instance the arrangement has proved in most ways an outstanding success: the Board has, in the main, achieved its object of providing "a passenger transport service, by rail and road, worthy of London as a great metropolitan city". Few Londoners would deny this: it is not so certain that the inhabitants of some other capital cities would be equally enthusiastic about the transport facilities available to them.

The magnitude of the Board's achievement can better be appreciated by reference to some of the figures contained in the report. The area served covers some 2,000 square miles, with a population in 1933 of 9,358,000. One of the first tasks was to rationalize the unrelated and often wasteful competitive services operated by the many transferred undertakings. During the pre-war years the number of vehicles owned rose from 11,753 to 12,819, and the annual mileage run by them increased from 515 to 573 million miles, providing more than nine million passenger journeys a day in 1933 and ten million in 1939—the usual calculation indicates that if the tickets issued daily were placed end to end they would stretch from London to New York. The receipts from fares rose concurrently from about 27 million pounds to nearly 31 million pounds sterling a year. While this expansion was in progress, the many types of buses and coaches were being replaced by standard designs, the maintenance system was overhauled, new equipment was introduced to increase reliability and efficiency and, most important of all, a vast programme of new works was undertaken in conjunction with the 'main line' railway companies

The outbreak of war caused a great setback to this steady growth. As a result of evacuation, the 'blackout' and bombing, the volume of traffic was so reduced that the system ceased to be self-supporting. But after 1941, traffic again increased and reached a peak of 4,259 million journeys in 1946, totalling 11,479 million passenger miles. The number of journeys made per head of population per year is a measure of the 'travel habit'; this figure rose from just over 100 before the War to nearly 130 in 1946, which certainly indicates no reluctance on the part of the public to travel.

Mention may be made of some of the technical innovations originating with the Board. In 1938 re-designed rolling stock was introduced on the 'underground' railways, the electric motors being installed beneath the floors of the carriages. This eliminated the waste of one car in a seven-car train to house the power plant, and thus gave a 14 per cent increase in carrying capacity. The Board was among the first to recognize the advantages of the oil engine as compared with the petrol engine from the point of view both of performance and of economy in operation and maintenance. It accordingly adopted the oil engine from 1934 onwards as the standard power unit for all new buses and coaches. It was also a pioneer in the large-scale use of the pre-selective gear box and fluid flywheel transmission, which not only ease the work of the driver but also materially increase the comfort of passengers by virtue of the smoother running which they give. Before the War, the trams on many routes were replaced by trolleybuses; but since the War the financial advantage of the trolleybus has decreased to such an extent that further conversion of tramways will be to buses, which are more flexible in operation and offer wider opportunities for co-ordination of all services provided by the use of a single type of road vehicle. Another remarkably successful innovation of the Board was the novel constructional technique employed on the eastern extension of the Central Line.

The first regular passenger service in London was established in 1829, and during the succeeding century development proceeded under a multiplicity of private operators. The extraordinary complexity of the resulting system makes it difficult to offer a fair criticism of the Board's efforts, though it would appear that there is room for immediate improvement in certain directions: the rationalization of routes in the central area and, in particular, the links between the 'main line' railway stations require attention. It is, for example, impossible to get from King's Cross to Victoria station without at least one change, apart from the interstation buses which are so infrequent and circuitous in route as to be virtually useless.

The report concludes with a reference to future prospects and deplores the lack of materials and national restrictions which have prevented a more rapid recovery from the effects of war. It has been argued, however, that the present difficulties are attributable, at least in part, to the policy pursued before the War of scrapping vehicles when the body was worn out, instead of retaining the chassis with a new body and an oil engine; this criticism applies particularly to the 'ST' type of motor-bus. But the Board would probably be the first to admit that errors of judgment have occasionally been made and to acknowledge that the traffic system is still capable of much improvement.

Though the layman may occasionally wonder at some of the oddities of the system—what purpose is served, for example, by the posters informing us that London's transport is at our service when no other means of travel is available, and why does the hand-rail always travel slower than the escalator?—the Board is to be congratulated on furnishing an example of the efficiency which should be attained by all public undertakings.

R. H. MACMILLAN

RADIO RESEARCH IN BRITAIN

A REPORT from the Research Committee of the Institution of Electrical Engineers under the title "British Research in the Radio Field" has been published recently by the Institution*.

While the report includes a general review of the existing facilities for radio research in Great Britain and makes some assessment of the scale of effort involved, it is primarily directed towards considering the means whereby research may be still more actively and effectively pursued and better co-ordinated. The view is expressed that the present volume of radio research is inadequate to maintain, in the face of intensified international competition, a progressive and flourishing radio industry.

Recognizing the difficulty, when describing research in relation to industry, of differentiating sharply between research and development, the report gives a broad general classification under the three headings : (1) basic or fundamental research ; (2) applied research or advanced development ; (3) development and design.

Attention has been concentrated, in the main, on work considered to fall in the first and second categories; but the vital importance to industry of first-class engineering development is also emphasized.

In analysing the distribution of research activity, sub-division is again made under three headings, namely : (*a*) academic research ; (*b*) research by Government establishments, Department of Scientific and Industrial Research and B.B.C. ; (*c*) industrial research.

An interesting comparison is made, in tabular form, of the distribution of the existing capacity and facilities devoted, in these spheres, to various main branches of radio research.

The conclusions and recommendations of the report are the consequences, direct and indirect, of the acceptance as a basic principle that "successful research is more dependent on the qualities, character and inspiration of the research team leaders than on any other factor governing its conduct".

In a paragraph entitled "Research Leaders", it is asserted that "The key to the expansion of research in the radio field, as in all others, lies in the discovery and encouragement of the limited group of men who are competent to act as team leaders and who possess the intellectual and personal qualities which have always proved essential for the successful pioneering of research".

The position of the universities in relation to what may be termed research potential is considered to be a central one on the ground that, not only do the universities, and to a lesser extent the technical colleges, make a very material direct contribution of original research, but also it is through their teaching activities, both undergraduate and postgraduate, that the supply of potential research workers is maintained. Fairly detailed consideration is given to the factors governing the effective pursuit of research and postgraduate study in the universities of Britain, and it is suggested that many of the considerations affecting academic research apply with equal force in relation to industrial research.

In regard to finance, the existing mechanism, whereby official support comes through the University Grants Committee and through the Department of Scientific and Industrial Research, is regarded as satisfactory ; but it is emphasized that an expanded postgraduate programme necessitates increased funds from these sources. It is, however, reiterated that an essential requirement in university research is freedom of action in the development of the research programme.

In relation to the staffing of university research projects, attention is directed to the importance of maintaining, through the work of permanent members of the staff, continuity and integration of effort among postgraduate student members of research teams ; and, in a similar connexion, to the necessity for attracting and retaining in university laboratories adequate numbers of well-qualified laboratory assistants, technicians and craftsmen.

The postgraduate university research worker may vary in age and qualification from the relatively senior holder of a major research fellowship or scholarship to the young graduate of a few months standing. Improved financial provision is regarded as necessary for the important group that returns to the university after two or three years in industry. With regard to the young graduate class, it is recommended that a period of at least six months be spent in industry before taking up academic research.

A considerable part of the report is devoted to the question of the co-ordination of research in the radio field. A primary aim must be the early dissemination of results as widely as possible. Suggestions are made for the improvement of the existing mechanism by the use of an organisation resembling the Central Radio Bureau to collect and circulate information on researches in progress, thereby minimizing the delay which inevitably exists in the publication of completed research through the normal channels. In the field of basic research in the universities, it is considered that co-ordination of effort to a desirable degree can be better achieved by the efficient exchange of current information than by positive co-ordinative action which might take on a restrictive character.

With reference to research in Government establishments, the report welcomes the recent setting up under the ægis of the Department of Scientific and Industrial Research of a Committee on Fundamental Research in Telecommunications, and suggests that a broadening of the terms of reference of this Committee and its establishment on a permanent basis would serve to co-ordinate effectively the main body of research in this sphere. It is further suggested that an effort should be made to maintain something of the co-operation obtained during the War by the Inter-Services Radio Components Research and Development Committee which operated under the Ministry of Supply.

An important example of large-scale technical co-ordination in the telecommunications field is the work of the British Telephone Technical Development Committee, which, under the chairmanship of an assistant engineer-in-chief of the Post Office, achieves the co-operation of the main telephone manufacturing companies in Britain in technical development so that individual research effort is fostered, but also, by the pooling of inventions, a unified development policy for the telecommunications system as a whole is ensured.

Probably the statement of the greatest practical significance, not only in the field of radio communications but also in other subjects, which the document contains is the following: "The Panel have been impressed by the opinion consistently advanced by the University representatives who have attended the meetings that among their graduates those suited to a research career form but a small proportion of the whole; the remainder, while fully competent to absorb and profit by the scientific and technical curriculum, appear to lack those powers of patient and deep-seated inquiry which characterize the natural research worker and lead him to expose new truths".

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* British Research in the Radio Field : a Report from the Research Committee of the Institution. Pp. 20. (London : Institution of Electrical Engineers, 1947.) 1*s*. Also *J. Inst. Elect. Eng.*, 94, Pt. 1, 502 (Nov. 1947).

Such a conclusion emphasizes the duty of all in industry, research establishments or universities who have the opportunity of discovering real research ability to be vigilant for its occurrence and assiduous in its nurture.

J. GREIG

THE BRITISH COUNCIL

ANNUAL REPORT

THE annual report of the British Council for the year ended March 31, 1947, only became available a short time ago. The report itself is preceded by an introductory re-statement of the general aims, duties and organisation of the Council, which indicates concisely but lucidly the place of the Council in explaining British cultural achievements and the background of social life, and also the broad grounds on which a grant-in-aid of about three million pounds a year is justified. Referring to the widespread demand for teaching the English language created by the War, the report records the Council's decision in principle not to engage in the direct teaching of elementary English, but to assist, in conjunction with the ministry of education of the country concerned, in improving the standard of teaching of the English language. Concluding that too much effort had in the past been concentrated on the intelligentsia and on the capital cities of foreign countries, the Council also made every effort during the year to widen its influence through contacts with workers' educational movements and with study groups in smaller towns, and it is planned to provide a number of short-term bursaries to enable trade unionists, artisans and apprentices to visit Great Britain to meet their fellows and study the conditions of work in factories, etc. At the invitation of the Commonwealth authorities, a centre was established in Australia during the year, an experiment which has been an unqualified success.

During the year, 248 new scholarships, including three senior fellowships, were awarded as compared with 307 in 1945–46, and 190 scholarships were extended. In addition, nearly two hundred private students were assisted by the Council to secure places at British universities; and vacation courses for overseas students were held at St. Andrews, Oxford and Queen Mary College, London, the last being a specialized course on high-voltage engineering. Lecture tours organised numbered 97 in 28 countries, as against 70 in 1945–46. Thirty-seven new brochures, revised editions and reprints were issued during the year, the series generally in most demand in Europe being *British Life and Thought*, *Science in Britain* and *The Arts in Britain*; in the Balkans, the Middle East, Africa and South America, *Britain Advances* and *British People* are more in demand. The Council's work in the field of copyright has now been transferred to the Central Office of Information, but the year was marked by the founding of Council libraries in many European countries and their consolidation in others. Collaboration with the Information Services of the Foreign Office towards pooling resources in joint libraries, functioning both as special reference centres on current British affairs and as Council libraries, is designed to prevent overlapping. Large exchanges of books took place with the U.S.S.R. through the Lenin Library at Moscow, and universities and other centres of Russian studies in Britain have thus received valuable material. In the Colonies, the Council is concerned mainly with assisting the development of library services generally. Two small exhibitions of scientific and medical books were sent to Norway, and an exhibition, with extensive technical and medical sections, toured widely in Switzerland, while one of scientific and technical books was shown in Brussels, Antwerp, Liège, Ghent and Louvain. Some 1,800 periodicals, covering all branches of the humanities, science, medicine and technology, were made available in 1,168 centres in eighty-five countries; and exchanges totalled 3,476, involving 791 foreign and 765 British periodicals, including 77 British Commonwealth publications. Indexes and contents lists for the war years of sixty specialist periodicals were microfilmed and 25 copies of the film distributed to Austria, Belgium, China, Czechoslovakia, Denmark, Finland, France, Greece, Netherlands, Hungary, Italy, Norway, Poland and Yugoslavia, while in Europe 67 universities and specialist libraries in 15 countries were supplied with British periodicals by presentation or exchange.

Scientific workers form a large proportion of British Council visitors to Great Britain and of lecturers sponsored overseas by the Council. In collaboration with the Scientific Instrument Manufacturers' Association, under the auspices of the Academy of Engineering Science and the Swedish Association of Technical Physics, an exhibition of scientific instruments was organised in Stockholm in May–June, 1946. Assistance was given to the expedition planning to survey a large freshwater lake in Venezuela, and arrangements have been made for the exchange of biological specimens between Brazil and various museums and laboratories in Britain. Many countries have used the Science Department for effecting exchanges of material, and the Department has advised on scientific appointments overseas, scientific films and film strips and on the publication of *Science in Britain*. Production of *Science Comment* was suspended in September 1946 as it had become partly absorbed in the modified *Monthly Science News*.

The fourth volume of *British Medical Bulletin*, produced during the year in Spanish and French editions as well, has been placed on a sales basis in countries where currency and other regulations permit, and free distribution is being reduced to a minimum. Medical periodicals received by the Library from other countries, mainly in exchange for the *British Medical Bulletin*, now number more than 650, and all important British medical books as well as many foreign ones are now received for review in the *Bulletin*. The Medical Department also handled an increasing number of inquiries, mainly bibliographical, and supplied many reprints and Photostat copies of articles in response to requests from abroad. Advice was given on questions of technical education and postgraduate training in Britain to 93 overseas studies from thirty countries, ranging over some twenty branches of engineering and science, and advice was also given on numerous agricultural subjects.

PLANT VIRUS DISEASES

FOUR recent papers from the Rothamsted Experimental Station contribute to our knowledge of virus in the pure state and in the infected cell, and also to etiology. E. M. Crook and F. M. L. Sheffield (*Brit. J. Exp. Path.*, **27**, 328; 1946) have examined purified tobacco mosaic virus under the electron microscope. Particles from the slowly sedimenting fraction are almost spherical; but as the sedimentation-rate increases, particle-length increases. Treatment with phosphate and varying conditions of storage further affect the state of aggregation. Potato virus X also has particles of variable length.

N. W. Pirie (Cold Spring Harbor Symposia on Quantitative Biology, **11**, 184) discusses the state of viruses in the infected cell. In a fully documented account, he examines the possibilities that (*a*) the virus particle may form a complex with components of normal tissue, and (*b*) properties of the virus might be altered by the process of isolation. There must also be virus in a 'free' state, and it may be the properties of this phase which have hitherto been assessed. The influence of light intensity on the susceptibility of plants to certain virus diseases has been investigated by F. C. Bawden and F. M. Roberts (*Ann. App. Biol.*, **34**, No. 2, 286; May 1947). Reduction of summer light-intensity to one third increased their susceptibility to infection with tobacco necrosis, tomato bushy stunt, tobacco mosaic and tobacco aucuba mosaic. Shading increased the number of local lesions and the amount of virus in extracted sap and also of systemically infected leaves. Virus from leaves grown in reduced light is also superior for purification studies. The virus of tobacco necrosis has been found by F. C. Bawden and B. Kassanis (*Ann. App. Biol.*, **34**, No. 1, 127; Feb. 1947) to enter plants of *Primula obconica* and to multiply locally; most of the tissues are free from virus. This is in contrast to the systemic infection by most viruses.

I. W. Selman, reporting work at the Cheshunt Experiment Station, has also found (*J. Pom. and Hort. Sci.*, **22**, Nos. 3 and 4, 226; Dec. 1946) that tobacco and yellow mosaic viruses may, under certain conditions, become localized in developing fruits of the tomato for an indefinite period, without the virus infection being completely systemic. The same author has studied the effect of seven different base fertilizer treatments and two levels of watering on resistance of fruiting tomato plants to infection with yellow mosaic (*J. Pom. and Hort. Sci.*, **23**, Nos. 1 and 2, 71; Sept. 1947). Varying the manures had no effect, but over-watering decreased the resistance of plants to systemic invasion by the virus. On the dry border, however, the best result was obtained in one experiment in which only five plants developed systemic infection out of sixteen inoculated. Little critical work has been done on the general question of the growth of a plant in relation to virus infection, but a useful survey of the literature, still by the same author (*ibid.*, *J. Pom. and Hort. Sci.*, **23**, Nos. 1 and 2, 50; Sept. 1947), indicates that studies on these lines may lead to useful control of viruses in practice.

Bulletin 196, Council for Scientific and Industrial Research of Australia (Melbourne, 1946), by J. G. Bald, D. O. Norris and G. A. H. Helson, deals with aphid populations, resistance and tolerance of potato varieties to leaf roll. The aphids *Myzus persicæ* and *Macrosiphum gei* were studied as vectors. There were indications that the stage of development of the potato plant influenced the preferences of both species of aphid. Indeed, the latter species had no preference for diseased Up-to-Date potato plants if leaf-roll had caused severe stunting. Several varieties of potato have been evaluated for their tolerance or susceptibility to leaf roll, but the degree of tolerance is not always reflected in yield.

EDUCATION IN GUATEMALA

IN 1943 the U.S. Office of Education undertook the preparation of a series of basic studies on education in a number of Central and South American countries under the sponsorship of the Interdepartmental Committee on Scientific and Cultural Co-operation. The studies were begun to promote understanding of educational conditions in the American countries and to encourage co-operation in the field of inter-American education. "Education in Guatemala" is based on data gathered by Cameron D. Ebaugh in 1944 and 1945 and supplemented since by documentary study. Published in 1947, exactly a hundred years after Guatemala became a republic, this well-documented account of the state of education in the second largest and most populous of the Central American republics shows how the original method of education by religious indoctrination to limited numbers is now slowly giving way to a system of liberal education for all (Washington, D.C.: Gov. Printing Office).

Instruction by religious orders on organised lines was begun many centuries ago, and a *colegio* to offer education at the secondary school level was founded by a religious order so long ago as 1573. Schools of this type were generally open to the sons of peninsular and, later, of American-born Spaniards, the native Indians seldom being granted admission. In 1676 a university was authorized by royal mandate for the teaching of theology, law and medicine and the conferring of the degrees of bachelor, master, licentiate and doctor. The new institution was given the same scholastic standing as the University of Mexico and in 1875 became the National University of Guatemala; in 1945 it was made autonomous and its name was changed to the Universidad de San Carlos de Guatemala. To-day it is regarded as the most advanced and popular institution of higher learning in Central America.

Education in Guatemala continued largely in the hands of the church until the revolution of 1871. In that year, education was declared the right of all citizens, regardless of caste, creed, age or sex. Many elementary schools and a number of secondary schools were founded by the Government, many of them in former convents. Lay teachers were appointed and curricula devised on lines closely similar to those of Western European Countries. In 1875 the Organic Law of Public Education made public elementary education universal and uniform in organisation, administration and supervision. From that time Guatemala has provided compulsory, free and non-secular instruction at the elementary school level. Because of the lack of school buildings and teachers, however, compulsory education has not been widely enforced. To-day, of the population of 3,407,444, about 70 per cent are still illiterate. As in other Latin American republics, education in Guatemala is highly centralized and administration, organisation and supervision are controlled through the Ministry of Public Education in Guatemala City; the University of San Carlos is alone autonomous.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, June 14

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting.

Physical Society, Low-Temperature Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. C. S. Collins: "Expansion Engines for Helium Liquefaction and Oxygen Production".

Monday, June 14—Saturday, June 19

South-Eastern Union of Scientific Societies (in the Town Hall, Great Yarmouth).—Fifty-second Annual Congress.

Tuesday, June 15

At 8 p.m.—Mrs. Jacquetta Hawkes: "Archæology and the Present" (Presidential Address).

Tuesday, June 15

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. C. E. V. Leser: "Industrial Productivity in England and Scotland".

Wednesday, June 16

Geological Society (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Philip H. Kuenen: "Slumping in the Carboniferous Rocks of Pembrokeshire"; Prof. Alan Wood: "The Structure of the Wall of the Test in the Foraminifera".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Capt. C. E. N. Frankcom: "The Operation of Ocean Weather Ships"; Discussion on "Optical Properties of the Atmosphere" (to be opened by Mr. James Paton).

Wednesday, June 16—Friday, June 18

Illuminating Engineering Society (at the Royal Hall, Harrogate).—Summer Meeting.

Thursday, June 17

Royal Society (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "Analogues of Growth Factors in relation to Antibiotics" (to be opened by Sir Paul Fildes, F.R.S.).

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Jack Spalding: "Impressions of Mining Practice in North America".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. L. S. Bosanquet, Mr. A. E. Ingham, F.R.S., and Prof. E. C. Titchmarsh, F.R.S.: "Some Aspects of the Work of G. H. Hardy".

Institute of Sociology (at Kingsway Hall, Kingsway, London, W.C.2), at 5.30 p.m.—Mr. Leslie Paul: "Personalism and Humanism"; Mr. Gordon Rattray Taylor: "The Nature of an Organic Society".

University of London (in the Senate House, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. H. A. Innis: "The Press—a Neglected Factor in Economic Development since 1900" (Stamp Memorial Lecture).*

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Annual General Meeting; Prof. M. Erfan: "Pulmonary Bilharziasis".

Friday, June 18

Institute of Navigation (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.30 p.m.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Technical Authors under the Ministry of Supply for the preparation of technical publications on aircraft and associated equipment used by the Royal Air Force and Royal Navy—The Ministry of Labour and National Service, London Appointments Office, 1–6 Tavistock Square, London, W.C.1, quoting K.U.261 (June 19).

Junior Laboratory Assistant (female) for animal work—The Head of the Nutrition Department, College of the Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1 (June 19).

Chair of Philosophy in the Natal University College, Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (June 20).

Lecturer in Philosophy—The Registrar, University College, Southampton (June 22).

Gas Light and Coke Company Research Fellowship in Gaseous Fuel and Combustion—The Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (June 24).

Lecturer in Taxonomic Botany—The Secretary, The University, Edmund Street, Birmingham 3 (June 26).

Sewage Research Chemist—The Town Clerk, Town Hall, Bradord (June 26).

Chair of Veterinary Pathology—The Registrar, The University, Liverpool (June 28).

Lecturers in Physical Chemistry, Pure Mathematics, Botany, Agricultural Chemistry, and Agricultural Zoology, at the Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (June 30).

Lecturer and a Junior Lecturer in Mechanical Engineering, and a Lecturer in Pure Mathematics, at the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (June 30).

Dewar Research Fellowship tenable in the Davy Faraday Research Laboratory—The General Secretary, Royal Institution, 21 Albemarle Street, London, W.1 (June 30).

Head of the Sheep Section of the Department of Applied Nutrition—The Secretary, Rowett Research Institute, Bucksburn, Aberdeen (June 30).

Senior Entomologist, and Junior Entomologists (2), in the Department of Agriculture and Lands, Government of Southern Rhodesia—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (June 30).

Engineer (Experimental Officer or Senior Experimental Officer), a Physicist (Experimental Officer), and a Physicist (Assistant Experimental Officer), at the Chemical Defence Experimental Establishment, Ministry of Supply, for work in connexion with insecticide research and development—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (June 30).

Readership in Bacteriology at Guy's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 5).

Research Officer (Cement and Ceramics) in the Division of Industrial Chemistry, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1524 (July 5).

Lecturer in Surveying to work under the direction of the Professor of Surveying and Photogrammetry—The Secretary, University College, Gower Street, London, W.C.1 (July 23).

Professor and Head of the Department of Aeronautical Engineering, and a Professor and Head of the Department of Internal Combustion Engineering, in the Indian Institute of Science, Bangalore—The High Commissioner for India, India House Aldwych, London, W.C.2 (Bangalore, July 31).

Metallurgists (*a*) to undertake research and development on problems concerning the properties and treatments of steels, (*b*) to investigate problems concerning the applications of steels; Chemists and Assistants (Ref. 'Corrosion') for the development of methods of combating the corrosion of iron and steel; and a Physical Chemist (Ref. 'Steel Making') to study problems in connexion with the physical chemistry of steel-making—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting the appropriate Reference.

Assistant Lecturer in Mathematics—The Registrar, University College, Nottingham.

Laboratory Assistant (male or female) to work in a metallurgical research laboratory—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Metallurgical Laboratory'.

Lecturer in the Department of Electrical Engineering and Physics—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

Research Chemist—The Director of Research, Research Association of British Flour-Millers, Cereals Research Station, St. Albans.

Senior Technological Chemist, Junior Research Chemists, a Junior Research Physicist, and a Junior Graduate in Physics, Engineering or Chemistry—The Director of Research, British Leather Manufacturers' Research Association, 1–6 Nelson Square, London, S.E.1.

Laboratory Assistant (Grade II) for Physiology Department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Senior Technician in charge of special Histological Laboratory, National Hospital—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

Chief Engineer, an Electrical Engineer, and a Chemical Engineer, in the Pakistan Ordnance Department—The Army Technical Liaison Officer, High Commissioner for Pakistan, 16 Fitzhardinge Street, London, W.1.

Geologist on the Geological Survey of the Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Geologist'.

Field Overseer in a Research Unit proceeding to Mauritius to undertake a large-scale mosquito eradication experiment using D.D.T. and B.H.C. insecticides—The Under-Secretary of State, Colonial Office (Research Department), Palace Chambers, Bridge Street London, S.W.1.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Committee of Privy Council for Medical Research. Medical Research in War. Report of the Medical Research Council for the Years 1939–45. (Cmd. 7335.) Pp. 455. (London: H.M. Stationery Office, 1948.) 7*s*. 6*d*. net. [35

British Intelligence Objectives Sub-Committee. Overall Report, No. 4: The Glass Industry of Germany during the Period 1939–1945. By Prof. H. Moore. Pp. 12. (London: H.M. Stationery Office, 1948.) 4*d*. net. [45

Other Countries

Institut de France: Académie des Sciences. Annuaire pour 1948. (No. 31.) Pp. 236. (Paris: Libr. Gauthier-Villars, 1948.) [35

Publications scientifiques et techniques du Ministère de l'Air. No. 209: Sur les vibrations de certains systèmes élastiques dans un champ sonore. Par Dr. Théodore Vogel. Pp. iv + 80. (Paris: Service de Documentation et d'Information technique, 1948.) 220 francs. [35

NATURE

No. 4103 SATURDAY, JUNE 19, 1948 Vol. 161

CONTENTS

Page
Education and Colonial Development 947
Approaches to Sociology. By Prof. D. W. Brogan 950
Solar and Terrestrial Relationships. By Dr. M. A. Ellison . . 951
Fisherman and Nature Lover. By Seton Gordon, C.B.E. . . . 951
Microwave Electronic Valves. By Prof. J. T. Randall, F.R.S. . . 952
Internal Secretion. By Dr. F. H. A. Marshall, F.R.S. . . . 953
A Technique for Mechanical Vibration Problems. By Prof. W. G. Bickley 954
College Physics. By S. Weintroub 954
The Role of Chemistry in Combating Tropical Diseases. By Sir Ian Heilbron, F.R.S. 956
The Health of the School Child. By Dr. Robert Sutherland . . 960
Industrial Fibres 961
Obituaries :
  Prof. F. A. A. Lacroix. By Dr. W. Campbell Smith . . . 962
  Dr. E. P. Harrison 963
News and Views 963
Letters to the Editors :
  Anomalous Effects in Ionospheric Absorption.—Sir Edward Appleton, G.B.E., K.C.B., F.R.S., W. J. G. Beynon and W. R. Piggott 967
  Theory of Superconductivity.—Prof. Max Born, F.R.S., and Kai Chia Cheng 968
  An Anomaly in Electromagnetic Theory.—Prof. E. G. Cullwick . 969
  Development of the Spark Discharge.—Dr. T. E. Allibone, F.R.S. 970
  Low-Frequency Noise from Thermionic Valves Working under Amplifying Conditions.—Dr. E. J. Harris and P. O. Bishop . 971
  A Correlation between Molecular Vibrations and Bond-forming Orbitals.—Dr. J. W. Linnett and P. J. Wheatley . . . 971
  Electrical Resistivity of Alkali Metals Below 20° K.—Dr. D. K. C. MacDonald and Dr. K. Mendelssohn 972
  A Simple Way of Photographing Spectra.—Dr. R. A. Houstoun 973
  Differential Effect of 2-Benzoylbenzoic Acid and its Derivatives upon Plant Species.—Dr. W. A. Sexton and Dr. W. G. Templeman 974
  An Improved Method for the Assay of Toxicity of Arsenicals.—W. L. M. Perry 975
  Reaction of β-Naphthol with l-α- and l-β-Phellandrene.—G. G. Acheson and Dr. T. F. West 976
  Inhibition of Hexosediphosphatase by Sulphhydryl Reagents and by Ascorbic Acid.—Dr. E. O'F. Walsh and Mrs. G. Walsh . 976
  Influence of Folliculin on Bone Metabolism, Studied by Means of Radiophosphorus, $^{32}_{15}$P.—Dr. J. Govaerts and Prof. M. J. Dallemagne 977
  Sublittoral Seaweed Survey : Relationship of Algal Growth and Depth.—F. T. Walker 977
  Transplantation of Fertilized Rabbit Ova : the Effect on Viability of Age, *in vitro* Storage Period, and Storage Temperature.—Dr. Min-Chueh Chang 978
  Hearing in Cetacea.—Robert Clarke 979
  A Plant Disease Caused by a Spore-forming Bacterium under Natural Conditions.—Miss Z. Volcani and Dr. W. J. Dowson 980
B_T, a New Vitamin of the B-Group and its Relation to the Folic Acid Group, and Other Anti-Anæmia Factors. By Dr. G. Fraenkel, with the assistance of M. Blewett and M. Coles 981
Agro-Climatic Analogues. By G. Melvyn Howe 983
South African Museums Association : Annual General Meeting. By J. R. Harding 984
The Imperial Institute 985
The Fisheries School at Cronulla, New South Wales. By G. A. Steven 986
Bottom Deposits of Lake Windermere in Relation to the Quaternary History of the British Isles. By Dr. H. G. Baker 987
The Norwegian Polar Institute 987

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EDUCATION AND COLONIAL DEVELOPMENT

A LONG series of reports on almost every aspect of welfare in the British Colonial Empire, quite apart from the quiet but increasing work of the Colonial Research Committee, the Colonial Products Research Committee and other committees concerned with Colonial research in different fields, and more recently of the Colonial Primary Products Committee, have brought many scientific men into close touch with the particular economic, social, scientific and technical problems of these great areas. In the last ten years there have been important general surveys of nutrition, higher education, labour conditions, development and welfare; and also studies in more limited fields such as cocoa control in West Africa, West African oils and oilseeds, the groundnuts scheme in East and Central Africa, the advancement of Africans in industry, and the relation of the game reserves to the slaughter of game, with all of which the man of science is more or less directly concerned. Quite recently, it has been announced that medical specialists from a panel of eighteen will each visit Africa twice in the next six years, and if the experiment, which is being financed by the Nuffield Foundation, is successful, it may be extended to other territories.

Precedent for this unofficial contact is to be found in an earlier visit of university representatives to Nigeria, under the same ægis, or again in Service medicine during the War; scientific workers who have had personal contact or experience with any of these developments may well have been impressed with the way in which Great Britain is facing its responsibilities under the Colonial Development and Welfare Act. Mr. Marquand's recent tour of the East African Colonies is further evidence of the keen interest of the Government in Colonial welfare and development, and of the sincerity of the desire to promote self-government as well as a high standard of living in the British Colonial Empire.

It should not be necessary to do more here than mention the immense potentialities which science itself holds for the promotion of welfare in the Colonies, by the control of or even elimination of disease, the raising of nutrition standards, the improvement of agriculture and production, either by the introduction of more efficient methods or the control of pests of plants or animals, or by extending man's command over natural resources by irrigation and like methods.

Some of the recent advances in such fields promise really spectacular developments in the control or elimination of tsetse fly and other pests, with most valuable results from the point of view of health and economics alike. Nevertheless, even the man of science responsible for such advances can scarcely fail to note the signs of widespread discontent with existing conditions. The disorders which occurred in the Gold Coast early in March and arose out of the serious increase in the cost of living in West Africa, and the evidence of fundamental discontent among the intellectuals in the West Indies which finds violent and extreme expression in the report for 1942–43 of Dr. T. P. Achong, the Mayor of Port-of-Spain, Trinidad, are symptoms of a cynicism and disbelief in British policy and intentions which cannot wisely be disregarded. Inevitably they raise questions about the functioning of democracy among the Colonial peoples, and how best these peoples are to be fitted for self-government.

The contemporary review of British, United States, French and Dutch policy and practice in their Caribbean possessions which Paul Blanshard has written under the title "Democracy and Empire in the Caribbean"* is of interest from that point of view. The picture of the British West Indies as seen through American eyes is instructive, if sometimes a little crude, unimaginative and intolerant; but the comparative appreciation of the practice of the four Colonial Governments is fairer than some of his criticism, and beyond that he displays plainly the fundamental aspects of the situation in the Caribbean. This book makes very clear the background against which the Colonial research committees have to work, and in particular the limits which economic, social and political factors set to the work of the Caribbean Research Council.

Many will think that Mr. Blanshard takes too pessimistic a view of the prospects of regionalism and of the future of the Caribbean Commission; some of his criticism leads naturally to such pessimism. None the less, his forecast of the future may well be near the mark, for in it he seems to shed some of his prejudices. He believes that for most of the Caribbean colonies, independence is undesirable and undesired by the people themselves; but he urges that the first step in political progress is to make all legislatives genuinely democratic, and that next the governors should be elected by the people or their elected representatives. He admits, indeed, that in some areas the people are obviously unready for this step, and that when it is taken safeguards will be required for the standards of the Civil Service; clearly his criticism of the present system is not to be taken entirely at its face value.

Next, the colonies of the Caribbean should be fitted into a democratic regional agency with power to co-ordinate and develop the economic life of the area, and serve as a link between the region and world organisation. He would place all these colonies under the Trusteeship Council of the United Nations, giving the Council full power to investigate and report upon all aspects of Colonial administration. Here again he admits that his proposition has no immediate hope of realization, and he further recognizes that all his political proposals demand universal, free and compulsory education for a generation as preliminary preparation for self-government.

In the economic sphere, he says little about the question of nutrition and raising the standard of living, though he recognizes a trend in the area towards increasing social control of economic life and the need to maintain the large-scale plantation system, regardless of the type of land ownership, because of the greater productive efficiency of large operating units. He has little to say about the contribution of science to the social welfare or economic progress of the area, though, surprisingly in view of much of his criticism, he concludes on the note that the Caribbean peoples will remain loyal to the Western democracies, provided that those democracies be worthy of their allegiance.

Mr. Blanshard's book should certainly dispel any complacency with which British rule in the West Indies is regarded, or even the operation of the Colonial Development and Welfare Act. There is, however, a wealth of material against which the objectiveness of his criticism can be tested, and it is to be hoped that his book will stimulate at least some scientific workers to make that effort. What stands out most clearly is the need for much closer and objective study of the working of democratic institutions among the Colonial peoples, and the means by which the idea of true local self-government may best be furthered in terms of the economic, social and cultural as well as political welfare of those peoples.

Mr. Blanshard, although at times excessively caustic in his comments upon governors in the Colonial systems, is not so obsessed with his dislike of that system as to fail to recognize that the strongest indictment of the Colonial Powers in the Caribbean is that for a hundred years after emancipation they did so little to prepare the people for self-government, and that the Caribbean peoples were not given a fair chance to learn democracy by practice. Nevertheless, his survey makes little constructive contribution as to the way in which that problem of education is to be tackled, and for all its merits as a comparative study of different systems and as a guide to the trend of local opinion—in which last a bibliography and some notes and comments on Press articles are useful further aids—his book of three hundred and seventy pages, so far as education is concerned, falls far short of the forty-page report on "Education for Citizenship in Africa" which has come from the Colonial Office Advisory Committee on Education in the Colonies (London: H.M.S.O. Colonial No. 216, 1948. Pp. 40. 9*d.* net). It might be objected that the sub-committee responsible for the report should have included a representative of the Colonial administrators on whom will fall the main burden of providing the appropriate political and economic organisation, and some Africans whose presence might have added to its authority. No such additional representation could well have improved on its statement of general principles, or increased its consciousness of the necessity of preparing not merely Africans but also other Colonial peoples for self-government, and affording them the opportunity for its practice.

Under its terms of reference, the sub-committee was to study the technique needed to prepare people for responsibility, and examine generally the problem of building up a sense of public responsibility, tolerance and objectivity in discussion and practice, and an appreciation of political institutions, their evolution and progress. It was decided, however, to prepare a report which, though taking Colonies outside Africa into consideration so far as possible, should frankly apply principally to Africa, where its members had principally gained their Colonial experience. Speaking of the title of the report, the Committee emphasizes that there is no true education which is not education for citizenship, and that education which does not produce good citizens has not justified its claim to be called education at all. It is in this spirit that the Committee faces the central purpose of British Colonial administration, which has been described by successive Secretaries of State for the Colonies in similar terms, namely, to develop the Colonies and all their resources so as to enable their peoples speedily and substantially to improve their natural resources and, as soon as may be, to attain responsible self-government.

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* Democracy and Empire in the Caribbean: a Contemporary Review. By Paul Blanshard. Pp. xi+379. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 25*s.* net.

Self-government, however, is a much heavier responsibility in the twentieth century than in the eighteenth, and in pointing out that education must aim at fulfilling the special needs created by social and political changes and that with the great variations in culture, in social and economic conditions in the Colonies the path to self-government can scarcely be the same for all, the Committee affirms its belief in the soundness of the principle, which has guided British Colonial education policy in the past, that education to be effective must be based partly at least on local conditions. Not only must it take account of cultural differences; it must equally seek to present to the Colonial peoples Western civilization at its best side. The Western world should place its political experience of democracy and its conception of democratic government at the disposal of the Colonial peoples without any reserve. It will be for them to make what use they think fit of this experience. We must remember that democracy is not merely a matter of political institutions but of the spirit in which they are worked; democracy must arise from within, though it may be helped or hindered from without, and it can only be judged by being seen in action.

It is in dealing with the difficulties that exist in the path of the Colonial peoples who are endeavouring to advance towards full citizenship of the modern world that the report is so much more realistic than Mr. Blanshard's book. There is no less sympathy with, or understanding of, the aspirations of nationalism; but the disintegrating influence of Western civilization is more fully appreciated. The prerequisites of democracy are clearly stated: a profound belief in the value of the individual, and with it a general feeling of confidence in one's fellow citizens; the intellectual equipment—not merely informed minds, but minds capable of straight thinking and not to be deceived by the demagogue; and a political and economic organisation which permits such spiritual and intellectual qualities to flourish.

Much of the report is occupied by detailed recommendations, throughout which runs one main principle already adumbrated: you cannot educate people for citizenship unless you give them the chance of exercising their citizenship. For this reason the Committee urges that every opportunity should be taken of entering into full and frank discussion with the Colonial peoples while policy is still only half-formed and even if no formal organisation exists for such discussions. The importance is emphasized of bringing together around the council table the young educated men and the traditional elders; and that any tendency to restrict discussion on the plea that the people are not yet able to understand the questions involved is shirking the task of education for citizenship.

The report urges in conclusion that the task is too great to be left to one section only of the Government organisation, or of the European or educated Colonial public. The task is so large and urgent that the help of everyone will be needed, and in one section of the detailed recommendations, dealing with the teaching of science, the Committee shows how the man of science can help. It suggests the study of science from the historical point of view, with a background of its social implications and an indication of the indirect contribution to education for citizenship which training in science in this way can make. No constructive educational policy can ignore the dangers of producing a class of men of mainly academic training larger than can find a useful place in the body politic, and of neglecting the improvement of craftsmanship. One sound reason for welcoming such developments as the groundnuts scheme in East Africa is the increased outlet it might afford for African craftsmen and technicians; and for that reason alone the unexpected difficulties and greater cost of the scheme should not be allowed to exert undue influence. Similarly, while we may welcome wholeheartedly the recent recommendation for an institution of full university standing in Malaya, neither there nor in the West Indies nor in Africa should it be forgotten that with economic and industrial and educational development must go a careful study of the social-psychological factors which underly the rising tide of nationalism and have provoked the disorders on the Gold Coast and elsewhere. The full inquiry already promised into the Gold Coast riots, for example, should establish the facts; but something more is needed. Fundamental research into the real causes of Colonial discontents is a matter of the greatest urgency, not merely to point the way to appropriate remedial measures, but also to assist in the adjustment of our own attitude to the Colonial peoples. Collaboration with other peoples is imperative not only for the development and welfare of those peoples, but also to enable them to make that contribution to the welfare of mankind at which Mr. Bevin hinted in a memorable speech early this year; and collaboration involves mutual understanding and trust. The proposal for the establishment of a University of Malaya is much more than a further token of our goodwill and of our determination to build a noble structure of higher education in the Colonies. It is equally important as one more step towards the provision of institutions where fundamental research can be prosecuted, and where the Colonial peoples may learn the technique of research in many fields where it is so urgently required. In that way and in co-operation with their Western teachers they may make their own distinctive contribution in advancing knowledge, and also gain the vision and wisdom which will increasingly fit them for the searching responsibilities of full self-government.

APPROACHES TO SOCIOLOGY

From Max Weber

Essays in Sociology, translated, edited and with an Introduction by H. H. Gerth and C. Wright Mills. (International Library of Sociology and Social Reconstruction.) Pp. xi + 490. (London: Kegan Paul and Co., Ltd., 1947.) 21*s.* net.

The Analysis of Political Behaviour

An Empirical Approach. By Harold D. Lasswell. (International Library of Sociology and Social Reconstruction.) Pp. ix + 309. (London: Kegan Paul and Co., Ltd., 1948.) 21*s.* net.

MAX WEBER was no believer in mystical doctrines of national genius, but he did believe that given societies had their own way of noticing, defining, and solving problems. There was, for example, a British way of approaching physics that differed from the Continental way. This truth is admirably illustrated by these two important new volumes in the "International Library of Sociology". It is not a simple contrast between the German academic temperament and training and the American. Max Weber was, in many ways, *anima naturaliter Americana*. But as a German professor and a German citizen deeply and justly concerned for the present and future of his country, he was bound to deal with different problems than those which rightly concern and interest Prof. Lasswell; and if the publication of these books had no other justification, it would have this, that the two books illustrate this difference of approach and of method.

Max Weber's fame in Britain is mainly due to his "Protestant Ethic", and however much that famous essay may be criticized, it did illustrate an important truth, that there is not, in the nineteenth-century sense of the word, a political or economic 'religion of all sensible men' that has only to be set out to be accepted. The uniqueness of the European economic and scientific achievement was bound up in some form with the 'configuration of institutions'—and of ideas caused by and causing the configuration. It has reasonably been objected that Max Weber simplified his problems, produced too neat contrasts; but he did sow an idea that has had its fruitful crop.

In this collection, naturally, attention has mainly been directed to those parts of Weber's very varied contributions to our knowledge of society that have not been already translated, and it might be said that the reader coming to Max Weber for the first time might do well to read Prof. Talcott Parsons' introduction to "The Theory of Social and Economic Organization" (that is, the recent translation of Part I of "Wirtschaft und Gesellschaft"). But the choice of themes has been judicious and it gives the flavour as well as the weight of Weber's work. For this reason it is probably worth having the essays on the Chinese *literati* and the Indian caste system, though they are not novel or particularly enlightening to-day.

The main themes of these selections are centred around power in its various forms, economic, political and intellectual, and around organisations of power—feudalism, bureaucracy, churches, universities. Contemplating the problems of power, Weber was repelled by two fashionable German doctrines, simple Marxism and the great national superstition of belief in the expert. Marxism repelled him much less than the ignorant and dangerous complacency of the German officers, officials, professors. Professing to be an aristocracy, they were complacent and, in the field of general politics, highly incompetent *dilettanti*. Weber was fascinated by America, to which he went with a far more open mind than did most Europeans, above all than did most Germans. He held the view, not as a paradox but as a saving truth—if only he could get it accepted—that Tammany Hall was a more valuable political institution than the German bureaucracy with its flippant monarchical top-structure and its pedantic, complacent and deeply maladjusted professorial allies and apologists. Few political essays written in a time of crisis read better, a generation later, than "Politics as a Vocation", a sermon in the Munich that knew Kurt Eisner and was about to house Hitler; and the prophecy of the coming of the "charismatic leader" is almost awe-inspiring. Of almost equal interest, though calling for less remarkable powers, is the essay on German universities; and the two taken together explain a great deal about the fate of the Weimar Republic—and the present problems of German rehabilitation.

When we turn to Prof. Lasswell we are conscious of a drier light and a cooler ambition. Prof. Lasswell takes for granted the democratic premise that the object of a democratic society is "the realization of human dignity in a commonwealth of mutual deference". That society will be more easily attained and maintained if we think hard about what we are aiming at and import as much controllable knowledge into our policy-making as is humanly possible. There are many dangers which face American (or any other) democratic society; but Prof. Lasswell is mainly concerned with two. One is the degree to which a society abolishes or encourages "skill blockades", impedes the ability of the individual to contribute to society and to acquire the resources to contribute. All existing societies impede, unnecessarily, such contributions, by financial, racial, dogmatic, political barriers; all are obstacles to the "open society" (to borrow Prof. Popper's useful term). The most interesting example of Prof. Lasswell's analysis of such problems is to be found in his proposals for the reform of American legal education. In no free country do lawyers play so great a part as they do in America. It is not only that constitutional law gives the courts and so the lawyers an importance to which there is no European parallel, but (possibly for reasons that would have interested Max Weber) the lawyer has had his prestige and field of functions greatly extended. So the curriculum of the great law schools is of the utmost importance and the criticism of it made here is very enlightening. Critics of the preliminary training of British Civil Servants or advocates of increasing the number of administrators who are trained scientists might well ponder, in an English context, Prof. Lasswell's questions and answers.

Both these books are so timely that it is perhaps unkind to end on a note of criticism. The translators of Max Weber have excellent principles and nothing could make him easy to read. But too often he has been translated into a language that is almost as near German as it is English or American, and this holds up the reader and may put him off. D. W. BROGAN

SOLAR AND TERRESTRIAL RELATIONSHIPS

Sunspots in Action

By Dr. Harlan True Stetson. Pp. xiv+252. (New York: Ronald Press Co., 1947.) 3.50 dollars.

THE time is surely ripe for the appearance of an authoritative popular work dealing with the fascinating topic of sun–earth relationships. If Dr. Stetson's book fails to qualify for acceptance in this category, it may well be because he devotes too much space to what is uncertain and speculative, while giving too little attention to those relationships which are clear and unassailable.

The amplitude of the 'daily variations' in the terrestrial magnetic elements has shown a close correspondence with the Zurich sunspot numbers over more than a century. Both variables are capable of precise measurement, and an examination of Fig. 13 in Dr. Stetson's book will show that the correlation between them is of the closest kind. At rare intervals also there occur very violent fluctuations of the magnetic elements, known as 'magnetic storms'. Maunder, of Greenwich, showed, more than forty years ago, that each 'great' magnetic storm coincided in time with the passage of a large sunspot across the sun's central meridian. More precisely, the storm began about thirty hours, on the average, after the central meridian passage of the sunspot. The converse, however, was not true, that the central meridian passage of every large sunspot was followed by a magnetic storm. It remained uncertain whether the corpuscular stream responsible for the storm was emitted continuously from the sunspot region, confined, perhaps, to a narrow radial beam which sometimes missed the earth altogether, or was emitted only intermittently, some of the larger spots being relatively inactive in this respect.

Atmospheric ionization must be attributed in a general way to the action of solar ultra-violet light, with perhaps a small contribution from meteors, and it will therefore reflect in its changes the progression of the spot-cycle. However, with the development of the spectrohelioscope by Hale (1926), chromospheric flares came to be recognized as sudden, short-lived emissions of monochromatic radiation (including enhanced ultra-violet) and having their origin in the vicinity of active sunspot regions. Spectrohelioscope observers, co-operating under the ægis of the International Astronomical Union, rapidly accumulated a large body of facts. These results were discussed by H. W. Newton in an important series of papers, in which he established that each intense (3+) flare was followed by a remarkable train of events. The radiation emitted by the flare is both wave and corpuscular. Simultaneously, with the visual observation of the flare by light of the hydrogen α line, a burst of ultra-violet light reaches the ionosphere, giving rise to: (*a*) the magnetic 'crochet' effect, (*b*) the low-level (*D*-layer) ionization which causes the fade-out for short-wave radio transmissions (Dellinger effect) along sunlit channels of communication. Some twenty-six hours later, with the arrival of the charged corpuscular stream (emitted at the time and place of the flare), the 'sudden commencement' marks the onset of the magnetic storm, with its accompanying radio and visible (auroral) effects. The discussion of the locations on the sun's disk of intense flares preceding magnetic storms makes it clear that the corpuscular stream is confined to a radial beam of semi-vertical angle about 40°.

Thus Maunder's statistical relationship between magnetic storms and the central meridian passages of large sunspots is found to be, in reality, a one-to-one correspondence between storms and intense flares associated with the sunspots near the times of their meridian passages. None of this is made at all clear by Dr. Stetson. Indeed, we find no reference, either in the text or in the bibliography, to the work of Newton, Waldmeier and others on flares, and Maunder is referred to, but in quite a different connexion, as Professor (*sic*) Maunder and in the index as A. S. D. Maunder (which was Mrs. Maunder). The author seems to regard sunspots as the primary phenomenon in all his relationships, whereas most solar physicists would now consider the spots as no more than the visible accompaniments of the much more extensive 'active regions' which are manifest through the occurrence of flares, active prominences, coronal excitations, bursts of radio-noise and in other ways. In Fig. 30 we find an unusual version of Maunder's 'butterfly' diagram, intended to illustrate Spoerer's law of the progression in latitude of sunspots with the eleven-year cycle. In the absence of a description of how the diagram was plotted, the reader will naturally conclude that there are *three* distinct belts of spots, instead of only one, on each side of the solar equator, and that each progresses independently towards lower latitudes as the cycle proceeds.

In the first six chapters the reader will enjoy very entertaining and lucid accounts of such subjects as the origin of solar energy, the measurement of the solar 'constant', the conditions in the ionosphere and the means by which radio-waves are propagated round the globe. There is also an admirable description of ionospheric sounding by the method of 'critical frequencies'. It is clear that Dr. Stetson is much more at home on the radio side.

In later sections the author summarizes much that has been written in an endeavour to relate the sunspot cycle to such matters as the growth of trees, world weather, economic cycles and human health, and he makes a plea for the further study of what he calls 'cosmecology', that is, the relationship of the earth to its cosmic environment. It is in these spheres, where we are no longer dealing with variables capable of accurate measurement, that knowledge becomes vague and a prey to opinion.

M. A. ELLISON

FISHERMAN AND NATURE LOVER

A River Never Sleeps

By Roderick Haig-Brown. Pp. 320. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 12*s*. 6*d*. net.

NO writer has written so vividly of fishing since Lord Grey of Fallodon. Roderick Haig-Brown's book has the rare combination of good prose written by a man who is a master of the subject on which he writes.

The book is divided into twelve chapters, under the twelve months of the year, and the author describes fishing experiences, both in Great Britain and in British Columbia, where he now lives. He is a skilled fisherman, but he is modest in describing his exploits. He is able to write with so great a vividness that the scene at once is brought before the mind of the reader. Take his description of the death of the Pacific salmon after spawning. This is one of the most strange, even inexplicable, tragedies in the world of Nature. Of the millions of Pacific salmon which enter the rivers to spawn, not one returns to the sea. It is strange, as the author says, that they should all die, not one escape, and strangest of all that the change should be from fullest life to death, with no intermission of growing weakness between. The act of spawning, both in the female and the male, soon brings death, grim and inevitable. The following description (p. 276) of the drama may give an idea of the author's clear and arresting prose: "The will to live continues after spawning. It would be reasonable to expect a resignation to the inevitable, but there is none. A spawned-out fish, almost dead, will turn away from danger in a surge of fear-built strength. I once watched two spawned-out, huge fish, in the shallow water of a long, broken rapid. They showed at first just over the lip of the pool above, dorsal and caudal fins breaking as the current forced them down. They drifted a little way, weakly and awkwardly and then, as though suddenly afraid of death, one threshed its way with furious strength for ten or a dozen yards upstream. The other followed instantly, and for a while they held, side by side again, weaving back and forth until the current caught their sides and swept them down. This happened many times; and each time they were swept down they fought back again, keeping always together but never winning back quite to the place they had left. They swung over at last into an eddy on the far side and seemed to rest there, because I could not see them again. There was a painful sadness in watching, a bleakness in the struggle against death that could gain nothing. . . . It is strange that they should all die, that life should go out with the spawn; for it does go out with the spawn. Age has little to do with it, for even the grilse die."

Yet, as the author points out, not all Atlantic salmon die after spawning. Many of these salmon return to the sea, though a few return again to spawn in the rivers. The restoration of the Atlantic salmon must come within, for there is little feeding in the rivers, yet a 'well-mended kelt' caught in the Scottish rivers in April is sometimes at first glance hard to distinguish from a clean fish. Many of these spawned fish apparently return to the sea in safety, yet very, very few come back to the river to spawn a second time. It is now known that the main feeding area of salmon is in the deep Atlantic. Can it be that the kelts recover their strength, and remain in the deep ocean for the rest of their lives ? Otherwise, what happens to the well-mended kelt ?

On one occasion when Mr. Haig-Brown was fishing, he watched a bear fishing on the farther side of the river; but the bear was less successful than the human angler (who had caught two salmon) and had no luck at all ("He looked sad and lonely and defeated, the more so because he was so big").

In all the author's writing is sympathy and understanding for the wild creatures. I have likened his writing to that of Lord Grey, yet there is one difference—he writes little of the birds of the rivers he has fished.

His story of his black Labrador reminded me of our faithful collie Dileas. She was as enthusiastic in salmon fishing as I was, and when a salmon jumped far out in a pool she would run with great excitement and stand opposite where the fish had showed, but she did not look from the splash to the rod's top, like the Labrador in this book.

Hear (p. 253) what the author has to say about this remarkable dog:

"When we came to the river he would stand beside me if the water was shallow, or sit on the bank as near to my wading as he could get, ears cocked, legs trembling a little. His eyes would follow the line of every cast, watching the drift of a dry fly or the sweep of a wet fly as closely as I did. If I moved my rod point sharply, he would press forward, his whole body trembling; if a fish jumped free in the river he would look from the splash to the rod top and back again in puzzled surprise to the splash. Whenever I hooked a fish he whined a little and followed every move of the fight until the fish was beaten and I sent him in to retrieve, which he always did faultlessly, bringing the fish to hand without a mark on it to show how he had held anything so awkward and slippery. He retrieved hundreds of fish for me, fish of all weights up to ten or twelve pounds, and I never lost one through him."

One of the charms of this outstanding book is that it must appeal not only to the fisherman, but also to the lover of wild Nature—and indeed to anyone who has an eye for good writing. SETON GORDON

MICROWAVE ELECTRONIC VALVES

Klystrons and Microwave Triodes

By Asst. Prof. Donald R. Hamilton, Assoc. Prof. Julian K. Knipp and J. B. Horner Kuper. (Massachusetts Institute of Technology, Radiation Laboratory Series, Vol. 7.) Pp. xiv+533. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 45*s*.

DURING the last year of its existence under the supervision of the National Defense Research Committee, prior to July 1946, the staff of the Radiation Laboratory at the Massachusetts Institute of Technology was chiefly occupied with the writing of twenty-eight large volumes on the scientific principles and techniques of radar: a task which has become known as the "five-foot shelf". The work described in these volumes is, as Prof. Du Bridge says in a foreword, the collective result of work done at many laboratories, Army, Navy, and industrial, both in the United States, in Britain, Canada, and other Dominions. I cannot recall that a task of this magnitude has ever before been undertaken by the staff of a single scientific laboratory. In assessing the achievement, one has to remember that the writing was done at a time when it must have been difficult to show a proper historical sense in relation to the share of other countries and laboratories; the personal and even the national share in any one discovery had often been lost in the tremendous urge to make of radar a decisive weapon of war. Many volumes of the series are still to appear; but all were written before the spate of post-war scientific papers had set in. Some effects of this no doubt deliberate editorial policy can be seen in the volume under review: the index contains very few references to individuals; such references are confined almost entirely to textual footnotes. In a book which devotes many of its pages to the klystron, one is surprised not to find the name Varian in the index. As is usual, scientific progress outstrips the speed of publishing, and reference to the important work at Oxford on the travelling-wave tube is confined to the preface.

Volume 7 deals with the basic principles underlying the operation of klystrons and planar-grid valves (such as the lighthouse and disk-seal types) as oscillators and amplifiers, with special emphasis on fundamental principles rather than descriptive or constructional details. The first four chapters discuss the fundamentals of valve types and function, electronic and circuit phenomena at high-frequencies. Chapters 5–8 are concerned with planar space-charge valves as amplifiers and oscillators and the pulse operation of microwave triodes.

More than half the book (Chapters 9–18) deals with klystrons, and the treatment is comprehensive. There are chapters on velocity modulation and klystron bunching, amplifier klystrons; frequency multiplier and reflex klystron oscillators, load effects, and hysteresis; noise in reflex klystrons; modulation, and practical reflex klystrons.

Chapter 15 on load effects in reflex klystrons is good, and of quite general usefulness apart from its context; the long-line phenomena are discussed in quite a clear way. The British reader, perhaps inevitably, takes exception to occasional Americanisms; this text is singularly free from such defects or jargon. The use of the term 'electronic equivalent' in the sentence "probably the best known type of the external cavity is the 707B or its electronic equivalent, the 2K28" on page 495 is certainly, however, open to objection.

Those who have some acquaintance with the subject-matter of this volume will already be aware that it cannot be presented without a good deal of mathematical background. The volume is well suited to those wishing to make use of klystrons and microwave triodes in a particular field of research. It is not suited, as a whole, to the undergraduate, unless he is fortunate in having an expert to guide him. There are, however, chapters of special value in this connexion; readers whose interest is of a general character would do well to study the relevant portions of the introductory volume to the series, edited by L. N. Ridenour. J. T. Randall

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INTERNAL SECRETION

Textbook of Endocrinology

By Prof. Hans Selye. Pp. xxxii+914. (Montreal: University of Montreal, 1947.) 10.25 dollars.

Prof. Selye's "Textbook of Endocrinology" is probably the most complete account of the subject which has yet appeared, at any rate within the compass of a single volume. It is, however, only a miniature of the much larger "Encyclopædia of Endocrinology" which the author is bringing out in many volumes, six of which have so far been published, but which, it is hoped, will ultimately give a critical survey and a complete guide to the entire endocrinological literature. The present volume begins with an interesting preface by Prof. Houssay, of Buenos Aires, who points out how far we are from the theories which prevailed between 1880 and 1900 and which attributed to the internal secretions the role of neutralizing and destroying the toxic substances arising in intermediate metabolism. Long before that time, however, Berthold definitely promulgated the idea that an organ may exert its influence upon the bodily characters or upon other organs by means of chemical substances secreted internally into the circulating blood. This was in 1849, when he published his experiments upon testicular transplantation in fowls. His work was for many years lost sight of; but his results have been completely confirmed. In the meantime, Claude Bernard employed the term 'internal secretion' to describe the glycogenic function of the liver, because this gland stores up carbohydrate as glycogen and secretes it into the blood as sugar. Brown-Séquard's claims, made in 1889, to have rejuvenated himself as a consequence of injections of testicular extract attracted a great deal of attention, and although they did not stand the test of a later examination and repetition, nevertheless are usually regarded as marking the beginning of the modern science of endocrinology. The term 'internal secretion' is now usually restricted to substances which, after being carried in the blood-stream, promote the secretion of particular glands or the growth of particular tissues on which they have a specific action. Such chemical excitants were named 'hormones' by Starling in 1905. Prof. Selye does well to remind us of the beginnings of a science which in recent years has developed into such a large and important branch of physiology.

In the succeeding chapter, the author describes the chemistry and pharmacology of the steroids. This is a group which contains four sub-divisions of substances of similar chemical constitution and hormonal action, namely, the œstrogens, the androgens, the progesterone-like bodies and the compounds with a 'cortin-like' action. It is interesting to note that any one of these substances may produce not only its own characteristic effects but also some of the effects of those of the other three groups. The author next deals in alphabetical order with all the organs of internal secretion, and the account of these is followed by a chapter on the hormones or hormone-like substances produced by simple endo-exocrine and non-glandular organs, and a final chapter on functional correlations. The pathology of the organs is very fully described, and this is a feature of the book. There are numbers of illustrations and many of these show the effects of endocrine diseases.

In a book of this size, it was inevitable that there should be mistakes, as the author himself remarks; but it is unfortunate for science when an important text-book contains misleading statements about the reproductive processes of common domestic animals, and such as any practical breeder knows to be absurd; for example, the statement that the so-called pre-œstrous bleeding in the dog occurs at the mid-interval between two œstrous periods. Moreover, monœstrous mammals are those with one œstrus in the sexual season, not those with one cycle per annum, as the book states; and again, the diœstrum is not a phase of complete sexual rest but an abbreviated pseudo-pregnancy. There are other similar mistakes; but they must not be regarded as detracting seriously from the value of the work as a whole. In my opinion the book would benefit by giving the references to the more important papers that are quoted, for this is only occasionally done.

F. H. A. Marshall

A TECHNIQUE FOR MECHANICAL VIBRATION PROBLEMS

Mechanical Admittances and their Applications to Oscillation Problems

By Prof. W. J. Duncan. (Ministry of Supply: Aeronautical Research Council, Reports and Memoranda, No. 2000.) Pp. 128. (London: H.M. Stationery Office, 1947.) 22*s*. 6*d*. net.

IN the days when electrical engineering was emerging from physics and when alternating current circuit theory was in its infancy, progress was greatly helped by the fortunate circumstance that the equations to which the new theory led were formally similar to those already encountered in mechanics. Thus Maxwell, in his treatise, devotes a chapter to the dynamical principles and equations of Lagrange and Hamilton, and is at pains to stress the fact that the circuit equations fall within their scope. As it grew, electric circuit theory elaborated concepts, developed techniques, and invented a nomenclature, appropriate to the problems encountered and to their growing complexity. More recently, problems in mechanical vibrations, of increasing complexity, have presented themselves, notably in aeroplane design, and circuit theory has been able to repay with interest the debt it has for so long owed.

The word 'admittance' in the title of this monograph is borrowed from circuit theory, where it signifies, for any branch, relative to a pair of terminals, the ratio of current in the branch to E.M.F. across the terminals. The most obvious analogue of electric current is mechanical *velocity*, but since the interest in mechanical problems is more often focused on *displacement*, the liberty has been taken of altering the significance and of defining 'mechanical admittance' as a ratio of displacement to force—with 'displacement' and 'force' used as in the language of generalized co-ordinates. More immediately descriptive terms would have been 'dynamic flexibility', or a 'dynamic influence coefficient'—expressing the harmonically varying response to a harmonically varying unit stimulus.

The power of the 'admittance' method lies in the ability it confers of expressing rapidly the displacements at chosen key points of a system in terms of internal and external forces acting on the system or upon a sub-system. Eliminating internal forces from the set of equations so formulated leads to either (i) the frequency equations in the absence of external forces, or (ii) equations for the chosen (generalized) co-ordinates in terms of the external forces. As the author says of admittances, "their use greatly facilitates the splitting of problems on mechanical vibrations into manageable portions", so that "the range of tractable problems is greatly extended".

The monograph contains an elementary exposition of the fundamental ideas, with examples of their application to a number of systems. The purpose is didactic, and the examples are 'academic', but the advantages of the method are clear to see, and students and designers should derive much profit therefrom. There are conceivably other topics upon which similar monographs might be included in the Reports and Memoranda Series issued by the Aeronautical Research Council, and Prof. Duncan may be congratulated upon creating an excellent precedent.

The electro-mechanical analogy is, however, not perfect, and the technique of mechanical admittances has not yet acquired all the facility of electric circuit theory. The idea of mechanical 'circuits' needs elaboration, and the analogues of Kirchhoff's laws would seem desirable, although the greater complexity of mechanical couplings and interconnexions does present some difficulties. W. G. BICKLEY

COLLEGE PHYSICS

College Physics

By Prof. John A. Eldridge. Third edition. Pp. x + 720. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 27*s*. net.

College Technical Physics

By Robert L. Weber, Marsh W. White and Kenneth V. Manning. Pp. x + 761. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 22*s*. 6*d*. 4.50 dollars.

THESE two text-books, designed for use in the first-year course of American colleges, are suitable for classes in Britain of intermediate degree examination standard, particularly where a combined course of instruction is given for students from various faculties. The subject-matter is similar in both, covering mechanics, heat, sound, electricity and magnetism, and optics. Calculus is not used, and only an elementary knowledge of algebra and trigonometry is required.

"College Physics", which is now in its third edition, first appeared in 1937. In the new edition a large part of the text has been rewritten, a slight change made in the order of presentation, and a greater number of worked-out examples given, though the problems at the ends of the chapters have not greatly altered. The author has tried to arouse an interest in physics and to make the student think for himself. In this he has succeeded admirably, but it is a pity that occasionally he has allowed his enthusiasm to run away with him, for some of his language is much too colloquial and his historical sketches very often ridiculous. The diagrams and explanations are very clear, and fundamentals are carefully stressed. The British 'gravitational' system (in which the unit of mass is the 'slug'), and the C.G.S. system of units are used.

"College Technical Physics" is a new book, although some of the material has been adapted from an earlier book of the authors entitled "Practical Physics". It is on conventional lines, with one unique feature—the chapter headpieces. These are portrait drawings by C. S. Hauschka—one for every chapter—of the fifty Nobel prize winners in physics, arranged in chronological order, from Röntgen in 1901 to Bridgman in 1946. Every portrait is accompanied by a brief biographical note. The portraits bear no relation to the chapters to which they are attached, nor is any reference made to the drawings in the text. Indeed, several of these eminent physicists, for example, Sir J. J. Thomson, who it is expected would be mentioned even in an elementary text-book, get no mention at all in the text. The book is very well produced and contains some excellent illustrations, both line drawings and half-tones. In particular, the chapter on colour, with its unusual but excellent coloured illustrations, must receive special commendation. S. WEINTROUB

The Electron Microscope

By Dr. V. E. Cosslett. (Sigma Introduction to Science, 8.) Pp. viii+128+12 plates. (London: Sigma Books, Ltd., 1947.) 7*s.* 6*d.* net.

THIS little book can be confidently recommended to those for whom it is written—the biologist and others seeking information about a new tool and the layman interested in recent scientific advances. It contains a non-mathematical account of the principles underlying the construction of an electron microscope. Starting with a description of the properties of an optical lens and the formation of an image by rays of light, the book proceeds to develop the analogy with electron lenses of both magnetic and electrostatic type. The account is at all times clear and simple; and the large number of illustrations and plates make the book easy to read and to understand.

The book concludes with two chapters on the present uses and future possibilities of the electron microscope. The first of these serves to emphasize the rapidity with which this new method of investigating the fine structure of matter has been exploited both in fundamental and industrial research. The second suggests that further developments are still possible and are being actively pursued. G. D. P.

Les mesures physiques

Par Albert Pérard. (Que sais-je ?, No. 244.) Pp. 136. (Paris: Presses universitaires de France, 1947.) n.p.

IN this paper-covered pocket edition, one of the well-known 'Que sais-je?' series, the director of the Bureau International des Poids et Mesures gives an authoritative, concise, and logical account of the important part played by measurement in science. The first chapter deals with the general principles and methods of measurement, and errors of observation. The following chapters discuss, in terms of the fundamental standards, the measurement of length, time and mass, and electrical measurements; and, since a knowledge of the temperature is essential for the exact specification of the fundamental quantities, a further chapter describes the methods used to measure temperature. The final chapter indicates briefly the principles of measurement of several other physical quantities, and an appendix tabulates equivalents of the principal units.

It is no easy task to deal adequately with the subject of measurement in such a small volume, and the author is to be congratulated on the skilful way in which he has chosen and handled his material. Unnecessary detail is avoided, and only a few absolutely essential references are given, so that even those possessing only a slight knowledge of physics will have no difficulty, when reading this book, in appreciating the basic principles and methods of physical measurement. S. WEINTROUB

Simple Experiments with Insects

By Dr. H. Kalmus. Pp. xii+132. (London: William Heinemann, Ltd., 1948.) 7*s.* 6*d.*

THE surest way to arouse interest in a scientific subject is to make it interesting; to perform actual experiments is one way of doing this. In this little book Dr. Kalmus describes more than a hundred experiments in insect behaviour and physiology for the benefit of amateurs or of school children and their teachers. The experiments range from such simple things as putting a bee in a bottle and showing that it produces water, or catching a fly in the hand, to quite difficult experiments such as the comparative rearing of *Drosophila* on synthetic media or studying the optomotor reactions of the mosquito. Even with the help of the short explanations which accompany the descriptions, it is unlikely that the amateur will grasp the significance of all the experiments; but many of them are well calculated to excite his interest, and the book should prove a useful complement to the observations of insects in the field. It is likely to be useful, too, for university teachers of zoology. A few errors may be noted: the yolk is not formed by the accessory glands (p. xii); hæmoglobin is not broken down beyond hæmatin in the mosquito (p.15); on p. 20 'gills' are called 'tracheæ'; on p. 83 the book louse is called *Anthrenus*.

V. B. WIGGLESWORTH

Guide to the Study of the Anatomy of the Shark, *Necturus*, and the Cat

By Prof. Samuel Eddy, Prof. Clarence P. Oliver and Asst. Prof. John P. Turner. Second edition. Pp. vii+115. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 12*s.* net.

THIS admirable little book, which was designed for students of the University of Minnesota, is accurately described in its title. It gives the salient features of the anatomy of the three animals with which it deals in the form of directions for their dissection. It has the virtue that it is concise, but one feels that students might have been helped by more detailed statements of dissection procedures. Unlike many British text-books, there is some treatment of the muscles; it is perhaps to be regretted that they were not a little more fully treated in the spiny dog-fish. The illustrations are rather few but they are clear and pleasant to look at; the last point is important, as increasing the likelihood that they will be studied. It would have been an advantage to have given some very simple sketches showing dissection methods. The book is clearly printed on thick paper, the pages held together between card covers by metal rings which enable the book to lie flat on a bench. P. D. F. MURRAY

The Psychology of Industry

By Prof. James Drever. Second edition, revised. Pp. x+151. (London: Methuen and Co., Ltd., 1947.) 7*s.* 6*d.* net.

THE appearance of a second edition of this work some twenty-six years after the original is a tribute to the work of a pioneer. During the First World War experimental psychologists made one or two attempts to show how science could appreciably add to the productivity of industry. By the time of the Second World War the more up-to-date industrialists had realized that the nineteenth-century stress on material and monetary factors in industry had been greatly overdone and that efficiency could only be approached when as much attention was paid to the human factor. Prof. Drever's book is a record of the work done by himself and other investigators between the two wars. While it pays little attention to developments in industrial relations since that time, it is still a worthy guide for all who are seeking to provide optimum satisfaction to workers in industry and, concurrently, to raise the overall level of industry's productive capacity.

T. H. HAWKINS

THE ROLE OF CHEMISTRY IN COMBATING TROPICAL DISEASES*

By Sir IAN HEILBRON, F.R.S.

TO a great Colonial Power such as Britain, the control of the insect-borne diseases, malaria and trypanosomiasis, the vectors of which are respectively the Anopheles mosquito and the tsetse fly, is of paramount importance. Malaria, which claims anything from 300 to 800 million victims a year, with an annual death roll of 3 to 4 million, is the most prevalent of all human infectious diseases and the worst scourge with which we have to contend throughout all our tropical and sub-tropical Colonies. It is not only responsible directly for enormous damage to health but it so lowers vitality by its destruction of blood cells that other infections are enabled to create perhaps even greater destruction than the malaria itself.

The direct cause of all this sickness is a protozoon belonging to the genus *Plasmodium*. Of the three species, *P. vivax*, *P. falciparum* and *P. malariæ*, concerned, each produces distinctive symptoms and requires different treatment. They are injected into the blood of humans by the females of Anopheline mosquitoes during their act of sucking blood upon which they live. Of the hundred and forty or so different kinds of Anopheline mosquitoes, fortunately only about fifteen of these are important vectors of malaria. Thus in Africa the main carriers are *Anopheles gambiæ* and *A. funestus*; in America they are *A. quadrimaculatus*, *A. punctipennis* and *A. crucians*; and in India, *A. stephensi*, *A. culicifacies* and *A. rossi*, and so on.

Trypanosomiasis, or sleeping sickness, unlike malaria, is confined to Africa. Human sleeping sickness is caused by two species of trypanosomes, *T. gambiense* and *T. rhodesiense*. The latter produces a virulent type of the disease particularly difficult to control by drugs. The trypanosomes responsible for trypanosomiasis among domestic animals differ from those affecting humans. Of veterinary importance, mention may be made of *T. congolense* and *T. vivax*, of which the former is much the more virulent among cattle and presents the most serious veterinary problem. *T. brucei* is generally fatal to horses, while *T. simiæ* is a strain particularly dangerous to pigs. The organism responsible for transmission of the disease is the tsetse fly. Among the many species of tsetse, *Glossina morsitans* and *G. pallidipes* range over wide areas of bush, scrub and forest country and are found in all altitudes up to about 5,000 ft. A fly of a different habitat is *G. palpalis*, which generally lives in the proximity of water.

For Africa, especially equatorial Africa, trypanosomiasis is just as grave a problem as malaria, for where tsetse rules uncontrolled, domestic animals cannot exist, and thus vast tracts of valuable grazing land which fall within the fly-belt are left unstocked and uninhabited. As a result, the number of cattle in Africa is tragically small, but even so over-grazing occurs in many areas. In turn, the human population suffers from a deficiency of animal protein, the soil loses fertility due to lack of manure and generally conditions are created wherein disease, poverty and misery alone thrive.

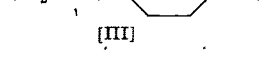
Malaria and trypanosomiasis constitute, without doubt, the biggest hindrance to the economic, social and political development of those territories afflicted by them. Until control of these diseases is effected, we cannot reasonably expect native communities to be sufficiently vigorous, either physically or mentally, to be entrusted with the many responsibilities which the rapid imposition of our social and political systems must throw upon them.

There are two distinct approaches to the problem. We can attempt either to destroy the parasites in man and animals, or we can concentrate our attention on the eradication of the vectors themselves. Both lines of investigation have been actively explored with considerable success for many years.

The search for synthetic drugs for combating both malaria and sleeping sickness has been pursued with increasing tempo ever since Paul Ehrlich, the brilliant founder of modern chemotherapy, established in the first years of the present century the principle that infectious diseases could be cured by employing specific chemical agents to bring about the selective destruction of the invading parasites.

Chemotherapy of Human and Animal Trypanosomiasis and of Malaria

With the experimental production of trypanosomiasis in mice and rats by Laveran and Mesnil in 1902 and the demonstration by Thomas in Liverpool in 1905 of the trypanocidal activity of atoxyl (I), Ehrlich decided to focus his attention on compounds of arsenic, rather than pursue his studies on purely organic compounds where some promising results had already been attained in mouse trypanosomiasis with a dyestuff, trypan red. As is well known, the culminating point of this series of investigations was the discovery of 'Salvarsan' (II) by Ehrlich and Hata in 1910 as a cure, not for sleeping sickness, but for the spirochætal infection syphilis. For human sleeping sickness the most successful and widely used arseno-organic compound is still 'Tryparsamide' (III), first described by Jacobs and Heidelberger in the United States in 1919. Its virtue lies in the fact that it is the only drug with any action in the deadly late stage of sleeping sickness when trypanosomes have penetrated into the central nervous system.



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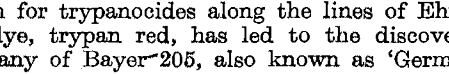

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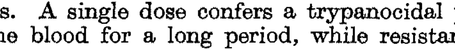

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Turning now to purely organic compounds, the search for trypanocides along the lines of Ehrlich's azo dye, trypan red, has led to the discovery in Germany of Bayer 205, also known as 'Germanin', 'Suramin', 'Antrypol', etc. This substance represents the most successful chemotherapeutic agent so far discovered for human sleeping sickness in its early stages. A single dose confers a trypanocidal power on the blood for a long period, while resistance of trypanosomes to it is acquired more slowly than with

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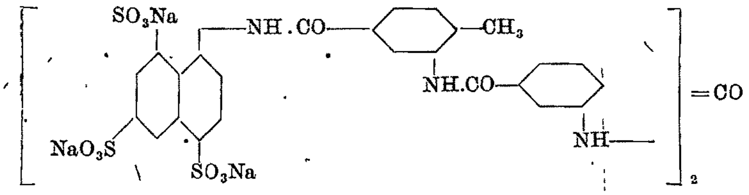
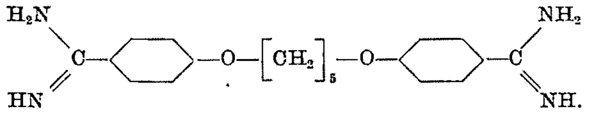
* From a Friday Evening Discourse at the Royal Institution on May 14.



[IV]

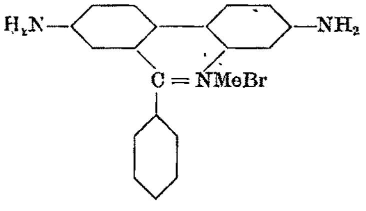
arsenical preparations. Furthermore, it is of value against *T. rhodesiense*, where arsenicals are ineffective. On the other hand, it is of no use in the later stages of the disease, and this seems to suggest that it cannot penetrate the blood-brain barrier.

Another highly important group of chemotherapeutic agents for human sleeping sickness are the diamidines, which have been developed in Great Britain following upon an investigation of Lourie and Warrington Yorke in Liverpool. Among the members of this series, pentamidine (V) is used on a large scale by Belgian, British and French medical services. It is an extremely powerful trypanocide for treatment of the disease in the lymphatico-blood stage, but like 'Suramin' is ineffective in cases of severe nervous involvement.



[V]

Until recently, the search for synthetic drugs effective against the dreaded *T. congolense* infections in cattle has been unsuccessful and only tartar emetic and certain other antimonials have been found of any value. In 1931, Morgan and Walls, working in the Chemical Research Laboratory, Teddington, discovered a new series of phenanthridinium compounds, among which certain members were found to possess strong trypanocidal properties. Of these, dimidium bromide (VI) (phenanthridinium 1553) is quite outstanding and appears to cure *T. congolense* infections at extremely low dosage.

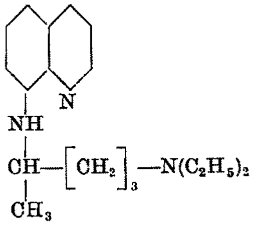


[VI]

The use of the drug is, however, not unattended by danger, as it is toxic and produces in cattle photosensitization if used in large amounts.

As a result of the world-wide distribution of malaria, the subject of specific therapy has commanded a great deal of attention. This was particularly the case during the Second World War, when both British and American troops were operating in some of the worst malarious spots in the world. The position was aggravated by the fact that quinine, the ordinary prophylactic and curative drug, became unavailable in consequence of the Japanese invasion of Java, which cut off our supplies of cinchona bark.

The possibility of studying the effect of drugs upon the malaria parasites was opened up when Roehl, one of Ehrlich's pupils, developed a method in 1926 of transmitting a related infection, *Plasmodium relictum*, to canaries. Following upon this discovery, chemical research work was actively pursued and rapidly resulted in the discovery in Germany of 'Plasmoquin' (VII) ('Pamaquin'), followed shortly afterwards by that of 'Atebrin' ('Mepacrine') (VIII) in 1930 This latter compound has proved to be a more effective suppressive than quinine, and its manufacture in Britain was begun during the War. The discovery by Curd, Davey and Rose of the important antimalarial 'Paludrine' (IX) in 1944 as a result of brilliantly planned war-time research in the laboratories of Imperial Chemical Industries, Ltd., at Blackley, marks a still further striking advance in chemotherapy. As is seen from the formula, 'Paludrine' is an entirely novel drug quite unrelated structurally to either 'Pamaquin' or 'Mepacrine'. Unlike the latter, it is colourless and hence produces no discoloration of the skin. At the same time, it is less toxic, and both for prophylactic and curative purposes is vastly superior.



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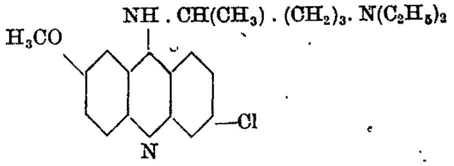

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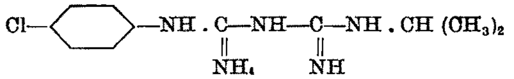


[IX]

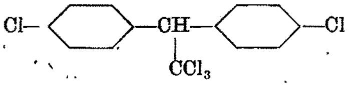
Attacking the Insect Vector

No one can question the great importance of the use of drugs for the treatment of either malaria or trypanosomiasis; but it is well recognized that in our Colonial territories with their many tribal communities, or in India with its teeming population, there is as yet no practical possibility of stamping out insect-borne diseases by such methods. The only alternative is to secure control by exterminating the vectors.

The idea of eradicating malaria and sleeping sickness in this way is, of course, not novel. The attack upon the mosquito by the drainage of swamps, the spreading of oil on water and the use of Paris Green for dusting to kill larvæ, and the spraying of houses with pyrethrum extract in kerosene are all methods which have been practised for a great many years. In 1930, a serious epidemic of malaria broke out in Brazil due to the introduction of *Anopheles gambiæ* into that country, probably by sea, from Africa. An area of 12,000 square miles was affected, but through the joint co-operation of the Brazilian Government and the Rockefeller Foundation complete eradication of the species was attained. Similarly in 1942, *A. gambiæ* spread from Central Africa into Egypt, causing a serious epidemic of malaria. The Rockefeller Foundation experts were again called upon to assist the Egyptian Government. Paris Green was employed as the principal insecticide and applied to all potential breeding places. House-to-house spraying with pyrethrum was also employed throughout the whole of the infested area. By 1945 the area was free from infestation. I mention these two campaigns as they serve to demonstrate what can be achieved by careful planning. The cost both in money and labour was high, but the extermination of the disease-carrying mosquitoes was achieved.

With the discovery of the newer and almost unbelievably potent insect-killing chemicals D.D.T. (dichlorodiphenyl-trichloroethane) (X) and benzene hexachloride ('Gammexane') the whole scheme of things has, in my opinion, become transformed. We have in these substances enormously powerful weapons for the waging of successful war against the mosquito, the tsetse and other vectors of human diseases.

So much has already been written about these two insecticides that it is unnecessary for me to do more than recall the fact that, like pyrethrum, they are contact poisons; but unlike the natural material which rapidly oxidizes in air and so loses its potency, D.D.T. is a comparatively stable substance remarkably resistant to oxidation, and thus capable of exerting insecticidal effects upon sprayed areas for prolonged periods. In addition to the above substances, many other powerful synthetic insecticides and miticides of promise have been produced in the United States. Of these, mention may be made of 'Chlordane', a chlorinated indane derivative, and 'Thiophos 3422' ('Parathion') (XI), which is said to be more effective against a wider range of insects and mites than any chemical now in practical use, and a series of alkyl polyphosphates originally prepared in Germany as a substitute for nicotine under the name 'Bladon'.



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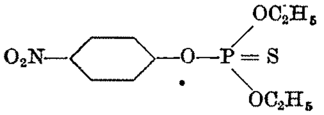

[XI]

Many experiments on insect control are being carried out in British Colonies, either by the respective Colonial administrations themselves or in conjunction with the Colonial Insecticide Committee set up by the Secretary of State for the Colonies, Mr. Creech Jones, at the beginning of 1947.

Although D.D.T. was used so extensively and with such success during the War both by the Americans and ourselves, we were by no means satisfied that we were employing it to the best advantage. Thus we commonly used a 5 per cent solution in kerosene simply because kerosene was readily available, and we had failed in our attempts at that time to obtain good emulsions or wettable powder. Similarly, we lacked precise information as to the best methods of spraying and made do with what equipment was available. Thus in the case of aircraft sprays, use was made of equipment originally designed for gas warfare.

Even to-day, comparatively little is known of the performance in tropical countries of fixed-wing aircraft as a means of disseminating insecticides, and nothing of the efficiency of the helicopter for that purpose. Experiments on these lines are now about to be conducted in Uganda and Tanganyika using a variety of insecticide formulations, including smokes, oil solutions, emulsions, water suspensions and aerosol fogs. Much research has also to be carried out on such unsolved problems as the causes and prevention of absorption of insecticides by mud and thatch, the absorption and decomposition of insecticides by green leaves, the use of surface-active agents to help the spray wet the leaves and insects, and the relationship between crystal size and toxicity. These and many other questions that have arisen during field trials necessitate studies of a fundamental nature which can only be satisfactorily undertaken by a team of scientific workers, including chemists, physicists, biologists, chemical engineers and other specialists. The Colonial Insecticide Committee, with the co-operation of the Ministry of Supply, is therefore establishing a research unit at Porton to undertake the necessary investigations.

In the meantime, large-scale experiments are in hand. The first of these was initiated in 1945 in British Guiana, where more than 70 per cent of the population, some 250,000 people, live under conditions of severe endemic malaria. The initial work was directed by Mr. C. B. Symes, now officer in charge of research for the Colonial Insecticide Committee, and was later taken over and expanded by the Government malariologist. Before spraying was commenced, 700–800 mosquitoes would be found in one small bedroom. These included not only the malaria carrier, *Anopheles darlingi*, but also *Culex fatigans*, which are carriers of filariasis, and *Aedes ægypti*, which are potential carriers of yellow fever. Spraying was carried out with 5 per cent D.D.T. at a dosage of 100 mgm. per sq. ft. to the inner surfaces of dwellings. After as long as ten months and using only a single spraying, *A. darlingi* mosquito captures were down to less than 2 per cent of the numbers in untreated huts. To date, approximately 84 per cent of the population are enjoying total protection from malaria. In one village where more than 60 per cent of school children showed chronic infection by malaria in 1945, only 18 per cent were infected in 1946. In 1938 the spleen index in school children was 51·2, whereas in 1947 it had fallen to 3·7.

Another highly successful experiment is being carried out in Cyprus. In the past, various efforts have been made to control the disease by treatment of water areas with oil and with Paris Green, but without success. In 1946 a large trial was conducted in the Karpass Peninsula over a total area of some

7,000 square miles. The attack, directed by Mr. M. Aziz, the chief health inspector, was concentrated upon larvæ in water courses, pools, wells, etc. Spraying was carried out in most places every fourteen days from April to the end of October, when *Anopheles*, both adult and larvæ, were completely eliminated from the area. The work was being extended in 1947 and it was confidently anticipated that the complete eradication of mosquitoes from Cyprus could be expected within two or three years.

A malaria eradication experiment is now being prepared to be conducted in the island of Mauritius, commencing in the autumn. Malaria was introduced into the island about 1862 and is now endemic. The disease is the principal cause of death in the Colony, the population of which is about 420,000. Most of the infection is due to *A. funestus*, supplemented by *A. gambiæ*. Apart from the highest part of the island, which excludes some five thousand houses from a total of eighty-three thousand dwellings, all houses and cattle and goat sheds in the remainder of the island are to be treated by the application of residual insecticidal formulations three times a year over a period of two years. If necessary, the extension of spraying to breeding grounds will be put in hand.

Large trials are also in progress in East Africa. These are being conducted by the Colonial Insecticides Research Unit in Uganda, and cover both work on mosquitoes and tsetse flies. An interesting field experiment was carried out in a rural area north of Entebbe in Uganda, in which some two thousand houses of the mud wall and thatched roof type were divided into six areas and treated with six different formulations of D.D.T. and benzene hexachloride. All treatments caused striking reductions in populations of mosquitoes in houses. Four sprayings prevented the usual seasonal increase of malaria, and two of these apparently resulted in a reduction of malaria by about 50 per cent. These results were obtained over two wet seasons.

An important factor in field trials is the reaction of the people to the experiments, especially as they involve removal of foodstuffs, clothes, etc., from the rooms to be sprayed. Actually Mr. Symes relates that the reception everywhere was so good that at times it became embarrassing. For the first time in their lives these people experienced an undisturbed night's sleep, free from the evil presence of hundreds of biting mosquitoes as well as bed bugs, 'chigger' fleas which burrow under the skin and nails of feet and hands and cause septic sores and many other pests.

Tsetse Flies

Interesting and promising results have also been obtained in field experiments with insecticides conducted by the Uganda research team on the tsetse-infested islands and shores of Lake Victoria (in Central Africa), by the South Africans in South Africa, and by the East African Tsetse Research Department in Tanganyika. Tsetse flies, both males and females, live by sucking the blood of animals, including domestic animals and man, where these are available, and they breed and live in bush (or jungle) of various kinds. Their young spend all their development period—some eight weeks upwards—in the soil, so that they are difficult to get at. It is the adult fly, therefore, while it is resting on leaves, tree-trunks and stones in the bush, or actually in flight looking for food, or while feeding on an animal, that is vulnerable to attack with insecticides.

Two obvious methods are the spraying of the bush and the spraying of cattle with contact insecticides. The first method has been tried on a number of small islands of 100 acres or so and on stretches of dense shore bush on Lake Victoria. Solutions and emulsions of D.D.T. and benzene hexachloride were applied with small knapsack sprayers to bush in places where the flies concentrated or patrolled. In order to do this and to do the necessary preliminary survey of fly densities, paths were cut through the bush. It was, of course, possible to spray only a small proportion of the total bush in this manner. In spite of this, the reduction in the fly population in the last few experiments was about 98 per cent. In one trial no flies could be found for nearly three months after the last of four sprayings. While this work was going on, it was discovered that the oil solutions that were being used appeared to lose their effect on flies after about a week because a very large proportion, sometimes as much as 80 per cent, was absorbed by the leaves and stems of the trees and bush. One of the urgent inquiries, therefore, is now to find formulations of D.D.T. and benzene hexachloride that will not be absorbed by plants and trees, and it seems that certain types of emulsions or wettable powders may suit in this way.

Since such a large proportion of the total flies were killed by treatment of so small a proportion of the bush, it is thought that by increasing the area sprayed, even the last 2 per cent of flies will have difficulty in escaping. It is proposed, therefore, to do this, and since no known type of ordinary spraying equipment is suitable for use in these large areas of dense bush, the spray is to be applied from aircraft. Extensive trials of this method are now planned to begin in a few months.

Trials of insecticidal smokes and fogs drifted through the bush have also been conducted with very promising results. The smokes have been produced from grenades and canisters, filled with burning mixtures and the insecticides mixed together. The fog was discharged from a special machine.

The South Africans have gone further than this with trials of insecticidal smokes for the control of tsetse flies (*G. pallidipes*). For the past two years or so they have used aircraft for this work and have treated about 170 square miles several times with smoke made from a 20 per cent solution of D.D.T. in toluene and fuel oil. The aircraft fly just above the tree-tops and the smoke is produced from their exhaust pipes, which are connected to the internal spray-tanks for this purpose. Kills of tsetse have been good over the areas as a whole (up to more than 99 per cent), but small numbers of flies have been left unharmed in dense evergreen thickets to which the smoke has not penetrated. These small pockets are now being dealt with by means of smoke canisters. South Africa has expended more than £300,000 and much effort on this work, and has had the full co-operation of its Air Force. The British effort has been much less costly so far, but it is likely to build up to a similar order of magnitude in the near future—in fact it must, if we are to deal with this problem in anything like an adequate fashion.

There is a second method of application, namely, the spraying of cattle with insecticide so that flies settling on them to feed come into contact with the insecticide crystals and so are affected. This has been tried by the Tsetse Research Department of Tanganyika. After preliminary work, they sprayed 350 cattle once a week for thirteen weeks and then twice a week for another eight weeks with 9 per cent D.D.T. solution in monkeynut oil plus resin. The cattle after each spraying were herded in small groups of five or six over an area of about five square miles of bush infested with the tsetse (*G. pallidipes*). At the end of this period the tsetse had been reduced by about 80 per cent. During this work it was found that the solution when applied to cattle lost its toxicity in a few days, though the same solution applied to a dried ox skin was toxic for months. Subsequent investigation has shown that this is due essentially to absorption of the solution into and through the living skin. This line of investigation will continue.

Effective application of insecticides is not quite the simple problem that it may seem. Chemical, biological, physical and engineering studies are all deeply involved and intermixed. It is only in so far as we are able to cope with these interrelated problems that we may expect to make progress. Our effort so far, however promising—and the results are very heartening—is a very meagre one. We in the British Commonwealth of Nations are faced with all the major insect-borne diseases and pests of animals and crops in larger measure than any other group of peoples. In the past there has seemed to be no way of dealing with these problems in any reasonable period. But with the new insecticides, supplementing the best of the old, we have weapons of which we have not hitherto dreamed. The future holds a challenge which we dare not refuse.

THE HEALTH OF THE SCHOOL CHILD

By Dr. ROBERT SUTHERLAND

Medical Adviser and Secretary, Central Council for Health Education

NOT the least of British war-time triumphs was the way the health of the children was maintained and even improved. Except in 1940–41 the death-rates in the war years were equal to or less than pre-war rates. There was an improvement in the height and weight of both sexes, the number of children with really bad nutrition was roughly halved, and the amount of anæmia was reduced.

These striking improvements took place although many children suffered the stresses of air raids and the disruption of evacuation, and although the staffs of school medical and school dental services were reduced because many of their members were serving in the armed forces.

There is no doubt, therefore, that these encouraging results were largely due to a raising of the standard of living of the poorer half of the population, to our very well-designed system of rationing, with its priorities for mothers and children, and to the tenfold increase in school dinners and the 30 per cent increase in the taking of school milk.

Part of the fall in the death-rates was due to a reduction in deaths from respiratory infections, notably pneumonia, and from diphtheria. The development of chemotherapy probably had much to do with the fall in pneumonia deaths, and the diphtheria immunization campaign introduced in 1942 was certainly largely responsible for the striking reduction in the diphtheria deaths.

The report of the Chief Medical Officer of the Ministry of Education for the years 1939–45* very properly stresses the ground that has been gained in difficult circumstances. But equally properly Sir Wilson Jameson notes some challenging facts that still confront us.

The nutrition of one out of every six (or at best one out of every nine) of our school children still leaves something, and in many cases much, to be desired. Despite the fact that the pre-school child is in many ways the most cared-for citizen, only one in five of our five-year-olds has had no dental decay: the average child aged five has four teeth missing, filled or decayed.

In some places one in ten of the children in our schools are educationally sub-normal, and—evidence of poor environment or poor parental care—one in ten children have head lice or nits.

Nutrition, of course, is a very complex matter which depends on much more than diet. Insufficient sleep, infectious diseases of childhood, lack of exercise, unhappiness, insecurity, all prevent a child from getting full advantage from his diet. Since less than half the mothers in Britain, however, get for their children the vitamin extras to which they are entitled, it is probable that the diet is not always as good as it might be. Nine-tenths of school children are now getting school meals, and there is little doubt that as a consequence we shall, over a period of years, see a considerable improvement in their nutrition; but, of course, no official provision is at present made, except in nursery schools, for well-balanced meals for the pre-school child. Although the school child gets one-third of a pint of milk a day entirely free of charge, milk for the pre-school child (except in cases of great need) has to be paid for, although at a cheaper rate.

It is certainly an indictment of our separation allowances for the dependants of Service men that the children of Service men showed a lower amount of hæmoglobin at all ages less than ten years.

Many of the 10 per cent of children who are educationally sub-normal are merely backward as a result of poor health or poor nutrition, so that here there is a close relation between the child's intellectual and physical health. Indeed, since in some cases a child may fail to use his intelligence principally because of emotional disturbances, emotional health is involved as well. The importance of emotional health is indeed recognized in the report, and developments of the Child Guidance Service are forecast. There are, too, throughout the report many indications of a clearer recognition of the child's unity of mind and body and of the consequent need for the closest possible co-operation between the teacher, doctor and nurse; and considerable space is given to a consideration of how physical education and health education can help.

The importance of the home and of factors outside the home is rightly stressed. However much school meals are developed, and other existing responsibilities of the parent taken over by the teacher or the school doctor or nurse, the health of the school child will still be largely determined by the care given him in his home. Nevertheless, the extension of the school's responsibility increases the influence of the school in health as well as in education.

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* The Health of the School Child. Report of the Chief Medical Officer of the Ministry of Education for the Years 1939–1945. Pp. 148. (London: H.M. Stationery Office, 1947.) 2*s.* 6*d.* net.

The whole report points strongly by implication to the need for a more dynamic and functional approach to school medicine.

One looks forward to the day when the school medical officer is an integral member of the school staff, whose duty it is to study the child at work and at play in the changing school setting. With its demands upon the child's senses and its opportunities for expression—intellectual, emotional and social—aspirations and powers, the school offers probably unique opportunity for the study of the functioning of the total child. The study of health in this dynamic sense would surely be much more profitable than the present sporadic and static methods of school medical inspection.

INDUSTRIAL FIBRES

BEFORE the Second World War, the Commonwealth Economic Committee issued annually a series of reviews which summarized the main facts of production, international trade and consumption for various important animal and plant commodities. These reviews are now being re-issued for the war and post-war years. Among the first to reappear is the volume on "Industrial Fibres"*, which surveys the world situation with regard to cotton, wool, silk, flax, jute, hemp, mohair, coir and rayon. While the data for several countries are not yet available, the information gives a broad indication of changing trade patterns. The main change has been the redirection of foreign trade caused by the dislocation of normal trading channels and the development of alternative sources of supply. The United Kingdom remained the chief importer of industrial fibres, although, after 1941, the United States imported most wool, some of which was accumulated as reserve on the United Kingdom's account. Imports into the main European countries and Japan were greatly reduced during the war years.

The world production of fibres at first expanded but soon declined sharply, reaching a minimum in 1944, with moderate recovery in 1946. Output was generally restricted to cover essential war purposes, and civilian consumption of textiles was curtailed. Where production exceeded demand, as in wool and cotton, stocks accumulated, thus increasing the supplies available in the post-war period. The recovery in 1946 continued in 1947, but future expansion will depend on changing conditions in Germany and Japan. There has been no significant modification in the post-war pattern of production of the different fibres compared with pre-war years, with the exception of rayon, which is now being mainly produced in the United States. Comparing production in 1945 with that in 1938, wool has declined least, namely, 2 per cent; rayon yarn has declined 11 per cent; cotton 26 per cent; staple rayon fibre 45 per cent; and silk 73 per cent. The serious decline in cotton production was caused mainly by the transfer of cotton-growing land to food production, particularly in India and the United States. Silk production was largely suspended in Japan during the War. In 1946, wool alone showed a small decline over the 1945 figure, but world stocks are still large. Rayon made good the war-time losses and rose 10 per cent above the 1938 figure. Cotton and staple fibre production also showed improvements but silk expanded only slightly, being in 1946 only 27 per cent of the pre-war figure.

The contribution made by the British Commonwealth to the world's production of fibres is considerable. Thus nearly all the world's jute, nearly half the world's wool, more than a quarter of all its hemp and nearly a fifth of its cotton are produced in the Commonwealth, which is still an exporter of these fibres, having built up surplus stocks before the War. The 1946 export balance for wool was the highest ever recorded; for jute and hemp it was about one-half of the pre-war figure. The war-time dependence on foreign supplies of rayon, silk and flax (imported on balance before the War) has now been lessened, but dependency on outside sources still applies to cotton.

The significance of industrial fibres in the exports of different Commonwealth countries has been amply maintained during the post-war period. For example, wool accounted in 1946 for 33 per cent of the total exports of South Africa, other than gold, as compared with 30 per cent in 1938 and only 6 per cent in 1944. Jute and jute products made up nearly 30 per cent of the exports from India in 1946, which were 24 per cent in 1938. Hemp reached 44 per cent of the exports from Tanganyika in 1946 as against 38 per cent in 1938.

Cotton. The main sources of cotton for world trade are the United States, India, Brazil and Egypt. In addition, Russia and China also grow large quantities of cotton but consume most of it domestically. The chief importers of cotton before the War were Japan and the United Kingdom, which used up nearly half the total production, other European countries consuming the rest. Production declined from 17,900 million lb. in 1938 to 10,000 million lb. in 1946, but consumption fell even more, so that stocks rose from 10,400 to 13,500 million lb., but have since fallen to nearly half this amount. Long-staple varieties are being increasingly grown in most of the chief areas.

Wool. This is produced as a main product in merino sheep farming or as a secondary product to meat in the rearing of crossbreds. A dry summer greatly reduces the output of fine merino wool. The rising trend in number of sheep before the War was reversed in 1941, and the decline was accentuated by the Australian drought of 1944–45. World production of wool fell rapidly after 1942, especially in the United States and Australia, and to a lesser extent in South Africa. Australia still retains its position as the leading wool-exporting country and usually exports more than twice as much wool as any other country. The chief importing country until 1941 was the United Kingdom, but since that year the United States has assumed first place. Lack of production statistics for *mohair* renders it difficult to assess the changes in world supplies over the war period.

Silk. Before the War, some 100 million lb., or 80 per cent, of the world's silk was produced in Japan. Since 1941, the production has diminished rapidly until, in 1946, Japan produced only 12 million lb. of raw silk. Even before the War, production was declining through increasing competition with rayon and nylon, which may eventually supersede natural silk.

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* Industrial Fibres. Summary of Figures of Production, Trade and Consumption relating to Cotton, Wool, Silk, Flax, Jute, Hemp, Mohair, Coir and Rayon. Compiled in the Intelligence Branch of the Commonwealth Economic Committee. Pp. 137. (London: H.M. Stationery Office. 1948.)

Flax. The best flax is produced in temperate regions such as Europe. In certain countries, the plant is grown primarily for linseed, the fibre being a relatively expensive by-product. Reliable information concerning the world's flax industry is difficult to obtain because of this dual-purpose objective. The output of flax appears to have declined by some 70 per cent up to 1945 and has since shown only a moderate recovery. Considerable reduction in output has occurred in Russia, Poland, Belgium and Holland, whereas it has expanded in Egypt, Australia, New Zealand and Canada. Cotton, jute and rayon are proving to be serious competitors of flax, partly because of the high price of linen goods.

Hemp. The chief hemp-producing countries before the War were the Philippine Islands (manila bast fibre, used for marine cordage), the Netherlands East Indies and Tanganyika (sisal bast fibre, used for binder twine), Eastern Europe and Russia (true, leaf hemp, used for twine and cord). World output of bast (or 'hard') hemps fell considerably through the effects of the War in the Far East, although the output in Tanganyika was maintained, and of leaf (or 'soft') hemp in Europe and Russia through curtailment of the area on which the crop was grown.

Jute. Most of the world's jute is grown in Pakistan, but the greatly increased home demand for sacking has brought about a marked reduction in exports. The jute mills and the main port (Calcutta) are situated in the Dominion of India, and future development of the jute industry will depend on the conditions of inter-trade between the two new Indian Dominions. The largest importer of jute is the United Kingdom, although present stocks are low.

Coir. The only important world-producers of coir (coconut fibre) are India and Ceylon, where the industry is carried out as a part-time occupation of villagers, who also utilize a large proportion of the material. The mobilization of native labour for war purposes in these two countries has led to reduced coir production during the past eight years.

Rayon. The output of rayon yarn has been maintained in recent times, despite the collapse of Japan, by the large increase in production in the United States, which has more than doubled since 1941. By 1946, the United Kingdom had become the second largest producer and the second largest exporter. Rayon depends for its raw materials on the supply of wood pulp or cotton linters. The filaments are reeled to produce 'filament yarn' or spun on to spindles to produce 'staple fibre'. The former competes with natural fibres; the latter s an intermediate product which is becoming increasingly important as an admixture to the natural fibres.

OBITUARIES

Prof. F. A. A. Lacroix

On March 16 there passed out of the scientific life of Paris a great figure and one whose scientific writings have been read by mineralogists and geologists the world over for the past sixty years. François Antoine Alfred Lacroix, 'secrétaire perpetuel' of the Paris Academy of Sciences for thirty-four years and professor of mineralogy at the National Museum of Natural History during 1893–1936, was born at Maçon on February 4, 1863, and died in Paris on March 16. He studied at the *lycée* of his native town, at the Sorbonne, and at the Collège de France. He commenced to study pharmacy but soon was attracted to geology and mineralogy, and in 1887 was appointed 'préparateur' at the Collège de France and a collaborator on the French Geological Survey. Before he was thirty he succeeded Des Cloizeaux as professor of mineralogy at the Natural History Museum. He added many fine specimens of minerals and a superb collection of rocks to the Museum collections. In this he was assisted by many of his pupils, mining engineers and government officials in France's overseas possessions who, catching the enthusiasm of the master for his science, seem to have been ever ready to gather materials for his scientific work and for the national collections.

On his appointment to the Museum, Lacroix commenced at once a great work on the mineralogy of France and her Colonies: its fourth volume was completed in 1913. In these volumes he described the associations and paragenesis of the minerals as well as their crystallography and optical properties. A separate work in three volumes on the mineralogy of Madagascar was published in 1922 and 1923. This included a wealth of detailed petrology and many new analyses of rocks as well as descriptions of the minerals. In this book he developed his classification of igneous rocks, a modified form of the American quantitative classification. In later years he devoted more time to petrology than to descriptive mineralogy, and published a great many papers describing the rocks of many regions, and introducing, sometimes in very brief papers, ideas of considerable importance. Meteorites and tektites—the mysterious glass bodies supposedly of meteoritic origin—were also subjects of his research and were described in important memoirs. To geologists Lacroix will be best known for his early work on the granite of the Pyrenees and its contact phenomena (1898–1900), and for the well-illustrated memoirs recording his observations on active volcanoes in several parts of the world, including especially Mt. Pelée, Vesuvius and Réunion.

In addition to all his mineralogical work, Lacroix devoted an immense amount of time to the affairs of the Academy of Sciences, working at the development of its library and the classification and enrichment of its archives, gathering together letters and other documents of great interest. He published biographies of many mineralogists. His two-volume history of the life of Déodat Dolomieu appeared in 1921, and in 1928 a historical note on the distinguished occupants of the 'chair' of the section of mineralogy of the Academy from Nicolas Desmarest (1795) to Lucien Cayeux (1928).

In all his work Lacroix had a sympathetic and devoted companion in his wife, Catherine Fouqué, daughter of the geologist, Ferdinand A. Fouqué, with whom Lacroix worked in his early years. Madame Lacroix accompanied her husband on many of his travels, visiting with him many active volcanoes. Their married life was extremely happy, and their home had a charm which touched all who were admitted to their friendship and their hospitality. Madame Lacroix died in 1944 and Lacroix never completely got over it; but still he remained enthusiastic and immensely active, and went daily to the museum and the Academy. To the end of his life he was surrounded by devoted friends and colleagues. Many geological societies had done him honour during his life-time and many tributes have already been paid to his memory. The president of the Paris Academy of Sciences, in announcing Lacroix's death to the members, described him as a man who had devoted his whole life to science and "qui restera dans la mémoire comme un des représentants les plus admirables de ce que peut donner, dans notre race, l'association d'un génie scientifique de premier ordre, avec un de ces caractères incorruptibles qui sont l'honneur de l'humanité". W. CAMPBELL SMITH

Dr. E. P. Harrison

DR. E. P. HARRISON, for many years professor of physics at Presidency College, Calcutta, and head of the Observatory, and later chief scientist to the Mine Design Department in H.M.S. *Vernon*, died suddenly at Chigwell Row, Essex, on May 6.

Born in London in 1877, he was the eldest son of Robert William Harrison. His school career was much interrupted by illness, but he entered University College, London, where he won the Clothworkers' Exhibition, and an 1851 Exhibition Research Scholarship in physics. From London he went to the University of Zurich, where he took a Ph.D. in science. In 1904 he went up to King's College, Cambridge, as an 'advanced student', and worked at the Cavendish Laboratory for two years. He lectured at King's College, London, and the Royal College of Science, Dublin, and was then appointed professor of physics at the Mahommedan College of Aligarh in India. Afterwards he was appointed to the Indian Educational Service, and became professor of physics at the Presidency College, Calcutta, and later, in addition, meteorologist to the Government of Bengal.

In 1923, he became chief scientist to the Mine Design Department, H.M.S. *Vernon*, a post which he held until his retirement under the age limit in 1937. His work during this period naturally received no publicity; but under his direction the application of scientific research to the problems of naval mining, begun in the First World War, under the inspiration of, among others, W. L. Bragg, F. E. Smith and G. W. Walker, was continued and extended, and the results he achieved bore good fruit when another war came. He was happiest when working in a laboratory, and never allowed the responsibilities of administration to keep him from active research.

Among Dr. Harrison's personal contributions to naval problems were pioneering work in the application of magneto-striction to the generation of high-frequency sound in water, and the investigation of various properties of the high-permeability alloys of the 'permalloy' group. Perhaps the most interesting of these are the very large changes of impedance which occur in a wire carrying audio-frequency A.C. when small longitudinal magnetic fields are applied to it. An account of fundamental work on this effect was published by Dr. Harrison and members of his staff in 1936, and a practical application was a novel form of magnetometer which was used before the War, in anticipation of the use by the enemy of magnetic mines and torpedoes, to explore the possibilities of controlling the magnetic fields of warships by current-carrying cables. This was probably the earliest practical essay in 'degaussing'. During the War the magnetometer was developed on behalf of the Admiralty by the Electrical Research Association, and became a standard measuring instrument on degaussing ranges.

On leaving the Admiralty, Dr. Harrison joined the staff of Messrs. Hughes and Sons, of Barkingside, and arranged to continue the work he had begun earlier on magneto-striction in H.M.S. *Vernon*. The original oscillators made by him were developed by the firm, and a large number of experiments were made with listening devices off Gourock pier, which led to increased sensitivity.

The outbreak of war attracted his attention to the detection of mines, either floating or submerged, by supersonics, and very valuable data were collected. Later he did much work, both in the laboratory and in trials at sea, on non-contact firing devices for torpedoes.

Dr. Harrison was a physicist in the classical tradition, and had a very keen brain which he applied with great zest to new technical arts of war and peace. He had a large circle of friends, and will be greatly missed for his constant kindness and help to young scientific workers.

NEWS and VIEWS

The King's Birthday Honours List

THE following names of men of science and others associated with scientific work are included in the King's Birthday honours list:

Baron: Sir Alfred Webb-Johnson, president of the Royal College of Surgeons.

K.B.E.: Sir Hector Hetherington, principal and vice-chancellor of the University of Glasgow; Acting Air Commdre. Frank Whittle.

Knights Bachelor: A. Leigh B. Ashton, director of the Victoria and Albert Museum; Dr. A. H. Gardiner, the well-known Egyptologist; Dr. C. R. Harington, director of the National Institute for Medical Research; Prof. C. N. Hinshelwood, Dr. Lee's professor of chemistry, University of Oxford; J. D. G. Medley, vice-chancellor of the University of Melbourne.

C.B.: H. M. Garner, principal director, scientific research (air), Ministry of Supply; N. H. Kinnear, director of the British Museum (Natural History); O. Thornycroft, director of aeronautical and engineering research, Admiralty.

C.M.G.: W. N. Allan, recently director of irrigation, Sudan Government; Dr. P. Stocks, chief statistician (med.), General Register Office; Dr. H. H. Storey, secretary of the Colonial Agricultural Research Committee.

C.B.E.: Prof. W. E. Agar, lately professor of zoology, University of Melbourne; H. H. B. Allan, director of the Division of Botany, Plant Research Bureau, New Zealand; Prof. J. H. Biggart, professor of pathology and dean of the Faculty of Medicine, Queen's University, Belfast; Dr. H. W. Cremer, president of the Institution of Chemical Engineers; Mrs. Maud E. Cunnington, for services to archæology; Prof. A. Findlay, emeritus professor of chemistry, University of Aberdeen, for services to chemistry; B. E. Frayling, Colonial Mines Service, lately chief inspector of mines, Nigeria; Lieut.-Colonel W. French, superintendent of the Technological Department, City and Guilds of London Institute; Dr. A. A. Griffiths, research engineer, Rolls-Royce, Ltd.; W. F. Higgins, superintendent of the Physics Division, National Physical Laboratory; Prof. W. R. Jones, emeritus professor of mining geology, University of London (Imperial College of Science and Technology), for services to the Board of Trade; C. Kershaw, director of British Optical and Precision Engineers, Ltd., for services to the production of optical instruments; Dr. A. King, chief scientific liaison officer, Office of the Lord President of the Council; Prof. H. A. D. Neville, lately professor of agricultural chemistry, University of Reading; Miss Margery Perham, reader in Colonial administration, University of Oxford; Prof. J. Ritchie, professor of natural history, University of Edinburgh; Dr. H. V. Taylor, lately senior education and advisory officer, Ministry of Agriculture; S. G. Taylor, director of irrigation, Ceylon.

Sir James Chadwick, F.R.S.

Sir James Chadwick has been pre-elected Master of Gonville and Caius College, Cambridge, of which he has been a fellow and more lately an honorary fellow. Sir James began his scientific work under Rutherford in Manchester; after studying in the University of Berlin he was interned in Germany during the First World War, and there continued his scientific researches. When Rutherford moved to Manchester, Chadwick joined him and took part in Rutherford's classical researches on the disintegration of elements by α-particles. With Bieler and later with Rutherford he studied the scattering of α-particles by hydrogen and heavier nuclei, and from these experiments determined the law of force around atomic nuclei. He became assistant director of research under Rutherford at Cambridge, and as such was responsible for the training of Rutherford's young research students and for the satisfaction of their modest needs. Many nuclear physicists will remember the attic of the Cavendish equipped with ancient vacuum pumps, gold-leaf electroscopes and the simple apparatus for counting α-particles which was then the main tool of nuclear research. The discovery of the neutron in 1932, followed by the photodisintegration of the deuteron (with Goldhaber) and the creation of electron pairs by γ-rays (with Blackett and Occhialini), marked the peak of Chadwick's experimental work. In 1935 he was appointed Lyon Jones professor of physics in the University of Liverpool, and at once embarked on the construction of a 36-in. cyclotron, completing this just prior to the Second World War.

On the outbreak of war, Chadwick took up the study of nuclear chain reactions based on the fission of uranium, and with Frisch and Peierls informed the Government in the spring of 1940 that an atomic bomb could probably be produced if sufficient U235 were concentrated. Further studies of nuclear constants in Liverpool and Cambridge confirmed this view. At the end of 1943, Chadwick was largely instrumental in restoring the collaboration with the United States in atomic energy which was severed in 1941. He recruited a small but powerful British team to work in Los Alamos and Berkeley, and took a leading part with Dr. Mackenzie in establishing the Canadian Atomic Energy Project at Chalk River. Since the War he has served on the Scientific and Technical Committee of the United Nations Atomic Energy Commission. On his return to Liverpool he initiated the construction of a cyclotron to produce 300 MeV. protons. Chadwick's pupils in nuclear physics are distributed over the whole world. They will regret his severance from active experimental work but will all wish him well in the tasks which lie ahead.

Dr. E. D. Merrill

Dr. E. D. Merrill retires from the Arnold professorship of botany, Harvard University, at the end of June. As professor emeritus he is to remain in the house on the margin of the Arnold Arboretum that has been his as director of the Arboretum where, granted good health such as all his many friends wish him, he will enjoy the facilities for botanical study that have been so considerably shaped by him. Under him the inflow of material, living and dried, into the Garden and Herbarium from eastern Asia, Malaysia and the Pacific has been tremendous; and it is well that he should take a large part in elaborating it. Born on October 15, 1876, Elmer Drew Merrill passed in 1899 from College into the United States Department of Agriculture. In the Department he was selected (1902) for the appointment of government botanist in the Philippine Islands and went out to Manila, one of a few men chosen to start a science service towards which at that time there was nothing but a budgetary appropriation. It was soon evident that his methods were direct and effective. Botanical teaching was added (1912) to his work, and in 1918 the administration of the Bureau of Science. In 1923 the University of California sought and secured his service as dean of the College of Agriculture, where it was his duty to draw into order State-wide organisations that were growing up too loosely knit. In 1930 New York induced him to cross the continent to take the post of director-in-chief of the New York Botanic Garden. Institutions in the United States such as it, depend much on private generosity, and in bad times suffer checks to their activities: it is so in New York, and he had the years of the great depression to combat. It need be no secret that his successes in adjustment led to an invitation to move to Boston (1935) into a post made for him with the title of administrator of the Botanical Collections of the Harvard University and director of the Arnold Arboretum. The collections that passed under him had some likeness to the miscellany he set in order in California, at least in diversity. The University has rearranged these responsibilities; and his last, the teaching of advanced students in methods of research, passes elsewhere. He is now free to devote his time to botanical research.

Dr. L. H. Bailey

Dr. Liberty Hyde Bailey, eminent administrator, botanist, horticulturist and author, attained his ninetieth birthday on March 15. On this date he was actually on Arruba Island in the West Indies on one of his annual palm-hunting expeditions to tropical America. He was signally honoured on his return to Ithaca, New York, in May by a complimentary dinner sponsored by Cornell University, with which institution he has been associated for the past sixty years. On this occasion, with approximately two hundred guests in attendance from various parts of the United States, the speakers extolled Dr. Bailey's eminent services to Cornell University, to agricultural instruction, research and extension, to botany, to horticulture, and to the humanities. The outstanding feature of the evening was Dr. Bailey's informal address, which dealt with his early experiences and some of his later achievements. Tall, straight, speaking extemporaneously and without notes, it was indeed an inspiration to all who heard him on this occasion.

Bailey's career has been an extraordinary one. His father was an early settler in what a century ago was the wilderness of Michigan, and the son's early years were thus associated with the primitive conditions of pioneer life. Following his graduation from college in 1882 he served for several years as assistant to the eminent American botanist Asa Gray at Harvard University, and it was this experience, plus his personal interests, which determined his future career. He is the last living associate of Gray, who, in turn, was a frequent visitor to London and was the outstanding American exponent of the Darwinian hypothesis. Even when because of his special qualifications Bailey was selected as dean and director of agriculture at Cornell University in 1903, he accepted appointment only on the condition that he would be permitted to resign from administrative work at the end of ten years. He retired from academic work as emeritus professor of agriculture in 1921, but this did not mean quiescence on his part. His energies have since that date been devoted to his special botanical and horticultural interests, including the botany of cultivated beauty, an intensive study of North American *Rubus*, and a long-continued investigation of the palms and their classification; and it is this special interest in palms that has inspired him to make trip after trip to remote parts of Mexico, the West Indies and South America in recent years, with future ones already planned. In 1937 he presented his home, his library and his large herbarium to Cornell University, this unit being designated as "The Bailey Hortorium"; and of this he is still the director. His honours have been very numerous, for the value of his achievements has been recognized all over the world. Among these is foreign membership of the Linnean Society and honorary membership of the Royal Horticultural Society of London.

U.S. National Museum: Dr. A. Remington Kellogg

Dr. A. Remington Kellogg has been appointed director of the United States National Museum. Dr. Kellogg has been curator of mammals in the Smithsonian Institution for the past seven years. He is one of the leading experts on whales and whale-like animals. His doctorate thesis, dealing with cetacean palæontology, attempted to trace the ancestry of the earth's largest animals from their land origins. He has served as delegate for the United States on several international congresses dealing with whale conservation and had a leading part in the establishment of the great Antarctic whale sanctuary set up by international agreement. The National Museum, which Dr. Kellogg now will administer, is the largest of the Federal bureaux administered by the Smithsonian Institution. It is the storehouse of what now is probably the most extensive systematized natural history collections in the world, ranging from elephants to fossil insects. It contains large ethnological and historical collections and valuable series in the field of mechanics and inventions.

University of Cambridge

General Smuts was installed as chancellor of the University of Cambridge on June 10. He then conferred honorary degrees on the following, among others: Mr. Winston Churchill; Sir Stafford Cripps; Sir Hector Hetherington, principal and vice-chancellor of the University of Glasgow; Mr. Charles Seymour, president of Yale University; Mr. J. F. Cameron, master of Gonville and Caius College, Cambridge; Sir Hugh Lett, president of the British Medical Association; Sir Wilson Jameson, chief medical officer of the Ministries of Health and Education; Sir Richard Livingstone, vice-chancellor of the University of Oxford; Sir Robert Robinson, president of the Royal Society; Sir Paul Fildes, of the Medical Research Council; and Mr. Arnold Toynbee, director of studies in the Royal Institute of International Affairs.

National Federation of Educational Film Groups

The National Federation of Educational Film Groups recently held its first annual conference in King's College, University of London. Membership of the Federation now amounts to thirty-three groups, representing more than 2,500 teachers. The Federation aims at co-ordinating and assisting the activities of groups of teachers specifically organised to encourage and develop the use of visual aids to teaching, at stimulating the formation and development of such groups, and at collating and analysing the views and knowledge of those experienced in visual methods. Its work includes the development of a library of film strips and charts, the publication of surveys of existing films under specific subject headings, and the organisation of courses for the study of visual aids. The main resolution debated at the conference welcomed the plans of the National Committee for Visual Aids and reaffirmed the support of the Federation in the Committee's task of promoting the wider adoption of visual methods in education. Attention was directed to the need for breaking the "vicious circle of supply and demand in materials", to the importance of reducing production costs, and to the necessity of ensuring that units making educational films were at all times assisted by clear directives. It was decided to establish a fact-finding committee which should report to the Council of the Federation on matters concerning the production and distribution of visual aids.

The conference was also made the occasion of an exhibition housed in the large hall of King's College and designed to provide a wide selection of equipment and materials for visual presentation. Makers, producers and distributors of visual material and projectors had been invited to exhibit and nearly fifty had accepted. The range of exhibits included film and film strip projectors, film strips, wall charts and accessories. An ingenious arrangement of stalls made for the convenience of both exhibitors and visitors and allowed demonstrations to proceed simultaneously. A useful guide-book was available containing details of exhibits and available sources of supply. A nearby room was used for full-length projection of educational films and film strips. The exhibition was well attended, and stall-holders were kept busy throughout the day. The idea of combining conference and exhibition was certainly a happy one, and the organisers are to be congratulated on this and on the excellence of their arrangements.

Chemical Engineering and Fuel Technology at the University of Durham

Commencing in October 1948, King's College, Newcastle upon Tyne, will offer a two-year postgraduate course in chemical engineering leading to the degree of master of science in chemical engineering of the University of Durham. The course will be available to graduates in mechanical engineering or to those who possess some equivalent degree or qualification. The opportunity has been taken to link with chemical engineering the teaching of fuel technology, which has hitherto been carried out by individual departments as required. The main subjects of study during the course will include, in the field of chemical engineering, materials of construction and the design of chemical plant, the flow of fluids and the transfer of heat and matter and the various unit operations. The fuel technology course will include the fuel industries, steam, power and industrial gases. A series of lectures will also be given on the economic, legal, health and safety aspects of chemical engineering. Practical work will be carried out in a new fuel technology laboratory and in a new chemical engineering laboratory which will house a number of small-scale plants.

British Museum (Natural History)

THE first three sections of a new exhibition in the central hall of the British Museum (Natural History), South Kensington, dealing with viruses and virus diseases have been opened. The exhibition has been planned in collaboration with Dr. K. M. Smith, of the Plant Virus Research Station, Cambridge. The effects are shown of virus infection in animals and plants (for example, foot-and-mouth disease, and tobacco mosaic disease), and modes of virus transmission both by direct contact and by means of insects are illustrated. Further exhibits in this series which are in preparation will cover the subjects of virus 'carriers' and the study of viruses in the laboratory.

Colonial Service Appointments

THE following appointments in the Colonial Service have been announced: W. Finalayson, assistant conservator of forests, Tanganyika; R. R. H. Horsley, inspector of mines, Malaya; R. L. Rodda, inspector of mines, Nigeria; A. H. Foster, veterinary officer, Malaya; J. P. Knowles, veterinary officer, Nigeria; A. D. Swan, assistant meteorologist, West Africa; E. G. Waller, temporary agricultural survey officer (cocoa), Gold Coast; G. W. Anderson (agricultural officer, Kenya), agricultural officer, Zanzibar; W. J. Badcock (senior agricultural officer, British Solomon Islands Protectorate), chief soil conservation officer, Nyasaland; R. K. Kerkham (agricultural officer, Uganda), senior agricultural officer, Uganda; T. Y. Watson (senior agricultural officer, Kenya), deputy director of agriculture, Uganda; F. B. Wilson (agricultural officer, Zanzibar), agricultural officer, Kenya; A. C. Brooks (senior chemist, Singapore), chief chemist, Federation of Malaya; A. W. Burtt (senior chemist, Federation of Malaya), chief chemist, Singapore; W. D. Raymond (Government chemist, Medical Department, Tanganyika), Government chemist, Tanganyika.

Browne Research Fund of the Royal Society

THE Council of the Royal Society is prepared to consider applications for financial assistance from research workers at marine biological stations or universities in Great Britain who desire to visit Bermuda for periods of three to six months to carry out a specific programme of work at the Bermuda Biological Station. Applicants should state the nature of the research proposed, the sum required, including an estimate of any loss of salary incurred during absence, and give the names of not more than two referees who will support the application. In accordance with Mr. Browne's bequest, preference will be given to those who propose to work on purely scientific problems. As a guide to possible applicants, the special interest of the present director of the Station, Dr. D. E. S. Brown, lies in the effects of high-pressure on the physics and chemistry of biological functions, for which the deep water off Bermuda provides unique facilities. Applications for grants required for the period ending April 1949 should reach the Assistant Secretary, Royal Society, Burlington House, London, W.1, not later than September 1, 1948.

Announcements

SIR ALEXANDER FLEMING, professor of bacteriology in the University of London, has been awarded the Grand Cross of Alfonso X, and has also received an honorary degree from the University of Madrid.

THE following appointments in the University of Oxford have been announced: Mr. D. G. Champernowne, reader in statistics in the University, to be professor of statistics; Prof. J. Jewkes, Stanley Jevons professor of political economy in the University of Manchester, to be professor of economic organisation.

M. ROBERT COURRIER has been appointed 'secrétaire perpétuel' for the physical sciences of the Paris Academy of Sciences in succession to the late Prof. Alfred Lacroix (see p. 962 of this issue of *Nature*).

THE Commissioners of the Exhibition of 1851 announce the following awards of senior studentships for 1948: D. H. Perkins, for research in nuclear physics at the Imperial College of Science and Technology, London; J. H. Westcott, for research in electrical engineering at the Imperial College of Science and Technology, London; A. R. Pinder, for research in organic chemistry in the University of Oxford; N. Reynolds, for research in botany at University College, Cardiff. The awards are of the value of £500 a year (exclusive of allowances), and are tenable for two or three years.

A CONFERENCE of the British Society for Research on Ageing will be held on July 7, from 11 a.m. to 6 p.m., at the Royal Society of Medicine, London. Papers will be read by Sir Frederick Bartlett and Prof. E. C. Dodds, and Drs. F. Bourliere, L. Cosin, F. Denz, E. Geiringer, V. Korenchevsky and O. Olbrich. The Conference will be open to all who are interested in gerontology.

THE Trustees of the Lady Tata Memorial Fund announce that, on the recommendation of the Scientific Advisory Committee in London, they have made the following awards for research in blood diseases, with special reference to leukæmia, at the places mentioned, in the academic year beginning on October 1, 1948: *Grants for research expenses and assistance*: Dr. Marcel C. Bessis (Paris); Dr. Jörgen Bichel (Aarhus); Dr. Pierre Cazal (Montpellier); Dr. Johannes Clemmesen (Copenhagen); Dr. Peter A. Gorer (London); Dr. Andrew Kelemen (Szeged); Dr. Edith Paterson (Manchester); Prof. Edoardo Storti (Pavia). *Scholarships* (*for whole-time or part-time research*): Dr. Simon Iversen (Copenhagen); Dr. Claus F. M. Plum (Copenhagen); Dr. Guido H. R. Tötterman (Helsinki).

A CONGRESS of Genetics was held at the Centro di Genetica del Consiglio Nazionale delle Ricerche in Pavia during April 2–4. We understand that the *Proceedings* will be published shortly; a monograph on the biology of about a hundred species of insects more or less suitable for genetical researches is also being planned.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Anomalous Effects in Ionospheric Absorption

In current methods of vertical sounding of the ionosphere by radio waves, two relationships are usually experimentally determined, namely, (1) the value of the equivalent height of reflexion (h') as a function of radio frequency (f); and (2) the value of the attenuation ($\log \rho$) as a function of frequency f. (Here ρ is the experimental value of the overall ionospheric reflexion coefficient.)

Using the vertical incidence (h', f) relation, which expresses the refractive properties of the ionosphere, it has been found possible to predict, with fair accuracy, the refractive influence of the ionosphere on waves obliquely incident on it. In this case the relations between any two of the three variables, h', f and i_0 (where i_0 is the angle of incidence of the radio beams on the ionosphere), may be predicted when the other quantity is assigned a constant value. There has, however, been no such corresponding success in predicting the absorptive behaviour of the ionosphere for obliquely incident waves, using the ($\log \rho, f$) relation as determined for the conditions $i_0 = 0$. Indeed, under certain conditions, which we describe below, a most flagrant disagreement is found between the predictions of oblique-incidence absorption based on commonly accepted radio theories and the results found in practice.

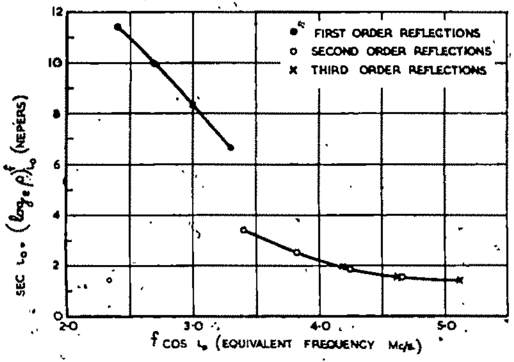

Fig. 1

Some years ago, Martyn[1] introduced the useful conception of equivalent frequency into theoretical relationships between vertical-incidence and oblique-incidence phenomena, by showing how it was possible to relate in simple fashion the absorption of a wave of frequency f, impinging on the ionosphere at an angle of incidence i_0, with the vertical incidence absorption of its equivalent frequency, defined as $f \cos i_0$. Martyn's absorption equivalence theorem can be written as follows:

$$\sec i_0 \, [\log \rho]^{f}_{i_0} = [\log \rho]^{f \cos i_0}_{0}. \qquad (1)$$

In some radio pulse experiments conducted during the War between Burghead (Scotland) and Slough, over a distance of 715 km., measurements were made of $\log \rho$, using F-layer reflexions, for different values of f and i_0. To test how far these results support the relation (1), we have plotted, in Fig. 1, $[\log \rho]^{f}_{i_0} \sec i_0$ as a function of $f \cos i_0$. If the results satisfied relation (1), we should expect all the points to lie on a single curve. The diagram shows, however, that, although second-order and third-order echoes are indicated by points which lie on the same curve, the points indicating first-order (and thus the most obliquely incident) reflexions do not also lie on that curve. There seems indicated, in fact, either abnormally heavy attenuation of the singly reflected echoes or else abnormally weak absorption on the higher orders. That the anomaly is the former rather than the latter is, however, shown in the following table, where the actual attenuations for the singly reflected F-layer echoes are compared with the values calculated from vertical-incidence absorption data using Martyn's relation (1), given above.

PREDICTED AND EXPERIMENTAL VALUES OF IONOSPHERIC ABSORPTION AT OBLIQUE-INCIDENCE (ORDINARY-RAY COMPONENTS)

Date	Frequency (Mc./s.)	Observed absorption of first-order F-echoes (nepers)	Predicted absorption (nepers), based on Martyn's theorem and vertical incidence data
Dec. 27, 1944	4·3	2·82	1·29
	4·53	2·42	1·11
	4·78	2·06	0·96
	4·9	1·94	0·91
	5·2	1·90	0·84
	5·42	1·22	0·85
	5·65	1·43	0·85
Dec. 28, 1944	4·3	1·49	0·71
	4·52	1·48	0·79
	4·78	1·69	0·74
	5·42	1·83	0·96
	5·65	2·24	0·76

We have detected a similar large discrepancy between the ionospheric absorption observed over a long-distance communication circuit and that predicted from normal incidence absorption data.

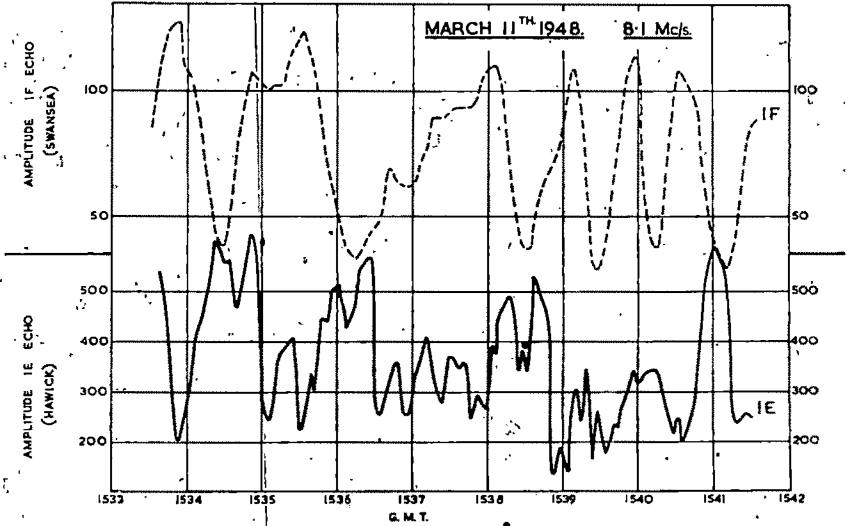

Fig 2.

It is therefore clear that there is some attenuating agency operative which is neglected in the physical basis underlying the formulation of Martyn's relation. Now Martyn assumed that the process of attenuation was that brought about by the ionospheric electron collisions with the air molecules. His theorem is also limited in applicability to conditions in which the frequency of such electronic collisions is small compared with the angular frequency of the radio waves and in which the influence of the earth's magnetic field on absorption can be neglected. In attempting to trace the source of the discrepancy described above, we have attempted to generalize the theorem so as to widen its applicability in the above two respects, but have found that the modified expressions do not account for the anomaly.

We have thus been forced to conclude that there is an agency of attenuation operative which is additional to that caused by electronic collisional friction. In this connexion we may note that under the conditions of our experiment, and indeed in many practical cases too, the frequencies used were only slightly in excess of the oblique-incidence critical frequency for the *E*-layer, which the radio waves traverse on their journey to and from the *F*-layer. This fact has led us to suspect that the additional attenuating agency might be the scattering or partial reflexion of the waves by abnormal or sporadic *E*-layer ionization, the effect of which, as can easily be shown theoretically, is not predicted quantitatively by Martyn's theorem.

To test this hypothesis, experiments have recently been carried out to see whether there is any correlation between sporadic *E*-layer reflexions and the attenuation of waves which pass through that layer. From a pulse sender situated near Frazerburgh, Scotland, *F*-layer first-order echo amplitudes were observed at Swansea over a distance of 685 km. It was estimated that the radio waves on their upward journey to the *F*-layer would pass through the scattering and partially reflecting centres of the *E*-layer at a distance of about 130 km. from the sender. Simultaneous observations of the amplitude of sporadic *E*-layer echoes were therefore made at double this distance, namely, at Hawick. In Fig. 2 are shown plotted some temporal variations of signal amplitudes observed at the two sites, from which it is seen that, when the strength of sporadic *E*-layer echoes at Hawick increases, the waves reflected by the *F*-layer suffer substantial attenuation. It is therefore clear that deviation by sporadic *E*-layer ionization may sometimes have an important influence on the amplitude of waves reflected by the *F*-layer, and we interpret these results as supporting our conclusion concerning the identification of the origin of the discrepancy mentioned above.

A fuller account of these and other absorption measurements and their interpretation will be published elsewhere. The work has been carried out as part of the programme of the Radio Research Board of the Department of Scientific and Industrial Research.

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May 7.

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[1] Martyn, D. F., *Proc. Phys. Soc.*, 47, 323 (1935).

Theory of Superconductivity

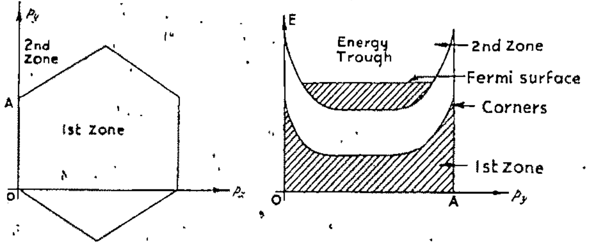
It is a controversial question whether the phenomenon of superconductivity is merely a consequence of the quantum theory of interaction among electrons or whether it depends on the specific crystal structures. The first point of view is taken in Heisenberg's theory[1]. However, it can be shown by general reasoning that if the ionic forces between ions and electrons are disregarded, all states with a total current different from zero will have higher energy than those without. Moreover, there is a strict isomorphic correspondence between all states without current and all states with a given current. Consequently the free energy of the states with a current cannot be the smallest at any temperature. Secondly, Heisenberg's theory predicts the existence of superconductivity in all metals, including the alkali metals; yet so far experimental evidence does not confirm this.

On the other hand, we have found an empirical rule that indicates a correlation between superconductivity and lattice structure; namely, that those metals are superconductive for which the Fermi surface, supposed to be a sphere, lies in very close proximity to one set of the corners formed by the boundary planes of a Brillouin zone. The following table shows the different ratios of the radius of the Fermi surface and the distance from the origin to those corners, for most of the superconductive elements and for some of the non-superconductive elements.

Lattice type	Superconductive elements		Non-superconductive elements	
Body-centred cubic	V, Ta, βZr	1·03 and 0·98	Li, Na, K, Rb, Cs,	$\leqslant$0·75
Face-centred cubic	Al, βLa, βTl, Th, Pb(?)	1·008	Ca, Sr	$\leqslant$0·88
			Au, Ag, Cu	$\leqslant$0·7
Close packed hexagonal	Zn	0·927		
	Cd	0·925		
	αTl	1·10		
	αLa	1·098		

This table encourages the view that a correct theory of superconductivity should be based on the ionic forces. It is known that these ionic forces have predominant influence on the behaviour of the electrons, if the Fermi surface is close to the boundary planes of the Brillouin zone. Now if the Fermi surface nearly circumscribes a complete Brillouin zone, it is certain that the circumscribed zone is full and the next zone is partially filled. The accompanying figure gives a rough sketch of the aspect of a plane (E, p_y), where E is the energy and p_y the component of the momentum along one side of the polygon representing a cross-section through a Brillouin zone. The energy surface $E(\mathbf{p})$ has a discontinuity along this plane which is largest at the corners O, A, and small between them. Hence if interaction of electrons is neglected, the first zone is filled up to the corners, while the second zone is partially filled at the bottom of the energy trough.

If now interaction of electrons is taken into account, the electrons near the corners of the first zone may



migrate into the trough of the second zone, or vice versa. One has to investigate which of these possibilities happens, and whether the symmetry in momentum space of the arrangement is not so disturbed as to produce a mean momentum (current). Among these correlation forces the Coulomb exchange force between electrons with parallel spins is the largest, as, according to the calculation of Wigner and Seitz[2] for the dissociation energy of sodium and lithium, the exchange energy is nearly four times as large as the correlation energy between electrons of antiparallel spins. For simplicity consider a unit volume of metal. We can now estimate the energy required to pick out n electrons from a filled corner and redistribute them in the trough on top of the Fermi surface. Let $\mathbf{p}_0$ be the momentum corresponding to the highest energy-level in the corner. Then the energy of a single electron with momentum $\mathbf{p}$ in the neighbourhood of $\mathbf{p}_0$ is

$$E(\mathbf{p}) = E(\mathbf{p}_0) - \frac{1}{2m^*}(\mathbf{p}_0 - \mathbf{p})^2, \qquad (1)$$

where m^* is the effective mass, generally small for the electrons near the top of a broad band[3]. For the assembly of electrons one has to consider further the interaction described above. Let ω_0 be the number of corners which can be assumed to lie symmetrically in the momentum space, and let $n_1, n_2, \ldots n_{\omega_0}$ be the numbers of electrons removed from the corresponding corners. The calculation gives for the total change of energy

$$\Delta E = \sum_i n_i \left\{ \varepsilon_0 - \frac{3}{4}e^2\left(\frac{3}{4\pi}\right)^{1/3} n_i^{1/3} + \frac{3}{5}\left(\frac{3}{4\pi}\right)^{2/3} \frac{h^2}{2m^*} n_i^{2/3} \right\} + \frac{h^2}{8\pi m}\left(\frac{\pi}{3n_0}\right)^{1/3}\left(\sum_i n_i\right)^2, \qquad (2)$$

where n_0 is the mean density of electrons. The constant ε_0 and the last term with $n_i^{2/3}$ in the bracket come from the kinetic energy (1), the middle term with $n_i^{2/3}$ from the exchange energy, and the last term with $(\Sigma n_i)^2$ from the filling up the free Fermi surface.

From (2) one calculates the minimum value of ΔE, varying the occupation numbers $n_1 \ldots n_{\omega_0}$. The result shows that it is possible to have a state of lowest energy such that, out of ω_0 corners, only $\omega (< \omega_0)$ are 'excited', which means that a number of electrons n ($\sim 10^{-5}\, n_0 \sim 10^{18}$) are removed from each corner and redistributed on the free Fermi surface, while the remaining $\omega_0 - \omega$ corners are intact. The magnitude of $n \sim 10^{-5} n_0$ obtained is easily understood by observing that the minimum of ΔE must be near that value of n where the two terms with $n_i^{2/3}$ and $n_i^{1/3}$ in the bracket cancel, that is, where (using the Bohr radius $r_1 = \hbar^2/me^2$).

$$l \equiv n^{-1/3} = \frac{8\pi^2}{5}\left(\frac{3}{4\pi}\right)^{1/3} \frac{m}{m^*}\left(\frac{\hbar^2}{me^2}\right) = 9{\cdot}8\,\frac{m}{m^*} r_1. \qquad (3)$$

Now it is known that $m^* = \frac{1}{5}m$, hence $l \sim 50\,r_1$, and $n = (50\,r_1)^{-3} \sim 10^{-5}\,n_0$, as the size of the cell is of order $r_1{}^3$.

An asymmetric occupation of the corners represents a state with a resultant momentum and therefore with a spontaneous current.

One has now to determine the thermodynamical properties of this state. The free energy can be calculated by taking account of the thermal agitation of electrons transferred to the free Fermi surface, their thermal energy being equal to $\frac{\omega}{\omega_0}\frac{2\pi^3 m}{3h^2}\left(\frac{3n_0}{\pi}\right)^{1/3} k^2T^2$. The transition temperature T_c is defined by $\omega = \omega_0$, because when this state is reached the asymmetry and hence superconductivity disappear.

Thus one finds

$$T_c = \sqrt{\frac{3}{8}}\,\frac{n\omega_0 h^2}{\pi^2 km}\left(\frac{\pi}{3n_0}\right)^{1/3} \qquad (4)$$

and $T_c \sim 1°$ K., if for n the value 10^{18}, previously obtained is substituted. The change of specific heat on passing the transition temperature T_c is found to be approximately

$$\Delta C = \frac{4\pi^3 mk^2}{3h^2}\left(\frac{3n_0}{\pi}\right)^{1/3} T\left(\frac{3T^2}{T_c{}^2} - 1\right). \qquad (5)$$

The formula agrees with one obtained empirically by Kok[4].

We have made a preliminary investigation of the electrodynamics of superconductivity and found that the length $l = n^{-1/3}$ represents the depth of penetration of a magnetic field in a superconductor as introduced by London. The theoretical order of magnitude $l \sim 10^{-6}$ cm. agrees with the requirement of measurements. The detailed theory will be developed by one of us (K. C. C.).

MAX BORN
KAI CHIA CHENG
Department of Mathematical Physics,
University of Edinburgh.
March 25.

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[1] Heisenberg, W., *Z. Naturforsch.*, II a, 185 (1947).

[2] Seitz, "Modern Theory of Solids", 365.

[3] Fröhlich, H., and Mott, N. F., *Proc. Roy. Soc.*, A, 171, 496 (1939).

[4] Kok, *Physica*, 1, 1103 (1934).

An Anomaly in Electromagnetic Theory

IN a paper which is being issued as a scientific report by the Defence Research Board, Ottawa, and which may be published elsewhere later, I have shown that it is impossible by means of the Maxwell–Lorentz theory of electromagnetism to obtain a reasonable or consistent result for the following problem.

If an electric charge in uniform motion passes near a stationary closed conducting loop, the magnetic field of the charge will link the loop, and hence an E.M.F. and current should be induced in the loop as the charge passes by. If, however, the loop moves and the charge is stationary, with the same relative motion as before, Maxwell–Lorentz theory gives zero-induced E.M.F., and it is shown that this result is not affected by the magnetic effects of the charges induced by the stationary charge on the surface of the moving coil.

The induction of a current in the first case, however, is inconsistent with the principle of the conservation of energy, since although the coil experiences the correct electromagnetic reactive force, the electromagnetic force on the moving charge is perpendicular to its direction of motion, and hence no work is required to maintain its prescribed motion.

The electromagnetic theory of Ritz is shown to give equal finite E.M.F.s in the two cases, but again the principle of conservation of energy is violated.

There appear to be only two possible ways of escape from the energy dilemma. Either no E.M.F.

can be induced or the electromagnetic force on the charge must have a component opposing its motion. The first possibility seems scarcely credible, since the facts of electromagnetic induction by the relative motion of two constant-current circuits, coupled with the electronic theory of conduction, present convincing evidence that an E.M.F. *should* be induced in this problem. The second possibility is contrary to the usual interpretation of Ampère's experiment, in which he found that a current-carrying wire could not be moved longitudinally by a neighbouring magnet or current. It is shown, however, that since the *current-path* in the movable wire in Ampère's experiment could not move, it is not possible to find out by means of such an experiment whether an electrically neutral current-element, or a single moving charge, can experience a longitudinal magnetic force or not. The existence of a small longitudinal force is not, therefore, inconsistent with experiment, and seems to provide the only possible solution of this anomaly of energy conversion.

It appears that the problem is amenable to experimental test, and a practicable arrangement for the apparatus is described. It is shown that the effects of electrostatically induced charges on the coil should not obscure the main effect.

It would appear that only a relative-velocity theory of the type developed in a preliminary way by Ritz can give a reasonable result for this problem. The description of the behaviour of high-speed charged particles by Ritz's theory, however, is different from that given by classical relativistic electrodynamics. For example, Bucherer's classical experiment is explained by Ritz without any variation of the mass of the electron. The problem, therefore, seems to be of considerable fundamental significance to physical science. The special theory of relativity does not appear to resolve it, since relativistic transformations confirm that a magnetic field, and hence an E.M.F., should exist in one case but not in the other.

E. G. CULLWICK

Defence Research Board,
Department of National Defence,
Ottawa.

Feb. 19.

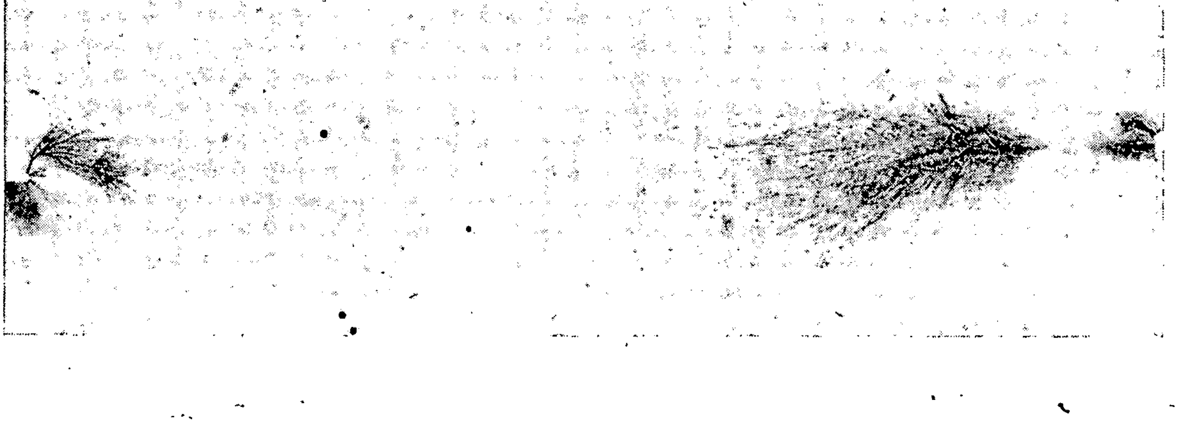
Development of the Spark Discharge

THE development of the spark discharge has been studied with the aid of the rotating camera[1,2,3] in a manner similar to Schonland's studies of the lightning discharge, and the leader-stroke mechanism which he first described has been shown to precede in similar manner the main spark discharge in air at atmospheric pressure. Schonland[4] suspected that the stepped leader discharge was not advancing into wholly un-ionized or virgin air, and suggested that it travelled along a pre-existing ionized path, the path of a 'pilot streamer', which probably moved from cloud to ground with the effective velocity of the stepped leader process, say, 10^7 cm./sec. He failed to record this pilot streamer—if it exists—photographically.

In the laboratory I found[2] it very difficult to photograph all that the eye could see of the discharge process between a point electrode at, say, one million volts to ground, and a plane earthed electrode, even with the aid of a quartz-rock salt lens of wide aperture. This fact was not sufficiently emphasized in Allibone and Meek's[3] account of the process, so that Bruce[5] has suggested that the leader-stroke might be formed from a diffuse glow discharge of the kind which is plainly visible in some of our rotating camera photographs and described as a "shower of discharge".

There is no doubt that a faint and very extensive corona discharge precedes the concentrated bright streamer which is readily photographed: I studied this corona carefully in complete darkness in 1931, though I did not describe it when the branching of the negative spark discharge was described[6]. In 1938 [2] I published the best photograph (Fig. 2 of that paper) that I had succeeded in taking in 1931: the corona discharge was seen to extend over the whole of a 4-ft. gap between electrodes, although the concentrated bright streamer (now called the leader-stroke) never exceeded 25 per cent of the gap length. This corona discharge and the leader-stroke can be seen quite easily if precautions are taken to prevent complete spark-over, which is so blinding to the eye; the use of a spark gap having the requisite time-lag placed in parallel with the gap under observation is the customary means of achieving this, and, by careful control, the leader-stroke in the gap under observation can be chopped at various periods of its development. Normal photographic techniques, however, do not show how this leader develops from the corona discharge.

I have recently studied this corona/leader-stroke transition, with the aid of the Lichtenberg figure technique I described in 1938 [2] in conjunction with the chopped-spark technique to prevent the recording of the main-stroke which otherwise would completely obliterate the photographic record of the corona discharge. One of the photographs obtained is shown. It records the corona at the negative high-voltage point electrode (– 500 kV.) and at the grounded point electrode; the bright streamers from both electrodes (negative and positive leader-strokes)



are both evident. Many observations have first been made without the photographic paper bridging the gap, and it can be stated beyond doubt that the presence of the paper makes very little difference, if any, to the appearance of the discharge. Details of the corona playing over the surface of the emulsion are far superior to any details which can be photographed through a lens: indeed, with a lens, practically only the leader-strokes would have been recorded.

I am certain now that the missing 'pilot streamer' is corona discharge similar to that shown in the photograph; that the leader-stroke develops behind this faint corona and is in the nature of a 'core' to the voluminous corona shower, a trunk and a few main branches in relation to the tree with its innumerable small branches and twigs. Why this is stepped in the lightning flash is still a matter for study; that it is stepped in the laboratory may be due mainly to the circuit; the terminal voltage may be diminished by the current taken by the leader-stroke, but the present experiments do not elucidate this, so further experiments are in progress.

I wish to thank Dr. F. J. Miranda and Mr. F. E. Chivers for assistance in these experiments, and the Metropolitan-Vickers Electrical Co., Ltd., for the loan of the portable impulse generator: also Dr. W. A. Berry, of Messrs. Ilford, Ltd., for the photographic papers selected for use.

Note added in proof. The printed record is inferior to the photographic record, which shows the corona bridging the gap.

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[2] Allibone, *J. Ind. Elect. Eng.*, **82**, 513 (1938).

[3] Allibone and Meek, *Proc. Roy. Soc.*, **166**, 97 (1938).

[4] Schonland's most recent review, *Proc. Phys. Soc.*, **55**, 445 (1943).

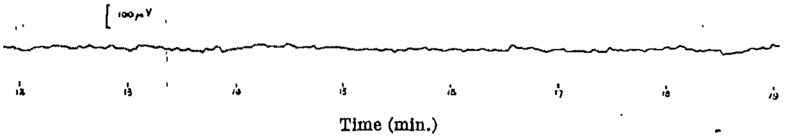
[5] Bruce, C. E. R., *Proc. Roy. Soc.*, **183**, 228 (1945).

[6] Schonland and Allibone, *Nature*, **128**, 794 (1931).

Low-Frequency Noise from Thermionic Valves Working under Amplifying Conditions

ALTHOUGH there is a great deal of information concerning the noise produced by thermionic valves at radio frequencies, there do not appear to have been published data for the low-frequency noise intensity they produce under amplifying conditions. It has long been known that the noise intensity increases as the frequency to which the observational system is tuned is diminished, and a theory of the origin of this so-called 'flicker' noise has been given by Schottky[1] and modified by Macfarlane[2]. One of us (E. J. H.) has made measurements of valve noise and found that the intensity of the low-frequency noise varies approximately inversely as frequency in the range 10–1,000 c./s. At 1,000 c./s. it was not observable above the 'shot' noise. If expressed as an equivalent fluctuation E.M.F. at the grid, the low-frequency noise was remarkably constant from valve to valve.

Those observations, however, do not suffice to allow calculation of the performance of a direct-coupled amplifier covering a band of zero to (say) 1,000 cycles, as it is the very low-frequency fluctuations which set a limit to the useful amplification. It is, of course, difficult to distinguish between fluctuations arising in the valves, and those resulting from irregularities in the external circuits; but the figure for the low-frequency noise which we have obtained using a particularly well-stabilized direct-coupled amplifier sets an upper limit to the valve noise integrated over the band zero—1,000 cycles. A balanced system using 6*J*6 valves with input shorted produces fluctuations having a maximum amplitude equivalent to 20 μV. (peak to peak) when observed on an oscilloscope over a period of several seconds. Using a moving coil pen recorder it has been possible to obtain an accurate record of the low-frequency fluctuations over a period of 30 min. (see record above). The maximum peak-to-peak fluctuation in the record was about 60 μV. One result of the concentration of the noise of the zero frequency end of the spectrum is that extending the band-width to cover 0–5,000 cycles does not appreciably increase the total valve noise.



PORTION OF THE PEN RECORDER TRACE COVERING THE 12TH TO THE 18TH MINUTE OF A 30-MIN. RECORDING.

ORDINATE: E.M.F. EQUIVALENT AT INPUT TERMINALS TO THE VALVE UNBALANCE.

When a 2·2 megohm resistance was connected across the input the thermal agitation noise (6 μV. r.m.s. for a 1,000-cycle band-width) of the resistance could be seen to increase the mean noise-level (observed in a short period) by some 50 per cent.

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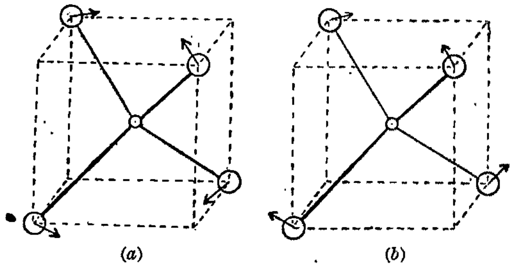
[1] *Phys. Rev.*, **28**, 74 (1926).

[2] *Proc. Phys. Soc.*, **59**, 366 (1947).

A Correlation between Molecular Vibrations and Bond-forming Orbitals

IN a recent letter, Heath and Linnett[1] suggested for the treatment of molecular vibrations a new force field, the orbital valency force field. This is based more closely on modern ideas of directed valency than is the simple valency force field. We decided to test the orbital valency force field on methane, which is a convenient molecule to use, since all the deuterium-substituted methanes have been studied[2]. The first result obtained was that the original theory failed in this case. In particular, for CH_4 and CD_4, it was found that, to explain the frequencies of the doubly degenerate bending vibrations, a bending constant (k_H/r^2) of $1\cdot35 \times 10^5$ dynes/cm. was required, whereas the triply degenerate bending vibrations needed a constant of $0\cdot86 \times 10^5$ dynes/cm. Bending motions which are members of these two degenerate sets are shown in the accompanying drawings.

The relative values of these two bending constants indicate that it is easier to bend the molecule in the sense of Fig. *b* than in the sense of Fig. *a*.



(a) THE DOUBLY DEGENERATE, AND (b) THE TRIPLY DEGENERATE BENDING VIBRATIONS OF METHANE

The bond-forming orbitals of the carbon atom in methane are sp^3 hybridized giving four equal bonds[3]. It can be shown that the hybridization of these orbitals can be changed so that the orbitals alter their directions in a manner similar to the vibration shown in Fig. *b*, but that they cannot change their hybridization to alter their directions in a manner similar to Fig. *a*. It appears, therefore, that the bending shown in Fig. *b* is easier than that shown in Fig. *a*, because the bond-forming orbitals of the carbon atom can, by changing their hybridization, partially follow the hydrogen atoms during vibration *b*, but not during vibration *a*.

This means that we need two constants to describe the bending: (i) an orbital bending constant measuring the force tending to restore the hydrogen atom when it is moved away from the line along which the carbon bond-forming orbital has its maximum value (k_H); (*b*) an orbital following constant measuring the increase of energy when the bond-forming orbitals are distorted by change of hybridization (k_β).

If $\Delta\alpha$ is the bending of the four C—H directions from their original orientation at a certain stage of the vibration in Fig. *b*, and $\Delta\beta$ is the angle through which the orbitals have followed this movement, we may write for the potential energy

$$2V = 4k_H\,(\Delta\alpha - \Delta\beta)^2 + k_\beta\,\Delta\beta^2,$$

since $(\Delta\alpha - \Delta\beta)$ is the angle between the distorted C—H direction and the new direction in which the orbital has its maximum value.

The value of $\Delta\beta$ will be that which makes the energy a minimum. By differentiating V with respect to $\Delta\beta$ and equating the differential to zero, we can eliminate $\Delta\beta$:

$$2V = \frac{4k_H k_\beta}{4k_H + k\beta}\,\Delta\alpha^2.$$

When k_β is infinite, there is no orbital following, and the above expression for the potential energy reduces to the simple orbital valency force field expression:

$$2V = 4k_H\,\Delta\alpha^2.$$

But if k_β is not infinite, $k_H k_\beta/(4k_H + k_\beta)$ is less than k_H, that is, distortion is easier.

This type of force field has been applied to CH_4, CH_3D, CH_2D_2, CHD_3 and CD_4 using three constants: valency stretching constant $k_2 = 4{\cdot}95 \times 10^5$, $k_H/r^2 = 1{\cdot}362 \times 10^5$ and $k_\beta/r^2 = 12{\cdot}98 \times 10^5$ dynes/cm. With these three constants it is possible to explain the fourteen stretching vibration frequencies with an average error of 0·81 per cent and a maximum error of 2·15 per cent, and to account for the fifteen bending vibration frequencies with an average error of 1·19 per cent and a maximum of 2·44 per cent.

The merit of this force field is that, not only does it account for the twenty-nine vibration frequencies of these molecules, but also it accords well with the wave-mechanical conception of the bond-forming orbitals of the carbon atom. It introduces a relation between the distortion of the bonding orbitals and the molecular vibrations, which means that information regarding these distortions can be obtained from molecular vibration frequencies. It is hoped to apply similar ideas to other molecules.

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Feb. 17.

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[2] MacWood, G. E., and Urey, H. C., *J. Chem. Phys.*, 4, 402 (1936). Benedict, W. S., Morikawa, K., Barnes, R. B., and Taylor, H. S., *J. Chem. Phys.*, 5, 1 (1937).

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Electrical Resistivity of Alkali Metals Below 20° K.

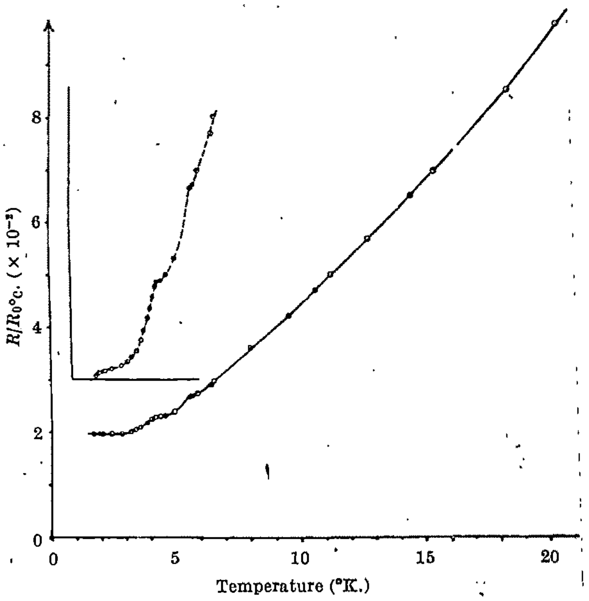
THE change of the electrical resistivity of pure metals at temperatures below 20° K. is of considerable theoretical importance. While there is available a great body of experimental data at the temperatures of liquid hydrogen and helium, only one set of experiments[1] exists in the intervening region, which covers a 5 : 1 ratio in absolute temperature. Since for most metals the resistance becomes largely independent of temperature below 4° K., this region (between 4° and 20° K.) is crucial for determining the law of resistance variation with temperature. We have now modified a previously described helium cryostat[2] working on the Simon expansion principle for continuous work between 1·5° and 20° K., temperatures being determined by a gas thermometer, and the electrical resistance with a sensitive galvanometer amplifier[3].

	Lithium	Sodium	Potassium	Rubidium	Cæsium
n	4·52	4·85	3·2	2	(1·4)
Θ	350	200	160	80	(50)
n_Θ	5·0	4·9	4·9	3·5	(2·4)
$\frac{n_\Theta - n}{n_\Theta}$	0·1	0·01	0·35	0·43	(0·42)
$\frac{\sigma}{M\Theta^2}\cdot V^{1/3}$	30·4	70·1	54·8	53·9	57·8

The whole alkali metal group has now been surveyed, and a short summary of the results is given in the accompanying table. Subtracting the temperature-independent residual resistance, in accordance with Matthiessen's rule, n represents the apparent power variation with temperature deduced from logarithmic plots of the data. According to Bloch's theory[4], n should be 5: the deviation of the lattice vibrations from the Debye T^3 law has, however, to be taken into account. Using Grüneisen's formula[5] in conjunction with the Debye characteristic temperatures, Θ, a corrected value of the theoretical power variation n_Θ (appropriate to each metal) can be derived for the region concerned. It appears that agreement between observation and theory only obtains in the case of sodium. An estimate of the degree of deviation $(n_\Theta - n)/n_\Theta$ is given in the fourth row of the table.

Bloch's theory (and Grüneisen's formula) will only be expected to be valid where the Fermi surface is a sphere in *k*-space as is generally assumed for the monovalent metals. Our results seem to indicate that, except for sodium, the Fermi surfaces of the alkali metals are distorted. A critical survey of other physical data on the alkali metals—for example, the reduced conductivity at 0° C., $\frac{\sigma}{A\Theta^2}.V^{1/3}$—appears to strengthen this assumption. Distortion of the Fermi surface in the case of lithium may possibly be due to insufficient screening of the valency electron; in the case of the higher alkalis, to the effect of electrons from the lower shells.

The parameters for cæsium appear in parentheses because, besides the general deviation from the expected power law, two definite 'kinks' in the resistance curve appear in the neighbourhood of 4° K. (see graph), leaving a degree of uncertainty in the residual resistance, etc.



ELECTRICAL RESISTANCE OF CÆSIUM AT LOW TEMPERATURES. *Inset.* RESISTANCE ON MAGNIFIED SCALE; TEMPERATURE SCALE UNCHANGED

Similar anomalies between 9° K. and 14° K. were observed with potassium. The obvious explanation of an experimental error in the temperature measurement was obviated by various control experiments. In the case of cæsium the suspicion that the anomalies might be caused by inclusion of mercury, superconductive below 4·1° K., was removed by chemical and spectrographic analysis. Furthermore, the high purity of the samples, which were obtained by redistillation, is indicated by the relatively low residual resistance. Another batch of cæsium from the same source showed a distinctive kink in the resistance curve at ~ 10° K., while the anomaly at ~ 4° K. was much less marked. Preliminary investigations on the variation of resistance in transverse magnetic fields (up to ~ 4 kG.) at 4° K. and 2° K. also yielded curves with analogous anomalies. In this connexion it is of interest to note that Meissner and Voigt[6] from their measured values on cæsium at 4° K. and 20° K. suspect a discontinuity in the resistance-temperature curve in the intervening range.

On the strength of the evidence before us, we cannot suggest an adequate explanation for these anomalies. The different behaviour of our two samples of cæsium suggests some sort of dependency on structure; it is worth remembering that superconductivity, too, exhibits structure-dependent features which are particularly strong in the less well-investigated metals such as vanadium, titanium and uranium. It appears possible, further, that these anomalies in the electrical resistance may be related to small anomalies in the specific heat, such as were observed in beryllium by Cristescu and Simon[7] and in sodium by Pickard and Simon[8].

A detailed account of this research will be published elsewhere. The investigation on the alkali metals is intended as the first part of a survey of the low-temperature resistivity of pure metals in general, and work is now in progress on the second column of the Periodic Table.

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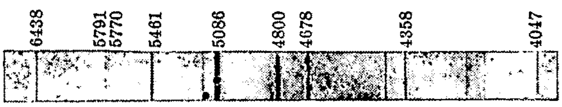
A Simple Way of Photographing Spectra

Recently, I have been photographing spectra in their natural colours with 35 mm. Dufaycolor film. The spectra were produced by a single 60° flint prism. 35 mm. film is used in a camera of 5 cm. focal length and, if this camera had been used by itself, the spectra would have been much too short. I therefore tried to photograph them through the telescope of the spectrometer; that is, the telescope object glass and eyepiece were left in position and the camera placed immediately after the eyepiece. The telescope had a magnification of about 11 times, so this would increase the angular extent of the spectrum from 2½° to 27½°. I found that the field of view of the spectrometer eyepiece was too narrow, but on substituting the eyepiece of a prismatic field-glass which took in a cone of semivertical angle 128′ instead of the previous 53′, the experiment succeeded; the visible spectrum covered the full breadth of the film and was in perfect focus from end to end.

The method is naturally not restricted to colour film, and the accompanying photograph shows what can be done by it with the Ilford Special Rapid Panchromatic plate and an exposure of three minutes. In this case a 3¼ in. × 2½ in. plate was used length-



ways and the spectrum occupied the full length of the plate. The wave-lengths are marked in angstroms. Any camera will do. The eye-ring of the telescope is only 2½ mm. in diameter and about 9 mm. out from the end of the telescope, so a lens working at $F/16$ is ample. The spectrum is focused with the telescope, and the camera is focused on infinity; so it does not require a focusing arrangement. Not only is the spectrum in focus from end to end of the plate, but also the latter gives the theoretical value for the resolving power all over it. The spectrum is that of the cadmium mercury arc.

It is almost impossible to discover anything new in optics nowadays, and someone is probably using this method at the present time. But I have seen no reference to it anywhere, and I have never seen or heard of a spectrometer with a wide-angle eyepiece. So I think it worth while to direct attention to the possibilities of the method here. It replaces the spectrograph for many purposes and opens up an interesting new field to experiment.

Some hints may be added. If a crown glass prism is used, the spectrum extends to 3500 A. But the ultra-violet portion is out of focus, the object glasses not being corrected for this region. Several spectra may be obtained on the same plate by tilting the camera or (not so good) by tilting the prism table. It is not possible to use the snapshot shutter of the camera for quantitative work; there are no sources bright enough. If the wide-angle eyepiece is used without the camera, but with a very wide slit, the arrangement is very suitable for projecting spectra and making them visible to a class; in this case the screen should be about three feet from the eyepiece.

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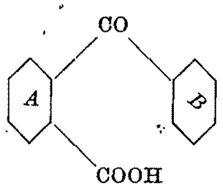
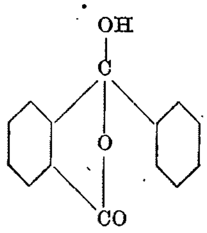
Differential Effect of 2-Benzoylbenzoic Acid and its Derivatives upon Plant Species

AT the time of the discovery of the selective herbicidal activity of (i) the substituted phenoxyacetic acids[1,2] and (ii) the arylcarbamic esters[3,4], many other chemical types were examined, and 2-benzoylbenzoic acid and its derivatives received considerable attention because of their marked biological activity[5]. The investigation of this type was at the time abandoned because of the superior promise of the phenoxyacetic acid derivatives as agents for the practical control of crop weeds. It is felt desirable, nevertheless, to place our observations on record, for it is our view that as the study of the subject develops, increasing numbers of different types of chemicals will be found to display selective herbicidal action, and the recording of data will contribute to the ultimate understanding of the relationships between chemical constitution and herbicidal effect.

2-Benzoylbenzoic acid and many of its derivatives are readily accessible chemicals since they are employed in the synthesis of anthraquinone derivatives. Since auxin-like activity, as well as the selective herbicidal effect which it is believed may depend on this biochemical function, is found in aromatic and heterocyclic carboxylic acids in which the carboxylic acid group is attached through a linking group to a cyclic nucleus, 2-benzoylbenzoic acid appeared to be a suitable choice for examination. This substance is considered to have the structure I, but it gives rise to isomeric pairs of esters; the normal esters of configuration corresponding to I, and the pseudo esters corresponding to structure II[6,7].



I



II

The benzoylbenzoic acid derivatives studied are all described in the literature and were prepared by conventional methods, being characterized by their melting points, which in all cases corresponded with the recorded data. The esters were of the normal configuration and the pseudo esters were not examined. The preparation of 2 : 4 : 5-trichlorophenylacetic acid has been described by Sexton[8].

The biological methods employed were described by Templeman and Sexton[2] and consisted of a laboratory germination test at a concentration of 200 parts per million of test substance in water, and a soil test. The acids were examined as sodium salts and the esters in dispersed form, prepared by dissolving them in a little alcohol and pouring into a large bulk of water. In the soil test, oats and charlock were sown together in boxes in the open, the chemical being applied in dry form diluted with sand at a rate equivalent to 25 lb. per acre. α-Naphthylacetic acid was used as a standard of comparison.

In accordance with the method previously used, the activities of the various compounds against charlock are recorded relative to that of α-naphthylacetic acid, as follows:

Class A: Substances of greater activity than α-naphthylacetic acid.
2 : 4 : 5-Trichlorophenylacetic acid.

Class B: Substances approximately equal in activity to α-naphthylacetic acid.
2-(4′-Chlorobenzoyl) benzoic acid.

Class C: Substances of some activity but less active than α-naphthylacetic acid.
2-Benzoylbenzoic acid.
2-(3′ : 4′-Dichlorobenzoyl) benzoic acid.
2-(4′-Chloro-3′-nitrobenzoyl) benzoic acid.
2-(α-Naphthoyl) benzoic acid.

Class D: Substances of low or doubtful activity or inactive.
Methyl 2-benzoylbenzoate.
Ethyl 2-benzoylbenzoate.
2-Benzoyl-4-(5)-chlorobenzoic acid.
2-Benzoyl-4 : 5-dichlorobenzoic acid.
2-Benzoyl-3 : 4 : 5 : 6-tetrachlorobenzoic acid.
2-(2′ : 5′-Dichlorobenzoyl) 3 : 6-dichlorobenzoic acid.
2-(2′ : 5′-Dichlorobenzoyl) 3 : 4 : 5 : 6-tetrachlorobenzoic acid (damage to oats).
2-(4′-Chloro-3′-aminobenzoyl) benzoic acid.
2-(4′-Methylbenzoyl) benzoic acid.
2-(4′-Chloro-α-naphthoyl) benzoic acid.
Phenylacetic acid.

In the seed germination test, it is known that the susceptibility of charlock and the resistance of oats is a characteristic response to β-indolylacetic acid, α-naphthylacetic acid and the substituted phenoxyacetic acids. Further, as all these chemical types produce characteristic effects such as epinastic responses on mature plants, it would appear that the mechanism of growth-inhibition of charlock may be concerned with hormonal defunction. 2 : 4 : 5-Trichlorophenylacetic acid also fits into this picture, for an epinastic response of oat coleoptiles on emergence was observed, and it is a powerful inhibitor of charlock seed germination. Preliminary experiments have indicated that a response in the Went pea test is given by one of the more active members of the benzoylbenzoic acid series, namely, 2-(3′ : 4′-dichlorobenzoyl) benzoic acid ; but the generality of the parallelism between the effect on charlock and auxin-like activity cannot be asserted until a more comprehensive examination has been made of these and other compounds.

Veldstra[9] has put forward the hypothesis that the biochemical effects of auxin-like substances have a physical basis, and that activity is found in substances in which an acidic group is bound to a cyclic nucleus in such a way that the direction of the negative pole lies at an angle (ideally, at right angles) to the plane of the ring. The activity of the benzoylbenzoic acids is not inconsistent with this hypothesis when it is borne in mind that the benzoyl radical can rotate freely about the bond uniting it to the benzoic acid nucleus (*A* in formula I), so that there is the possibility of the —COOH group projecting at an angle to the plane of the benzene ring (*B*) of the benzoyl group. It is perhaps significant that the weighting of this particular ring (*B*) alone by appropriately disposed chlorine atoms does not decrease the activity. Indeed, the activity was definitely increased in one case. A similar weighting of the ring *A* with which the —COOH group is coplanar reduced the activity.

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An Improved Method for the Assay of Toxicity of Arsenicals

Since the pioneer work of Durham, Gaddum and Marchal[1] on toxicity tests for arsenicals, comparisons have been carried out using the method of quantal responses. The statistical implications of this method have been the subject of a considerable volume of work[2-4]. No amount of perfection of analysis can, however, compensate for the inherent shortcomings of the method.

In a quantal response assay, each animal can contribute only a positive or a negative reading (in this case death or survival) to the total information obtained. In the event of the death of an animal, there is no indication as to whether the dose given was the exact minimum individual lethal dose for that animal, or whether, in fact, it was considerably in excess of this amount. Thus the method is usually wasteful of information when a continuous variate such as survival-time can be employed instead, and only where no such continuous variate can be used in an easily measurable form is recourse to quantal response methods necessary.

In the case of the arsenicals there seems to be no such difficulty. Using the survival-time as the continuous variate, it has been found possible to perform an assay with increased speed, accuracy, and economy in animals. Where the survival-time for each animal is used in this way, a definite numerical estimate of the toxicity of the drug for that particular animal has been obtained, and, provided that a linear dose-response relationship can be employed, it is naturally to be expected that more information will be gained per animal used in the test.

With this principle in mind a series of experiments was carried out. The same standard preparation of 'Neoarsphenamine' was used throughout, 'Neoarsphenamine' being one of the most widely used of all the arsenicals. The experiments were so designed that the methods of quantal responses and direct measurement of survival-times could be compared. The dose range in the latter case was chosen to ensure that all the animals treated should die, and that the longest period of survival should not exceed 10 hours. It was found possible to establish a linear relationship between dose of drug and mean survival-time when a logarithmic transformation of both was used. Statistical analysis of the results shows the graded response method to be accurate and unbiased. The accompanying table shows the calculated approximate limits of error for both types of assay, and for varying numbers of animals in the test. It is assumed in each case that the slope of the dose-response line is accurately known.

Method of assay	Minimum approximate percentage limits of error ($P = 0{\cdot}05$)		
	$n = 10$	$n = 20$	$n = 40$
Quantal response	77·5–129·0	83·4–119·7	88·1–113·6
Graded response	86·0–116·2	90·3–110·7	93·2–107·3

The limits of error for the graded response assay are thus about half as wide as those for the quantal response assay, and the accuracy of the estimation of potency is about four times as great. Trial assays have been performed on this basis with satisfactory results.

Although for the practical purpose of safeguarding against the issue for sale of highly toxic material the standard quantal response assay method may be satisfactory, it is hoped that this alternative method will be of value in those cases where a greater degree of accuracy is desirable. Work on these lines is still in progress and will be published in more detail at a later date.

Grateful acknowledgment is due to Dr. C. W. Emmens for his advice throughout the course of this work.

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Reaction of β-Naphthol with *l*-α- and *l*-β-Phellandrene

SOME years ago, Goodway and West[1] reported that low yields of the maleic anhydride adduct corresponding to α-phellandrene were obtainable from β-phellandrene, and it was considered probable that the *l*-α-phellandrene adduct isolated was derived by the thermal decomposition of the primary resinous material obtained from the *l*-β-phellandrene.

In attempts to obtain another derivative characteristic for β-phellandrene, we have studied the reaction of this terpene with β-naphthol and obtained a product which melted at 137–138°, whereas Salfeld[2] obtained a product melting at 139–140° from a sample of α-phellandrene of which the constants were not recorded. The *l*-β-phellandrene utilized in our experiments was derived from Canada balsam oil which has been shown to be free from the α-isomeride[3], and the *l*-α-phellandrene used for comparison was prepared by fractionation from the oil of *Eucalyptus dives*. From the melting point, mixed melting point, and optical rotation of the reaction products of the two terpenes with β-naphthol, the adducts appear to be identical. Further evidence of the identity and structure of the adducts is being sought, and in view of the fact that the infra-red absorption spectra[4] of α- and β-phellandrene offer the best possibility of distinguishing readily between the two terpenes, it is hoped that it may be possible to establish the mechanism of the reaction of the β-isomeride with β-naphthol.

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Inhibition of Hexosediphosphatase by Sulphhydryl Reagents and by Ascorbic Acid

DURING the course of an investigation of the action of vitamin K and its biological antagonists (dicoumarol, salicylate) on various phosphatases, details of which will be published elsewhere, it was observed that liver hexosediphosphatase[1] exhibited a much greater sensitivity towards quinones than did the other phosphatases. Purified bone phosphomonoesterase[2], for example, required a concentration of $10^{-3} M$ benzoquinone for complete inactivation, whereas $10^{-5} M$ benzoquinone was sufficient completely to inhibit the hexosediphosphatase.

It is well known that enzymes the activity of which is dependent on free —SH groups are inhibited by quinones in very low concentrations, and it has been suggested that the antibiotic activity of quinones is a result of this effect[3]. With the exception of some pyrophosphatases and transphosphorylases, the phosphatases, the activity of which is probably dependent on free amino-groups[4], are, on the other hand, not affected by —SH reagents[5]. The comparatively high quinone sensitivity of hexosediphosphatase, however, led us to examine the behaviour of this enzyme towards other substances which are known to react with thiol groups.

Our experiments show that hexosediphosphatase is inhibited by iodoacetate, by phenyl mercuric nitrate and by alloxan. Cysteine, which itself inhibits in sufficiently high concentration but strongly activates at lower concentrations, completely reverses the iodoacetate and phenyl mercuric nitrate inhibitions and partly reverses that by alloxan. Thus inhibition by iodoacetate ($10^{-2} M$) or by alloxan ($2{\cdot}5 \times 10^{-3} M$) is 40 per cent. Cysteine ($10^{-3} M$) reactivates the iodoacetate-inhibited enzyme 100 per cent and the alloxan-inhibited enzyme 37 per cent (that is, inhibition is reduced from 40 to 25 per cent). Inhibition by alloxan ($5 \times 10^{-3} M$) is complete and there is no reactivation by cysteine. Phenyl mercuric nitrate ($10^{-4} M$) inhibits 100 per cent, with complete reactivation by cysteine ($2{\cdot}5 \times 10^{-4} M$). Cysteine ($5 \times 10^{-4} M$ and $1 \times 10^{-3} M$) alone activates 98 and 96 per cent respectively, while an increase in concentration to $5 \times 10^{-3} M$ results in complete inactivation.

The hexosediphosphatase used was prepared as described by Gomori[1] and was free from non-specific phosphatase activity. Mixtures (10·0 ml.) of the enzyme solution (0·1 ml.), borate buffer (2·0 ml.), $0{\cdot}05 M$ magnesium sulphate (2·0 ml.), sodium hexosediphosphate solution (2·0 ml. ≡ 0·2 mgm. phosphorus) and inhibitor were incubated for 30 min. at 37° and *p*H 9·1 in separate tubes, and the inorganic phosphate in each was determined colorimetrically. The quantity of enzyme used was such that half the substrate was hydrolysed in the controls (that is, no inhibitor) during the period of incubation. No phosphate was liberated in the absence of enzyme. When iodoacetate was used, it was incubated with the diluted enzyme-magnesium-buffer mixture for 15 min. before addition of the substrate and of cysteine.

Experiments with ascorbic acid, which was expected to activate the enzyme by virtue of its reducing properties, showed it to be a very powerful inhibitor. Concentrations below $5 \times 10^{-7} M$ resulted in slight activation (up to 5 per cent), but concentrations greater than $10^{-6} M$ inhibited, with complete inactivation in the presence of $2 \times 10^{-3} M$ ascorbic acid. This inactivation by ascorbic acid is undoubtedly due to competition with the hexosediphosphate, as indicated by the results of experiments with varied substrate concentrations. Results of a typical experiment are given in the accompanying table.

Ascorbic acid, molar concentration × 10^4	Substrate solution (ml.)	Inorganic phosphorus (μgm.)	Inhibition (per cent)
0	1·5	573	0
2·5	1·5	371	35
5	1·5	317	45
5	3·0	245	32
10	3·0	200	45
0	3·0	360	0

These results also confirm Gomori's observation that the substrate itself inhibits the enzyme as the concentration is raised and, for this reason, the amount of enzyme solution used was increased to 0·15 ml. in the above experiment.

Inhibition of β-malt amylase by ascorbic acid and related compounds was attributed by Hanes[6] to the presence in the molecule of the di-enol grouping. Giri[7] has shown that several plant and animal phosphatases, which were not affected by ascorbic acid, were inhibited by an ascorbic acid-copper complex. Our experiments demonstrate that ascorbic acid may compete for an enzyme with a substrate which it resembles in ring structure. The possibility that ascorbic acid may compete with hexose diphosphate for other enzymes such as aldolase or with other furanose-sugar phosphates, and thereby influence the course of carbohydrate or nucleotide metabolism, seems to us to be worthy of further investigation.

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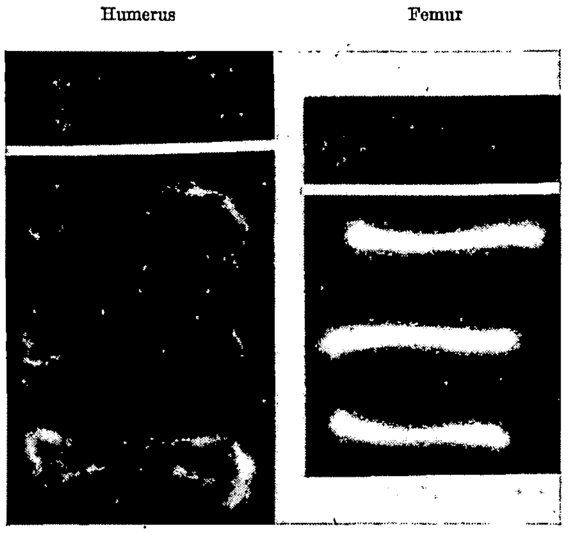
Influence of Folliculin on Bone Metabolism, Studied by Means of Radiophosphorus, $^{32}_{15}P$

IN these experiments, all pigeons received daily 0·15 mgm. phosphorus labelled with radiophosphorus (subcutaneously) and 80 mgm. phosphorus provided by a normal diet (principally Indian corn). In addition, all pigeons, except control birds, received daily 0·25 mgm. œstradiol dipropionate ('Ovocycline P' Ciba, intramuscularly). The radiophosphorus was prepared by irradiations of phosphorus with deuterons produced by the cyclotron of the Laboratoire de Chimie Nucléaire of Paris (Prof. F. Joliot-Curie).



UPPER PHOTOGRAPHS: CONTROLS
LOWER THREE PHOTOGRAPHS: EFFECT OF FOLLICULIN

The right-hand autoradiograph was taken after a 20-day treatment; it shows the femur of a control pigeon and those of three pigeons submitted to folliculin administration. The new medullary bone is very rich in injected radiophosphorus; the quantity of the latter present in the control femoral diaphysis, however, is clearly perceptible. It appears, indeed, according to the determination of radioactivity by means of a Geiger–Müller counter, that the new medullary bone contains on an average seven or eight times more injected radiophosphorus than the femur of a control pigeon. As it can be seen from the left-hand autoradiograph, the mineral metabolism of bones such as the humerus, the medullary cavities of which are not filled with folliculinic bone, is, however, accelerated under the influence of œstradiol; radiophosphorus takes the place of phosphorus in the diaphysis as well as in the epiphysis to a greater extent in the treated pigeon than in untreated ones.

By calculating the amount of ordinary phosphorus from food and of phosphorus from parenteral administration (radiophosphorus), by measuring the rate of elimination of both forms of phosphorus and the quantity of these two elements present in bone, we have found that nearly half the phosphorus present in new medullary bone does not come directly from phosphorus fed or injected, but from phosphorus already stored in the skeleton. The proportion of labelled phosphorus observed at the end of a 20-day experiment shows that nearly 13·1 per cent of bone phosphorus (femur) has been renewed in a pigeon receiving folliculin, but only 1·7 per cent in the controls.

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Sublittoral Seaweed Survey: Relationship of Algal Growth and Depth

DURING the current survey of seaweed of the sublittoral zone of Scotland, very extensive sampling has been carried out. The samples are taken by means of a calibrated spring grab which closes by trigger action on touching bottom. The seaweed samples are weighed, species noted and also the depths from which they are obtained.

A survey of the sublittoral zone around the Argyllshire coast[1] has shown that a straight-line relationship exists between the mean density (d_t) of the total number of sampling operations and the depth:

$$d_t = 5{\cdot}48 - 0{\cdot}34 f,$$

where d_t is density (kgm./m.^{2}) and f is depth (metres). *Laminaria Cloustoni* is the dominant species. No large brown algæ were found below nine fathoms.

With the data obtained from the survey of Argyllshire, it was estimated that more than one million tons of seaweed was likely to be found growing in Orkney waters. Surveys to date indicate this figure to be conservative.

The results of surveys in Scapa Flow, Orkney (800 acres), have again shown that a straight-line relationship occurs between mean density and depth:

$$d_t = 6{\cdot}95 - 0{\cdot}41 f.$$

Laminaria Cloustoni is the dominant species, and the density of seaweed growth is greater than on the coast of Argyll. No very strong tidal streams occur in either of these two above areas.

Two separate and extensive surveys have been carried out on opposite sides of Wide Firth, Orkney, namely, the Bay of Firth (1,500 acres) and around the island of Shapinsay (3,000 acres). *Laminaria saccharina* is dominant in both areas.

Unlike the formula above, it is found that the square root of the mean density of total sampling operations divided by the percentage cover is approximately a constant:

$$\frac{\sqrt{d_t}}{C} = k;$$

where d_t is mean density of total sampling operations, and C is cover (number of samples with weed expressed as a percentage of total number of sampling operations).

For Bay of Firth

$$\frac{\sqrt{d_t}}{C} = 3{\cdot}04 + 0{\cdot}10f\ (\pm 4\%)\ \text{1–6 fathoms L.W.}$$

For Shapinsay

$$\frac{\sqrt{d_t}}{C} = 4{\cdot}06 - 0{\cdot}07f\ (\pm 4\%)\ \text{1–7 fathoms L.W.}$$

Very strong tidal streams are associated with Wide Firth.

A recently completed survey of Sanday Sound (8,300 acres), involving more than 2,500 sampling operations, showed a similar formula to that found for Bay of Firth and Shapinsay. *Laminaria saccharina* is the dominant species in these two areas, whereas *Laminaria Cloustoni* is dominant in Sanday Sound as in Scapa Flow.

The value for Sanday Sound is

$$\frac{\sqrt{d_t}}{C} = 3{\cdot}05 - 0{\cdot}02f\ (\pm 5\%)\ \text{1–10 fathoms L.W.}$$

$$\text{Now } d_t = d_w C.$$

$$\therefore\ \frac{\sqrt{d_t}}{C} = \sqrt{\frac{d_w}{C}},$$

$$\text{so that } d_w \propto C,$$

where d_t is mean density of total sampling operations, d_w is mean density of sampling operations which brought up weed, and C is cover expressed as percentage.

It follows, therefore, for Bay of Firth, Shapinsay coast and Sanday Sound, where very strong tides occur, that seaweed density (d_w) is directly proportional to the cover of the whole area, and in Scapa Flow and around the Argyllshire coast, where strong tidal streams do not occur, the mean density (d_t) of the whole area is inversely proportional to depth.

In the former cases $d_t \propto C^2$ and in the latter case $d_t \propto 1/f$.

Variations from the constant, $\frac{\sqrt{d_t}}{C}$, are due to small differences in the weights of individual plants.

Sampling has shown that at 4 and 5 fathoms in the Bay of Firth and Shapinsay, the *number* of plants and not their individual weights is chiefly responsible for great differences in mean density. The number of plants is found to be exactly proportional to the cover of the whole of the survey areas:

	% Cover at 4 and 5 fathoms	No. of plants/unit area
Bay of Firth	41	2·5
Shapinsay	77	4·7

The most interesting points brought out in these surveys of the sublittoral zone is that seaweed density of the larger brown algæ and the depth at which they grow conform to two simple mathematical laws: (1) that where strong tidal forces occur, the density of algæ is proportional to the weed coverage of the *whole* area. This can be accounted for by reproduction and spore dispersal; (2) that where strong tidal forces do not occur, the density is inversely proportional to the depth at which the algæ grow.

Full details will be published later.

The above surveys are part of the programme of research of the Scottish Seaweed Research Association.

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Transplantation of Fertilized Rabbit Ova: the Effect on Viability of Age, *in vitro* Storage Period, and Storage Temperature

IN 1890 and 1897, Heape[1] demonstrated the unimportance of somatic tissue to the germ cells by his successful transplantation of rabbit ova to a uterine foster mother. In 1934, Pincus and Enzmann[2] obtained normal young by transplanting rabbit ova fertilized or cultured *in vitro*. Recently[3], I reported normal development of ova stored at low temperature, and an optimal temperature for storage. I now have data on the probability of normal development after various treatments.

Ova were obtained from superovulated rabbits[4], and kept in undiluted rabbit serum. 25 hours after insemination they were recovered from the oviducts, and were mostly in the two-cell stage. If recovered after 72 hours they were mostly morulæ, some in the oviducts and some in the uterus. At 96 hours they were nearly all in the uterus, some being at the blastocyst stage. The ova were either transplanted fresh, or stored at 0° C. (slow cooling over a five-hour period) or at 10° C., or cultured at 38° C. (subcultured daily), before transplantation.

Recipient does were caused to ovulate by gonadotrophin injection. In one series of experiments, fresh 25-hour ova were transplanted to the uterus. In all the other experiments (most of which are summarized in the table), irrespective of the period of culture or storage, ova one day old at recovery were transplanted to the oviducts of does injected one day before the operation, while ova three and four days old were put into the uteri of does injected three and four days previously. Ova were placed in the oviducts through the fimbria, and into the uterus by puncturing its wall with a pipette containing the ova. Each host doe received five to twenty ova, the average number being increased with the length of time the ova were kept *in vitro*.

Most of the pregnant recipient does were killed 25–28 days after the operation. Some fœtal degeneration is normal in the rabbit[5], and young dead *in utero* (about 6 per cent of all young) were taken to represent normal development. The sex of live young, the number of maternal placentæ (ova implanted but failing to develop) and number of fœtal placentæ (resorption of embryo or fœtus) were recorded.

TRANSPLANTATION OF FERTILIZED RABBIT OVA: THE EFFECT ON VIABILITY OF AGE, *in vitro* STORAGE PERIOD, AND STORAGE TEMPERATURE

Storage temperature (°C)	Storage time (hr.)	Age of ova before storage (days)	Number of				Young as percentage of ova transplanted
			Ova transplanted	Recipient does	Does pregnant	Normal young	
30	1–2	1	239	24	21	130	54
		3	132	11	5	41	31
		4	89	9	5	21	24
10	24	1	94	7	4	35	37
		3	103	7	6	38	37
		4	138	8	7	26	19
	96	1	182	14	9	28	15
		3	46	4	3	21	46
0	24	1	91	7	3	10	11
	96	1	146	9	4	9	6
38	24	1	137	13	8	28	20
	48	1	153	9	6	41	27

The results (see table) show: (1) that the younger the ova transplanted, the better is their chance of normal development. This is seen clearly in the case of ova freshly transplanted (1–2 hours storage time) and is also shown with ova stored 24 hours at 10° C. In the latter series the percentages of ova developing normally in the does actually pregnant were respectively 70, 44 and 22 with ova recovered at one, three and four days. The figures for ova kept 96 hours at 10° C. are not in agreement with this result; but the 46 per cent survival of the three-day ova is exceptionally high—perhaps because of the small number of cases.

(2) With storage at 0° C., normal development of one-day ova was very low after only 24 hours; but some young (6 per cent) were obtained after 96 hours storage. None of 59 three-day ova stored for 96 hours at 0° C., and transplanted among four does, developed into normal young. These results confirm that 10° C. is the optimal temperature for storage—as previously found[3] in a study on cleavage *in vitro*.

(3) When ova recovered at one day were cultured at 38° C. and then transplanted to the oviducts of does injected one day before operation, 20 per cent of those cultured 24 hours developed normally, and 27 per cent of those cultured 48 hours; but none of 109 ova cultured for 72 hours (six does) yielded normal young.

(4) The sex ratio of the young was not altered after storage *in vitro*; there is, therefore, no obvious differential mortality of the sexes at different storage temperatures. Of 429 young, only one, dead *in utero*, was abnormal, having a hernia and deformation of the fore limbs. It is probable that defective ova or embryos degenerated early. Because all non-pregnant animals were not sacrificed for examination, the recorded degeneration may be lower than its actual occurrence; several does were diagnosed as pregnant at two weeks but found to be not pregnant later, presumably owing to early degeneration of embryos.

Most of the ova that did not develop normally left no trace of having become implanted. Degeneration after implantation was more common with cultured or stored ova than after fresh transplantation. For does pregnant from freshly transplanted ova the mean litter size was 6·2, plus 0·58 degenerate. The corresponding figures for ova stored at 10° C. were 5·1 and 1·55, and for cultured ova 4·9 and 1·93.

(5) In the experiments previously mentioned, two-cell ova were transplanted to the oviduct; in other experiments (not shown in the table) they were freshly transplanted to the uterus. 92 one-day ova were divided among six does injected 72 hours before operation; none developed normally. 109 one-day ova were placed in the uteri of does 24 hours after injection; of the eight recipients one only became pregnant, the thirteen transplanted ova in this animal being represented at killing by a single normal fœtus, with no trace of other implantations. It seems that two-cell ova can survive *in vitro* at 0° C., 10° C. or 38° C., but fail to do so *in utero*.

(6) The following cases demonstrate the normal potentiality for development of large numbers of ova obtained by gonadotrophin injection; 53 two-cell ova from one doe, transplanted to four others, yielded 46 normal young. In another instance, 26 young were obtained from 35 two-cell ova divided among three recipients.

In conclusion, I wish to acknowledge my gratitude to Dr. Hudson Hoagland and Dr. Gregory Pincus for giving me the opportunity of working in their laboratory and especially to Dr. Pincus for advice. My thanks are also due to the Foundation for Applied Research, San Antonio, Texas, for a grant, and to Mr. Raymond A. Gunnarson for assistance.

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Hearing in Cetacea

DR. FRASER's remarks in *Nature* of November 29, 1947, p. 759, on sounds emitted by dolphins reached me by sea transport shortly after I had made the following observations which appear pertinent to his subject.

While examining male adults of the sperm whale (*Physeter catodon*) on board this factory, I have established that the external auditory meatus is a short blind sac which penetrates from the auditory aperture a distance no deeper than the blubber thickness, and which has altogether lost organic connexion with the middle ear. The sac has somewhat thickened unpigmented walls wherein muscular tissue may be developed: internally, these walls are thrown into transverse folds. On the other hand, the blue whale and the fin (*Balænoptera musculus* and *B. physalus*) retain the normal mammalian pattern, and in these whales one can trace, from external aperture to tympano-petrosal bone, a continuous meatus the thin smooth epidermal lining of which is pigmented for the greater part of its length. Their Eustachian tube also presents no unusual features, but I have not so far been able to examine it in the sperm.

Obliteration of the meatal lumen in sperm whales must occur somewhere in the middle region of the canal, since dissection with steam-saw and axe reveals that the proximal portion, running in the temporal bone, is still intact. Also, in two physically immature adults examined, the external meatus, after termination of its cavity, was prolonged into a short solid stalk representing the canal after obliteration of its lumen. This suggests that the fœtal condition may exhibit a continuous meatus, but unfortunately sperm fœtuses are not available in the Antarctic.

There is evidence that the sperm whale dives to great depths, and it is apparent that permanent closure of the external auditory meatus has adaptive advantage in this cetacean, which must be capable of tolerating considerable changes in hydrostatic pressure.

The adult sperm whale can thus only hear by penetration of vibrations through the solid tissues of the head. In a mammal this does not appear an efficient path; but in the light of Dr. Fraser's remarks on the sensitivity of dolphins to supersonic emissions, it seems clear that such vibrations of high frequency and short wave-length would suffer considerably less absorption, during direct transmission through the sperm head, than sounds within the auditory range.

The experience of whaling gunners in catchers fitted with 'Asdic' gear shows that the larger rorquals, as well as dolphins, are, in fact, sensitive to supersonic vibrations. The 'ping' not only locates but also frightens the whale, which makes off at speed. This becomes an advantage should the catcher be fast enough to overtake its quarry, because when blue and fin whales are running they blow more often and are therefore more easily followed; moreover, they are sooner exhausted. The deliberate working of the 'Asdic' at 'short-interval transmission' to keep whales on the run has, in fact, been employed successfully in chasing.

I am indebted to both Messrs. Chr. Salvesen and Co. and to the Discovery Investigations for facilities enjoyed in the south.

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A Plant Disease Caused by a Spore-forming Bacterium under Natural Conditions

THAT spore-forming bacteria, that is, species of the genus *Bacillus*, are responsible for some plant diseases has been recorded from time to time, but has rarely been confirmed; it is not yet generally accepted, as the great majority of bacterial plant diseases are known to be due to bacteria which do not form spores.

A few years ago, one of us (W. J. D.) recorded[1] the complete disintegration, under laboratory conditions, of the parenchyma of whole, or slices, of potato tubers, carrots, onions, cucumbers and iris stems by *Bacillus polymyxa* (Prazmowski) Migula, a soil-inhabiting organism. Madhok and Fazal-ud-Din[2] investigated a disease of tomato fruits which was also shown to be due to a species of *Bacillus* which they named *B. fructodestruens*, and the subject was further reviewed a few years later[3].

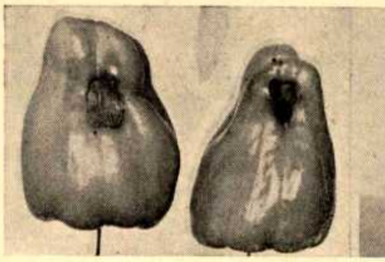

Fig. 1

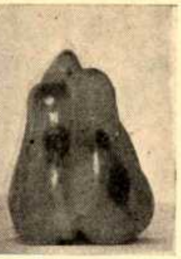

Fig. 2

Fig. 1. ORIGINAL FRUITS BROUGHT FROM THE SOUTH OF PALESTINE.
Fig. 2. INFECTION EXPERIMENT ON GREEN PEPPER FRUITS WITH THE ORGANISM ISOLATED FROM MATERIAL FROM THE SOUTH OF PALESTINE

Quite recently, one of us (Z. V.) has investigated a widespread fruit-spot of green pepper (*Capsicum annuum*) in Palestine, which was shown to be caused by a spore-forming bacterium identified at Cambridge as *B. polymyxa*. On the maturing fruits spots developed, one to five in number, light brown to grey, soft or firm, varying in size from 8 mm. to 12 mm. (Fig. 1). Microscopic examination of the softened tissues underlying the spots revealed the presence of numerous rod-shaped bacteria which were isolated in pure culture and produced subterminal spores. 48-Hour broth cultures were pasteurized at 85–90° C. for 10 min. and were used to establish cultures on potato dextrose agar from which suspensions in water were used for a series of infection experiments. Drops of the suspension were deposited on the surface of *Capsicum* fruits, which were then wounded by needle pricks. The inoculated fruits, placed under bell-jars over water, at room temperature (28–30° C.), developed lesions similar to those observed in the field (Fig. 2).

The organism was re-isolated from these spots, and the infection experiments were repeated with the re-isolated organism with like results. Controls pricked through drops of sterile distilled water did not develop any sort of infection. Various vegetables inoculated with the organism, under laboratory conditions, developed a typical soft rot of the parenchyma; but no infection of *Capsicum* was obtained either by spraying on a suspension of the bacteria or by inoculating wounds on *leaves*. This last observation is in agreement with that made at Cambridge with another strain of *B. polymyxa*, used to inoculate *stems* of iris and tomato plants which did not become infected, although kept under moist conditions and at a relatively high temperature.

It appears, therefore, that under *natural* conditions, involving high humidity and a relatively high (28–30° C.) temperature, the spore-former, *Bacillus polymyxa*, is a wound parasite, able to disintegrate the parenchyma of *Capsicum* fruits by means of its pectic enzymes.

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B_T, A NEW VITAMIN OF THE B-GROUP AND ITS RELATION TO THE FOLIC ACID GROUP, AND OTHER ANTI-ANÆMIA FACTORS

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THE mealworm, *Tenebrio molitor*, has recently been shown to be a very suitable test subject for folic acid and certain other, still unidentified B-factors. When grown on an artificial diet consisting of casein (20 parts), glucose (80 parts), water-insoluble fraction from yeast (2·5 parts), cholesterol (1 part), a salt mixture (2 parts), and aneurin, riboflavin, nicotinic acid, pyridoxin, pantothenic acid, choline chloride and inositol in ample amounts, at least two more factors are essential for growth and survival, folic acid and a factor contained in a norite filtrate from yeast or liver extract[1,2]. In view of the present interest in the folic acid group and its relation to anti-anæmia principles, our recent results on the mealworm may be of general interest. Throughout this report the term folic acid has been used to denote pteroylglutamic acid.

TABLE 1. THE EFFECT OF PTEROYLGLUTAMIC ACID, YEAST CHARCOAL FILTRATE, LIVER CHARCOAL FILTRATE AND PARENTERAL LIVER EXTRACTS ON GROWTH AND SURVIVAL OF *Tenebrio molitor*. NOS. ALIVE (OUT OF 20) AND AVERAGE WEIGHTS AFTER 10 WEEKS AT 25° C.

Addition to basic diet		No.	Average weight (mgm.)
Pteroylglutamic acid	Source of B_T		
Absent	absent	all dead	—
Present	absent	all dead	—
Present	1% yeast	17	55
Absent	liver charcoal filtrate	10	12
Present	liver charcoal filtrate	17	48
Absent	yeast charcoal filtrate	9	10
Present	yeast charcoal filtrate	20	42
Absent, in its place parenteral liver extract			
Lederle	0·6 % liver charcoal filtrate	14	13·1
'Examen'	0·6 % liver charcoal filtrate	10	9·5

The relations of folic acid and the above-mentioned norite filtrate factor are shown in Table 1: in the absence of both factors growth is very slow and the mortality high. Addition of a charcoal filtrate from liver or yeast extract has always the effect of increasing length of life, without noticeably improving rate of growth. Folic acid alone sometimes to some extent accelerates rate of growth; but death usually occurs even more rapidly than on diets without folic acid. Only in the presence of both factors do growth and survival become normal, as compared with the effect of 1 per cent yeast (Table 1). For the sake of convenience we have tentatively named the norite filtrate factor 'vitamin B_T' (to indicate its activity on *Tenebrio*). *Tenebrio*, therefore, is an admirable subject for testing the activity of any substance in regard to its possible relation to folic acid or B_T; thus we can investigate the relationships of a number of substances which have come to light in connexion with and since the discovery of folic acid.

Pteroylglutamic Acid and Pteroylheptaglutamic Acid

It is now known that pteroylglutamic acid occurs in natural food substances largely in the form of 'conjugates' with glutamic acid. Of these, pteroylheptaglutamic acid, which had formerly been called vitamin B_c conjugate, was isolated from yeast. Recent reports emphasized that pernicious anæmia patients in contrast to normal subjects fail to utilize the conjugate as folic acid[3]. *Tenebrio*, similarly to the chick[4] and certain micro-organisms, utilizes pteroylheptaglutamic acid very well. Shortage of material restricted us to two series of tests which agreed in general trend, but not in detail (Table 2). In the first the minimum optimal dose was 0·5 μgm./gm. of the dry food with folic acid and 2·5 μgm./gm. with the conjugate, while in the second 0·12 μgm./gm. folic acid showed already an optimal effect, which only appeared with 10–20 times larger doses of the conjugate. However, in the latter case 0·12 and 0·25 μgm./gm. of the conjugate had already a marked effect.

TABLE 2. THE EFFECT OF PTEROYLGLUTAMIC ACID AND PTEROYLHEPTAGLUTAMIC ACID IN THE PRESENCE OF LIVER CHARCOAL FILTRATE ON GROWTH AND SURVIVAL OF *Tenebrio molitor*. NOS. ALIVE (OUT OF 20) AND AVERAGE WEIGHT OF LARVÆ AFTER 10 WEEKS

Experiment 367	Pteroylglutamic acid		Pteroylheptaglutamic acid	
Dosage (μgm/gm.)	No.	Av. weight mgm.	No.	Av. weight mgm.
0	3	10·6	3	10·6
0·1	12	23·3	9	17
0·5	16	51·2	16	39·8
2·5	18	54·8	15	50
10·0			18	52
Experiment 372				
0	17	14·5	17	14·5
0·125	18	53·5	18	23·3
0·25	20	53·5	19	28·1
0·5	20	47·2	20	38·7
1·0	18	59·7	19	42·2
2·0	18	51	18	50
4·0			20	53·5

These results, though rather incomplete, suggest that on a molecular basis the efficiency of pteroylglutamic acid and pteroylheptaglutamic acid cannot be very different.

There remained the possibility that pteroylheptaglutamic acid, which is the natural form in yeast, might have B_T activity as well as folic acid activity. This proved not to be the case; even very large quantities failed to give a survival effect in a diet which contained no source of B_T.

Pteroylglutamic Acid, B_T and Anti-anæmia Liver Extracts

After the activity of folic acid in the remission of pernicious anæmia had been discovered, it came as a surprise when statements appeared to the effect that purified parenteral anti-pernicious anæmia liver extracts did not contain significant amounts of folic acid[5] or of the conjugate[6]. These results have been fully confirmed in tests with *Tenebrio*. Two well-known commercial parenteral liver extracts were tested, one from Lederle Laboratories, Inc. (15 U.S.P. per ml.), and the other 'Examen' (Glaxo Laboratories). Neither of these preparations showed the slightest folic acid activity, as affecting the growth-rate, when tested in the presence of an effective supply of B_T in the form of a liver charcoal filtrate (Table 1).

Next the question arose as to the possible B_T effects of these parenteral liver extracts. Consequently a series of tests was set up in which folic acid was supplied as pteroylglutamic acid, and the effects of parenteral liver extracts compared in a series of concentration with that of a standard liver charcoal filtrate. No effect was recorded with 'Examen' in any of the concentrations used, while the Lederle extract gave a positive effect in

TABLE 3. COMPARISON OF THE EFFECTS OF YEAST, A LIVER CHARCOAL FILTRATE AND TWO PARENTERAL LIVER EXTRACTS AS SOURCES OF B_T. ALL DIETS CONTAIN 4 μGM./GM. PTEROYLGLUTAMIC ACID. NOS. ALIVE (OUT OF 20) AND AVERAGE WEIGHTS AFTER 10 WEEKS

Addition to diet	No.	Average weight (mgm.)
None	all dead	—
1% yeast	20	45·5
Liver charcoal filtrate, 0·6%	19	45
Parenteral liver extract		
Lederle, 0·075%	1	8
0·22%	3	13·3
0·66%	7	34·5
2·0%	15	39
'Examen' 0·075%	all dead	—
0·15%	all dead	—
0·3%	1	21
0·6%	1	13

a very large dose only (Table 3). It is somewhat difficult to compare the activity of liver preparations from different sources, even if the corresponding amounts of fresh liver from which they are derived are stated on the labels, as the total losses during preparation are unknown. The dry weights of the three preparations in question, and their fresh liver equivalents, were as follow:

	mgm./ml.	Liver equivalent
Liver charcoal filtrate	293	1 ml. ≡ 6 gm.
'Examen'	10	1 ml. ≡ 50 gm.
Lederle	140	1 ml. ≡ 100 gm.

The amounts in which these extracts were used in the diets are stated in Tables 1 and 3 as the percentages of the three solutions mentioned above added to the dry diet. For example, 0·6 per cent of an extract means that 0·006 ml. of it has been added to 1 gm. of the dry diet. It can then be immediately seen that the B_T activity of the liver charcoal filtrate is vastly greater than that of the 'Examen' or Lederle extract which derived from eight to sixteen times respectively larger amounts of liver. Similarly, 0·15 gm. of folic acid per gm. of the dry diet produced a good growth effect in *Tenebrio*. On the assumption that 1,000 lb. of fresh liver contains 1·5 gm. of folic acid[7], it follows that 1 gm. of fresh liver might contain 3·3 μgm. of folic acid, and an optimal effect should be induced with 0·05 gm. of fresh liver/gm. of the diet, that is, 5 per cent. On this reckoning, 'Examen' and the Lederle extract should have been equivalent to 5 per cent fresh liver in amounts of 0·1 and 0·05 per cent of the diet, while in fact they showed no effect in amounts of 0·6 per cent. Even allowing for the loss of appreciable amounts of active substances in such preparations, it remains obvious that the kind of activity for the purpose of which the anti-anæmia concentrates have been developed must by necessity be entirely different from that of folic acid or B_T.

It is interesting to record that similar results, stating the virtual absence of folic acid in six liver preparations of established clinical potency, have just been reported in tests which involved the use of another insect, the larva of a mosquito (*Aedes ægypti*). Here no relation could be found between folic acid activity, measured by the level of pupation response, and anti-anæmia activity[8].

Nature of B_T

The need for B_T by *Tenebrio* was originally discovered when, several years ago, attempts to grow *Tenebrio* on artificial diets had failed and a search was made into the nature of missing factors in diets for *Tenebrio* and other insects[1,2]. At that time the chief criterion for 'folic acid', as it was understood then, was adsorption on charcoal at an acid *p*H. It then became clear that *Tenebrio*, in addition to folic acid, required a liver or yeast fraction from which folic acid had been effectively removed by charcoal. It is, however, by no means certain that B_T remains quantitatively in the charcoal filtrate. In the course of our work, some loss of activity of filtrates, after treatment with charcoal, has sometimes been observed, up to about one third, though in most cases these losses were considerably smaller. This is important to keep in mind when comparing the properties of B_T with those of other unidentified B factors which have been reported from other laboratories. The existence of such factors adsorbable by charcoal but elutable with difficulty have, for example, been reported by Jaffé and Elvehjem[9] for the rat. A closer relation seems so far to exist in a guinea pig factor (*GPF* 3), described by Woolley and Sprince[10]. *GPF* 3 was not noticeably adsorbed on charcoal at *p*H 3·4, was not precipitated by lead acetate and was relatively stable to alkali. These properties seem to apply fully to B_T. A liver charcoal filtrate, which was treated with lead acetate, failed to show any loss in B_T activity.

Work undertaken at Cornell University with chicks[11] had revealed the presence in brewers' yeast of two essential nutritional factors which were termed *S* and *R*. These factors were afterwards shown to be separable by a simple charcoal treatment at *p*H 3·0 when *R* was adsorbed and *S* remained in the filtrate[12]. *R* was later found to be a folic acid conjugate[13]. So far the resemblance between B_T and *S* is very close. Recently, however, the Cornell workers[14] report the probable identity of factor *S* with strepogenin, a compound of polypeptide nature required by various micro-organisms. From our knowledge of the nature of B_T the possibility of its identity with strepogenin seems very remote, especially as our *Tenebrio* diet contains 20 per cent of casein, which is a very good source of strepogenin. In anticipation of facts to be discussed below, it is, however, relevant to record that chicks, on a factor *S*-deficient diet, fail to grow, become anæmic, show a generally weakened condition and usually die before they are eight weeks old.

Reports of additional unknown factors from yeast or liver, which are of importance for *Streptococcus fæcalis*[15], a monkey[16] and the chick[17,18] are not specific enough to allow comparison with B_T. B_T shows some features of the active principle in crude yeast or liver preparations, found by Wills to be effective in certain cases of nutritional anæmia which do not respond to parenteral liver extracts. The active principle of Wills's factor is not adsorbed on charcoal, and what has been so far published about its properties[19] shows a close resemblance to B_T.

It has been claimed in work with chicks, by Cornell workers, that for optimal effects of folic acid or 'conjugates' the addition of 4-pyridoxic acid lactone was required[20]. These reports made it possible that 4-pyridoxic acid might have B_T activity. 4-Pyridoxic acid in a wide range of concentrations was therefore added to purified diets which contained folic acid, but failed to reveal any B_T activity. The results of the Cornell group were not confirmed by two other groups of workers[4,21,22].

Attempts to isolate B_T from yeast and other natural products have been proceeding for some time in this Department, with the co-operation of Dr. A. H. Cook, of the Organic Chemistry Department of this College. The most active preparation so far obtained showed more than a hundred-fold concentration of B_T, and good responses have been recorded with quantities of roughly 3 μgm./gm. of the dry diet. By analogy with the activities of many of the known B-vitamins, it is reckoned that such concentrates may possibly contain 10–50 per cent of B_T.

Conclusions

The common mealworm, *Tenebrio*, has been shown to react very sensitively to the absence of folic acid and another, still unidentified, B-factor (B_T). This makes it an admirable subject for studying the folic acid or B_T activity of any known or unknown compound. There is reason to suspect that B_T may have some relation to the Wills's factor, and its similarity to factor *S* of the Cornell workers again points to a possible anti-anæmia effect. This would make *Tenebrio* an important tool in the study of anæmia, where the absence of a convenient testing organism has always hampered progress. But even if relations between B_T and anti-anæmia activity proved unfounded, a study of unknown B factors which have come to light in work with *Tenebrio* and other insects might still prove in the end to have a significance far beyond this class of animals. It has been shown again and again that the B-vitamins have all-important functions in the metabolism of all forms of life, from bacteria to man, and there has scarcely been a case of a new B-factor which was not ultimately proved to be of general significance. It is therefore perhaps not too much to hope that a further study of the nature and action of new B-factors in insects might, in the end, lead to the discovery of new principles of importance both in biology and medicine.

I wish to record my thanks to the Medical Research Council for a grant which made this work possible. Further, I wish to thank Lederle Laboratories, Inc., for pteroylglutamic acid and parenteral liver extract; Parke Davis and Co. for pteroylheptaglutamic acid (B_c conjugate); Merck and Co., Inc., for 4-pyridoxic acid; and Glaxo Laboratories for liver extracts.

Summary

The mealworm, *Tenebrio molitor*, requires for normal growth and survival, in addition to at least eight of the known B-vitamins, also folic acid and a new factor which has been tentatively named B_T. Folic acid conjugate can be utilized in the place of folic acid, but has no B_T activity. Concentrated parenteral anti-anæmia liver preparations do not contain significant amounts of either folic acid or B_T. The possible relation of B_T to other missing B-factors, reported from other laboratories, and to Wills's anti-anæmia factor is discussed.

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AGRO-CLIMATIC ANALOGUES

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THE majority of the cultivated plants of the eastern and western hemispheres are represented by totally different genera, and until comparatively modern times very few such plants were common to both hemispheres. Many of the cereal and legume crops cultivated in the Old World before the time of Columbus were quite unknown in America, and the reverse was equally true. The subsequent introduction of rubber into the Far East from the Amazon region, via Kew, is the classic example of plant introduction; but of equal importance we may note that of sugar cane from the East into the West Indies, potatoes from South America into Europe, cinchona from South America into the East Indies, groundnuts from Brazil into Africa and India, and in more recent years, soybeans from Manchuria into America and parts of Europe.

The Second World War witnessed, and to a certain extent was the cause of, increased numbers of plant introductions. This was especially so in the case of America, where numerous new plants were introduced in an attempt to overcome war-time shortages of various plant products. But it is with the urgent necessity of speedy rehabilitation of the many war-devastated agricultural areas at the present time that plant introduction assumes its greatest importance.

To facilitate agricultural rehabilitation the American Institute of Crop Ecology is at present engaged in publishing an International Agro-Climatological Series[1] which comprises studies dealing with North American agro-climatic analogues for the various countries of the world. Seven studies have already been published; another fifteen are in course of preparation. The objective of each study is "to organise, define, and analyse the various distinct agro-climatic conditions prevailing in the different parts" of the country under review and to compare them with the various agro-climatic regions of North America so as to determine "climatic analogues". Climatic analogues are defined as "areas that are enough alike with respect to some of the major weather characteristics affecting crop production, particularly during the growing period, to offer a fair chance for the success of plant material transplanted from one area to its climatic counterpart".

Each study gives a general and comparative geography of the country concerned and a brief account of its climate. Certain of the studies contain additional sections, as, for example, the one for the Ukraine, which also contains an account of the natural agricultural belts of the country and the major plant species of each, and the Albanian study, which gives an account of the natural vegetation, crop geography and agricultural practices of that country.

The source of the material for the main section of each study is the climatological data from the various meteorological stations of North America. The elements of comparison—monthly and yearly temperatures, maximum and minimum temperatures, average monthly, seasonal and yearly precipitation, precipitation-effectivity indices and ratios (Thornthwaite's method), length of frostless periods, and latitudes—are studied for a particular meteorological station and a search is then made among the North American stations for a "similar climatic and latitudinal environment". The North American environment when found is then noted as being climatically analogous to it. Relief maps of the country are presented to show the location of the various meteorological stations, and the names of States and regions of their North American climatic counterparts are given in each case, if such counterparts exist. Agro-climatic charts give full meteorological data for each observing station within the country studied and the North American climatic parallel of each.

This agro-climatological series by M. Y. Nuttonson, the background for which was developed by experiences gathered in non-emergency plant introductions where careful varietal field trials of introduced plant material were possible, will be welcomed by all plant exploration and introduction organisations, ecologists, agro-climatologists and geographers. Until such time as meteorological recording instruments are developed to give readings more in keeping with the requirements of agro-climatologists and such factors as evapo-transpiration and potential evapo-transpiration[2] are taken into account in the formulation of more detailed world homoclimes and agro-climatic analogues, they will serve as an excellent basis to all plant introduction work. It is to be hoped, however, that an institute similar to the American Institute of Crop Ecology will be set up in Britain to determine world homoclimes and agro-climatic analogues for the British Commonwealth. The Commonwealth Bureau of Pastures and Field Crops would appear to be the obvious centre for this work. Studies dealing with British Commonwealth agro-climatic analogues for the various countries of the world might well be initiated at this information Bureau. It would also serve as a pool for receiving suggestions from agriculturists and meteorologists concerning new types of meteorological instruments that should be evolved (for example, one for measuring water movement from the earth to the atmosphere) to meet the needs of the modern agro-climatologist and agriculturist generally.

Agricultural expansion in the British Commonwealth will most surely require, among other things, the introduction of new plant material into undeveloped or partly developed areas. Many of these areas will greatly benefit from new pasture plants, new legumes, etc., which might be obtained as a result of plant explorations in countries having similar homoclimes. For example, there is a proposal to send an Australian expedition to homoclimal areas in South America to study the more promising wild and cultivated plants with the view of transferring some to Australia. South America's richness in useful plant species is considered a valuable source for plant introductions for northern semi-tropical portions of Australia. Similarly it is proposed to send an expedition to Indo-China and Siam with the object of seeking and securing types of the banana family for use on the breeding work in the West Indies.

A series of studies such as have been suggested, dealing with British Commonwealth agro-climatic analogues for the various countries of the world, would undoubtedly facilitate plant introduction, adaptation and exploration work, and serve as a useful complement to the studies at present being carried out in the United States.

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SOUTH AFRICAN MUSEUMS ASSOCIATION

ANNUAL GENERAL MEETING

THE twelfth annual general meeting of the South African Museums Association was held in the Africana Museum (Public Library building), Johannesburg, during March 16–19. The Mayor of Johannesburg, Mr. G. B. Gordon, opened the meeting on a particularly happy note by remarking on the Johannesburg City Council's appreciation of the value of museums and art galleries in the preservation of objects of art, science and history, and stating that education departments in various parts of the Union had already recognized their importance in adult and juvenile education. In the course of his address, Mr. Gordon also referred to his Council's pledge to establish, in collaboration with the University of the Witwatersrand, a museum of science and industry, and to its promise to provide a site for the South African National War Museum (at present housed in two Bellman hangars in a portion of the Zoological Gardens). By 1952, furthermore, he hoped that a new building to house the Africana Museum would be erected. From this, therefore, it would seem that Johannesburg can look forward to cultural developments with optimism.

Following the Mayor, Mr. R. F. Kennedy, retiring president of the South African Museums Association, presented his report for 1947. This made it clear that South African museums suffer as much from inadequate financial support as do a large number of the museums in Britain. Mr. Kennedy stated that though applications for increases in grants for museums had been made both to the Union Government and to provincial councils, there had been little or no response. (In spite of a steady rise in costs, grants for museums in South Africa have not altered materially since 1938.) In the case of the State-aided institutions, the Minister of the Interior had promised the formation of a special committee to study their particular needs; but no action, apparently, had actually been undertaken in this direction. Since, however, the State-aided museums now come under the Ministry of Education, there is hope that their problems will receive the attention due to them.

In his presidential address, Mr. Kennedy saw in 1948 the beginning of "a considerable development in museum work in South Africa", but he reminded delegates that the advancement looked for would depend not so much upon Government, provincial and local taxation as upon the museums themselves. "If the museums," he said, "can show that they have a rational plan, the support of the public through their representatives will be forthcoming." In this Mr. Kennedy spoke candidly and with truth, for in most South African museums at the present time there is much room for improved and more up-to-date methods of exhibition, and for the better presentation and co-ordination of the subjects with which they deal. Educational services for the general public, also, are far behind those rendered by some European and most American museums.

An important outcome of the Johannesburg conference was the formation of a special committee (to be known as the South African Museums Association Research Committee), to deal with all matters relating to research carried out by museums and allied institutions in the Union. South African museums have long been noteworthy for the amount and quality of the research they carry out in various fields; but it is now felt that there is need for the proper co-ordination of this work. This Committee, therefore, will henceforward act as the co-ordinating body. Its principal functions will be: (1) to advise Government and other authorities in matters concerning museum research; (2) to consider applications made by museums for grants, and to forward such applications with recommendations to the appropriate authority; and (3) to prepare a survey of the research already being carried out by these institutions with the object of co-ordinating this branch of museum work. Function (2), moreover, means that in future all applications from museums for research grants will automatically pass through the Research Committee for first consideration. The co-option on the same Committee of representatives of the South African Council of Scientific and Industrial Research, and of the South African Council for Educational, Sociological and Humanistic Research (constituted in 1946 by the Minister of Education to promote research in the humanistic fields), is a probability.

Another special committee which was formed at this year's meeting will press forward matters relating to increased Government support for South African museums and art galleries. It was decided, also, that a deputation from the Museums Association should ask the Transvaal Director of Education to urge the appointment of guide-lecturers for the instruction of school classes visiting Transvaal museums. The Transvaal Provincial Museum at Pretoria will send an independent deputation upon the same subject, and by now the City Council of Johannesburg will have been asked to act likewise.

The proceedings of this year's South African Museums Association conference, therefore, have made it clear that museum officials, and others interested in the work of museums, recognize the need for improvement in the Union's museum services; and from the strenuousness of discussion and the resolution which marked the whole of the meeting, there is every indication that the improvement looked for will come through equally strenuous action. One of the first necessary steps, however, will lie in an increase of staff trained in modern museum methods and technique.

Prof. R. H. Compton was elected president of the South African Museums Association for the coming year, and Mr. E. C. Chubb was re-elected secretary. In recognition of his long and valued service to the Association, Mr. Chubb was also elected an honorary life member.

During the conference, the Abbé Breuil, assisted by Miss Boyle, addressed the members on the Makhetha rock-shelter paintings of Basutoland and the Brandenberg rock-paintings of the Tsisab Ravine in South-west Africa; his very fine coloured drawings of these paintings decorated the walls of the conference room.

Members of the Association and visitors attended a reception in the Town Hall on the opening day of the conference, and on subsequent days visits were arranged to the University of the Witwatersrand, the Art Gallery, the South African National War Museum and the Union Astronomical Observatory.

A feature of the Johannesburg meeting was a special exhibition depicting the work, aims and needs of South African museums and art galleries. Coloured posters executed by the staff of the Africana Museum, and sets of photographs sent by individual museums and art galleries formed an attractive and informative introduction to this subject. The exhibit is available for the use of other South African museums. Its publicity value is high, and it is to be hoped that it will find its way to all museum centres in the Union. It was a pity that this exhibition did not get the press notice it deserved while it was in Johannesburg.

J. R. Harding

THE IMPERIAL INSTITUTE

The annual report of the Imperial Institute, South Kensington, London, for 1947 shows that an unusually large number of economic inquiries and laboratory tests have been made at the Institute for Empire Governments, industrial research organisations and commercial firms in search of new sources of raw materials. In the Plant and Animal Products Department alone, 203 samples were examined and 824 inquiries handled. Three scientific papers were published by the Department recording research work on methods of pyrethrum analysis carried out in collaboration with other authorities. The consultative committees on vegetable fibres, on gums and resins, on hides, skins and tanning materials and on insecticide materials of vegetable origin all met again once during the year, and matters which received attention included manila hemp, the utilization of linseed straw, the possibility of increasing production of rosin, and the insecticidal properties of *Cymbopogon giganteus* and *Neorautenania ficifolia*, from Northern Rhodesia. *Barataballi* latex, from British Guiana, has yielded a coagulum of some promise as an ingredient of the base for chewing sweets. Trials with new insecticides as preventives against hide beetle have been completed, and a report is being prepared. The Consultative Committee on Silk has submitted to the Secretary of State for the Colonies a statement on the need for a programme of sericultural experiments in the Colonial Empire, and has also prepared for the High Commissioner for Southern Rhodesia a report on the nature and scope of such experiments that might be undertaken in Southern Rhodesia.

Investigations reported during the year dealt with wattle bark from Jamaica, cutch from Burma, *Melaleuca bracteata* oil from Kenya, a possible source of methyleugenol, citrus oils from Palestine, shark liver oils from Trinidad, tung oil from Nyasaland, soya beans from Nigeria and tobacco from Cyprus. Of the 824 inquiries, the report mentions particularly those relating to lemon juice and peel, papain, jute and jute substitutes, cellulose for wood and rayon pulp and short-length piassava from Sierra Leone.

The Intelligence Section of the Mineral Resources Department dealt with 1,048 inquiries, and among these vermiculite continued to figure, while other inquiries related to supplies of beryl, zinc deposits in Burma, Empire resources of sillimanite minerals, Indian and Australian pyrophyllite, barytes for oil-well drilling muds, and clays for bases in soap substitutes. Staff limitations have prevented resumption of the preparation of revised editions of the series of mineral monographs, but the mineral resources section of the quarterly *Bulletin* of the Institute has continued, and results of the investigations on samples of coal from Tanganyika were published as an appendix to an article in the *Bulletin* on the geology of the Namwele-Mkomolo Coalfield by R. B. McConnell. Among the investigations carried out during the year may be recorded those on bleaching earth from Cyprus, lignite from Sierra Leone, manganese ore from Dominica, and clays, coral, volcanic materials and sands from St. Vincent as possible building materials.

The Rubber Department gave its chief attention during the year to a continued study of the resilience of rubber, and improvement in resilience of *Hevea* rubber by thorough purification previously reported has been confirmed. The vulcanizing and mechanical properties of the highly purified rubber have been studied in some detail, as well as the effect of treating the latex with substances likely to affect molecular cohesions and linkages. Attempts have also been made to determine the association of phosphorus with the rubber particles in preserved latex.

The report also includes an account of the educational work of the Institute, both its publications and exhibitions, the Central Film Library, the Empire Lantern Slide and the Film Strip Library and the general library, to which more than 5,700 books, official reports and pamphlets were added in 1947, in addition to the 800 periodicals normally received.

THE FISHERIES SCHOOL AT CRONULLA, NEW SOUTH WALES

ONE of the most interesting and informative technical publications issued in connexion with any fishing industry is the *Australian Fisheries Newsletter* published by the Commonwealth Fisheries Office. This first-rate monthly never fails to provide a wealth of accurate and helpful information covering all aspects of Australian fishing activities together with a useful leavening of articles and news items dealing with the more general aspects of marine biology and its bearing on fisheries problems in all parts of the world. Of particular interest has been a series of articles* on the foundation and development of a fisheries training school on a site adjoining the Marine Biological Laboratory of the Australian Council of Scientific and Industrial Research in New South Wales.

The Australian fishing industry at the present time employs some ten thousand persons in actual fishing. No accurate figures are available concerning the number of persons engaged in ancillary occupations. Very rapid developments were made during the Second World War, and since the conclusion of hostilities there has been a heavy influx of new personnel. Many of those have come from families already in the industry; but there is also a steady recruitment of ex-Service men without previous experience of any branch of fishing activity. In order to ensure that those men shall have the best possible chance of making good in their new occupation a Commonwealth Fisheries School has been established at Cronulla, New South Wales, well equipped and adequately staffed for the work it sets out to do.

A technical supervisor is responsible for technical training. He is assisted by an assistant technical supervisor, and the masters and crews of the school's instructional vessels, which comprise a 75-ft. diesel trawler, a 66-ft. Danish seiner, a 25-ft. inshore motor fishing vessel and several smaller boats.

The more theoretical side of the instruction is given by officers of the Fisheries Division and the Division of Food Preservation and Transport of the Council of Scientific and Industrial Research, the staff of the Sydney Technical College, and members of the Commonwealth Fisheries Office.

The trainees reside on the premises, so a camp superintendent is in charge of the school buildings, assisted by a quartermaster, cooks and camp attendants. There are thirty bedrooms, each accommodating two persons, and a 'loughboy' for storing clothes and other personal gear. Adequate bathing facilities and a laundry are also available. The large messroom can accommodate seventy persons, and the catering staff, operating an all-electric kitchen, provide a good service of both hot and cold meals.

Approved applicants accepted for full-time training pay no fees for the course. Where necessary, an allowance is made for books, tools and other essentials, and, in addition, a living allowance of £3 5*s*. a week is paid to those without dependants. To a trainee with dependants an additional sum up to a maximum of £2 a week may be paid, according to the number of dependants and their degree of dependency.

The course at Cronulla was originally planned to extend over four months, after which the trainees were required to go into subsidized employment in the fishing industry in order to obtain further intimate experience of practical work. Difficulty has been experienced, however, in placing the trainees in subsidized jobs because fishing in Australia is mostly operated by one-man boat-owners, by crews who are joint owners of their own boat, and by owners with crews on a share basis. It has therefore been decided that the training course shall be extended from four months to thirty weeks and that the period of subsidized employment be abolished. It is thought that the longer course will provide sufficient practical experience in the fishery school's own vessels to enable its students to stand at once on their own feet in the fishing industry. To assist in achieving this objective some of the theoretical instruction given during the first course will be reduced and more time given to practical work both at sea and on shore. For the first twenty weeks all trainees will take the general fisheries syllabus, after which they will specialize in that branch of the industry which they intend to enter.

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* *Fisheries Newsletter*, 5, No. 2, 3 (April 1946); 6, No. 1, 3 (Feb. 1947); 6, No. 2, 8 (April 1947); 6, No. 5, 3 (Oct. 1947). Published by the Commonwealth Fisheries Office, Dept. of Commerce and Agriculture, at the Publicity Press (1938) Pty., Ltd., 71–75 Regent Street, Sydney.

It is felt in some quarters that a school of fishing should be established in Great Britain, particularly for the training of fishery officers and others who will be going out to British Colonies under the Colonial Development Scheme. It is doubtful whether there would be enough trainees derived from this source to support a satisfactory school on a permanent basis. But the British fishing industry also would benefit if the recruits to its ranks could have a period of training in a well-planned and wisely conducted school of fisheries such as that at Cronulla. Fishing in Britain and other European countries has long ceased to be run on primitive 'rule-of-thumb' lines, and there seems at present to be a decided danger that British fishermen may be outstripped by Continental rivals who give more attention to the proper study of fishing in all its aspects. G. A. STEVEN

BOTTOM DEPOSITS OF LAKE WINDERMERE IN RELATION TO THE QUATERNARY HISTORY OF THE BRITISH ISLES

THE importance of the bottom deposits of Lake Windermere as a source of information concerning the post-glacial history of north-western England has already been indicated by the stratigraphy and diatom sequence established by Winifred Pennington (Mrs. T. G. Tutin) (*New Phytol.*, 42, 1; 1943). These deep-water deposits (brought within reach by the unique qualities of the Jenkin core-sampler) have been used again by the same worker to extend our knowledge into the late-glacial period (*Phil. Trans. Roy. Soc.*, B, 233, 137; 1947). Water-laid, laminated clays are found above and below a layer of grey detritus silt which contains remains indicating that it was laid down during a cool-temperate phase. This is tentatively correlated with the Allerød oscillation established in north-western Europe and Ireland.

Analysis of the post-glacial layers (utilizing both pollen and macroscopical plant remains) reveals a fairly close correlation with events in East Anglia, except in the later stages where a *Salix* maximum occurs in Zone IV and *Betula* assumes, in Zone V and early Zone VI, the dominance characteristic of profiles from the west of Britain. *Tilia* does not appear until Zone VII, and *Fagus* and *Carpinus* are completely absent. *Pinus*, which appears to be consistently over-represented in the deep-water deposits, falls off very rapidly at the transition between Zones VIc and VII, but always reappears at a characteristic position near the surface, where the brown and indurated clay gives way to soft, black, rather unconsolidated gyttja. This reappearance may be due to planting (a rise in the importance of grass pollen in deposits laid down 2,000–2,500 years ago having already suggested the beginning of clearance of the primeval forests).

Samples from beneath shallow water provided the clearest pictures of the late-glacial and early post-glacial changes, but deposition appears to have ceased (due to turbulence) when the mud has approached to within about three metres of the water-surface. The lesser clarity of the early stages of deep-water samples appears to be due to a very slow deposition here.

Possible correlations of dating with geological reports for north-western England, Ireland and Scandinavia are clearly shown in tabular form, and it is concluded that the lower laminated clay is contemporaneous with the Scottish re-advance, the Carlingford re-advance in Ireland and the Lower *Dryas* clay in Denmark, and its end is placed at about 10,000 B.C. The commencement of the deposition of the upper laminated clay is placed at 8,300 B.C., and its continuation for some four to five hundred years (estimated by counting the varves) is believed to be the result of a valley glaciation in the Lake District. This is correlated with the Antrim coast re-advance and valley glaciation in the Wicklow Mountains, the Upper *Dryas* clay of Denmark and the formation of the great Fenno-Scandian moraines. In the post-glacial period, a dating between 6,300 and 6,000 B.C. for the Boreal-Atlantic transition also agrees with Scandinavian results.

A brief correlation with the previous work is made and the greater detail revealed by pollen-analysis is demonstrated, while the same technique is also made to shed further light on the stratigraphical results previously obtained. H. G. BAKER

THE NORWEGIAN POLAR INSTITUTE

ON March 1, the Norwegian Polar Institute (Norsk Polarinstitutt) was established in Oslo in order to continue and expand the activity of Norges Svalbard- og Ishavs-undersøkelser. The latter office was founded in 1928, when it took over the work which since 1909 had been carried out by Government-supported expeditions to Svalbard. Norges Svalbard- og Ishavs-undersøkelser has been engaged in the preparation of topographic maps and hydrographic charts of the Svalbard region and in geological investigation on Svalbard. It has provided facilities for numerous scientific workers to visit Svalbard and Eastern Greenland, and has carried out a large amount of practical work such as the establishment of aids for navigation and maintenance of weather stations.

Besides continuing this work, the Polar Institute will broaden the scope of the scientific activity, partly by adding specialists of its own permanent staff, and partly by securing the collaboration of specialists who are connected with university institutions in Oslo and Bergen and other scientific organisations. The sphere of interest will be expanded to include the regions of the Antarctic over which Norway claims sovereignty. It is hoped that the Polar Institute will be able to undertake, sponsor or stimulate geological and palæontological research, glaciological and meteorological studies as well as work in the fields of zoology and botany. The publications of Norges Svalbard- og Ishavs-undersøkelser (*Skrifter* and *Meddelelser*) will be continued from the Polar Institute without any break in the numbering.

The Polar Institute will not absorb organisations which are primarily engaged in scientific work in the polar regions, such as the Aurora Observatory at Tromsö or the Government Institute of Whaling Research in Oslo; wherever desirable, it will collaborate with these organisations.

The Polar Institute comes under the Department of Industry of the Norwegian Government, but Dr. H. U. Sverdrup, who has been appointed director, has also been attached to the University in Oslo. He will be able to accept special students at the Institute and thus to attract the attention of young men to the problems of the polar regions. Dr. Sverdrup, until this year professor of oceanography in the University of California and director of the Scripps Institute, has himself had a distinguished career as arctic explorer, oceanographer and mathematician. He is perhaps best known for his observations of the tidal currents over the Siberian Shelf made during the Norwegian expedition of the *Maud*, and for his two recent books—the part dealing with physical oceanography in "The Oceans" and his "Oceanography for Meteorologists", of which an edition has been published in Britain. He has taken an active and leading part in modern oceanographical research.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, June 21

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 8.30 p.m.—Dr. Isaiah Bowman: "The Geographical Relation of the U.S.A. to World Policies".

Monday, June 21—Friday, July 2

Royal Society (at Burlington House, Piccadilly, London, W.1).—Conference on "Scientific Information Services".

Tuesday, June 22

Royal Anthropological Institute (joint meeting with the International African Institute, at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. K. L. Little: "The Secret Society as an Arbiter of Culture" (Discussion Meeting).

Wednesday, June 23—Friday, June 25

Institution of the Rubber Industry (at Central Hall, Westminster, London, S.W.1).—Rubber Technology Conference.

Thursday, June 24

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir George Thomson, F.R.S.: "Nuclear Explosions" (Bakerian Lecture).

Mineralogical Society (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Thursday, June 24—Friday, June 25

Genetical Society of Great Britain (joint meeting with the British Empire Cancer Campaign, at the Royal Society of Medicine, 1 Wimpole Street, London, W.1).—Symposium on "The Genetics of Cancer".* (Afternoon Session on Thursday afternoon, at 2.30 p.m., at the Medical Society of London, 11 Chandos Street, London, W.1.)

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Director of the Research Institute of Launderers, Drycleaners and Dyers of New Zealand—The Scientific Adviser, New Zealand Scientific Office, B.C.S.O., Africa House, Kingsway, London, W.C.2 (June 23).

Readership in Biochemistry at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 23).

Assistant in the Department of Physiology, a Lecturer in Clinical Chemistry, and a Lecturer in the Department of Physiology—The Secretary, The University, Aberdeen (June 25).

Lecturers (3) in the Chemistry Department, Lecturers (2) in the Physics Department, and a Lecturer in the Chemical Engineering Department—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (June 26).

Senior Lecturer in Mathematics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 26).

Lecturers (2) in Geology—The Registrar, King's College, Newcastle-upon-Tyne (June 26).

Assistant Examiners in the Patent Office under the Board of Trade—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 45A (June 30).

Grassland Agronomist, and a Plant Breeder with training in mycology—The Director, Welsh Plant Breeding Station, Agricultural Research Building, Penglais, Aberystwyth (June 30).

Lecturer in Botany in the United College, St. Andrews—The Secretary, The University, St. Andrews (June 30).

Tutorial Research Studentship in Mathematics (Pure or Applied)—The Principal, Royal Holloway College, Englefield Green, Surrey (June 30).

Assistant Lecturer or Lecturer in Geology—The Secretary, The University, Aberdeen (June 30).

Lecturer in Metallography in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (June 30).

Patent Officers under the Ministry of Supply—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2175 (June 30).

Research Fellowships in Mathematical Physics—The Secretary, The University, Edmund Street, Birmingham 1 (July 1).

Research Award in the Department of Physics—The Registrar, University College, Hull (July 2).

Research Officer in the Division of Industrial Chemistry for the investigation of relationships between the molecular structure and dielectric properties of electrical insulating materials—The Secretary, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1701 (July 3).

County Horticultural Instructor (male) on the staff of the Somerset Farm Institute, Cannington, Bridgwater—The Chief Education Officer, County Hall, Taunton (July 3).

Head of the Department of Agriculture, a Head of the Department of Veterinary Science, and a Head of the Department of Forestry, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (July 3).

Professorships of Pharmacology, Entomology, Protozoology, and Pathology and Bacteriology, at the School of Tropical Medicine, Calcutta—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 4/26A (July 5).

Lecturer in the Department of Botany, University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Cape Town, July 15).

Professor of Civil Engineering Construction and Foundations, a Professor of Strength of Materials, a Professor of Hydraulics and Water Power, a Professor of Steel Bridges and Metallic Structures, a Professor of Line Telephony and Telegraphy, and a Professor of Electric Power Stations, at the Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (July 15).

Challis Chair of History in the University of Sydney—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

Professor of Mathematics and Head of the Department, and a Professor of Mathematical Physics, in the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

Chair of Electrical Engineering in the University of Sydney—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Sydney, August 15).

Lecturer in Mathematics—The Registrar, The University, Reading.

Professor of Physics and Electrical Engineering, and a Lecturer in Applied Mechanics, at the Royal Naval College, Greenwich—The Director (P.A.), Education Department, Admiralty, London, S.W.1.

Research Statisticians and Assistant Statisticians—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Lecturer in Botany, and a Lecturer in Economics, at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2.

Laboratory Assistant with experience of chemical and/or biochemical analysis—The Department of Veterinary Hygiene and Preventive Medicine, Royal (Dick) Veterinary College, Edinburgh.

Senior Lecturer and Lecturer in Physics in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

Physicist, and a Chemist—The Director of Research, British Hat and Allied Feltmakers' Research Association, Department of Textile Industries, The University, Leeds 2.

Senior Technician in the Pharmacy and Biology Laboratories—The Secretary, Royal Technical College, Glasgow.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Society for Psychical Research: an Outline of its History. By W. H. Salter. Pp. 54. (London: Society for Psychical Research, 1948.) 2*s*. [45

Family Planning Association. Conference on Infertility held at the Nuffield Institute for Medical Research, Oxford, July 26 and 27, 1947. Pp. 64. (London: Family Planning Association, 1948.) 5*s*. 6*d*. [45

Other Countries

University of Illinois: Engineering Experiment Station. Bulletin Series, No. 368: The Effect of Eccentric Loading, Protective Shells, Slenderness Ratios and other Variables in Reinforced Concrete Columns. By Prof. Frank E. Richart, Prof. Jasper O. Draffin, Tilford A. Olson and Richard H. Heitman. Pp. 128. 1 dollar. Bulletin Series, No. 365: Experience in Illinois with Joints in Concrete Pavements. By Prof. John S. Crandell, Vernon L. Glover, Whitney C. Huntington, J. Douglas Lindsay, Prof. Frank E. Richart and Prof. Carroll C. Wiley. Pp. 258. 1 dollar. (Urbana, Ill.: University of Illinois Engineering Experiment Station, 1947.) [55

Fonds National de la Recherche scientifique. Vingtième Rapport Annuel, 1946–1947. Pp. 140. (Bruxelles: Fonds National de la Recherche scientifique, 1947.) [65

NATURE

No. 4104 SATURDAY, JUNE 26, 1948 Vol. 161

CONTENTS

Page
Ethical Basis of Atomic Energy Control 989
Mineral Resources of the United States. By Dr. K. C. Dunham . 991
Chemistry from the School to the University. By Dr. S. H. Harper . 992
Chemical Promotion of Rooting in Plants. By Prof. M. Thomas . 993
Servomechanisms. By Prof. A. Porter 994
Orientation of Birds on Migratory and Homing Flights . . . 996
Medical Research during War-time. By Dr. G. Lapage . . . 998
Council for Scientific and Industrial Research, Australia: Annual Report 999
Obituaries:
  Sir George Newman, G.B.E., K.C.B. By Sir Arthur MacNalty, K.C.B. 1001
  Dr. George H. Pethybridge, O.B.E. By W. C. Moore . . 1002
  Dr. A. S. Corbet. By N. D. Riley 1003
News and Views 1003
Letters to the Editors:
  Amino-Acid Metabolism of Tissue Cells *in vitro*.—Dr. Albert Fischer 1008
  Absence of Correlation between Respiratory Inhibition of Plasmodia by Acridines and Antimalarial Action.—Dr. Adrien Albert and P. B. Marshall 1008
  Studies with Radioactive Penicillin.—Dr. D. Rowley, J. Miller, S. Rowlands and Dr. E. Lester-Smith 1009
  Effect of Antibacterial Analogues of Vitamin K on *M. tuberculosis*.—C. N. Iland 1010
  Dicumarol Poisoning and Vitamin K Deficiency in Relation to Quick's Concept of the Composition of Prothrombin.—Prof. Henrik Dam 1010
  Chemical Breakage of Chromosomes.—C. B. Allsopp and Dr. D. G. Catcheside 1011
  Electron Microscopy of the Sarcolemma.—W. M. Jones and Dr. Robert Barer 1012
  Capillary Distribution in Cow Skin.—Dr. J. D. Findlay and S. H. Yang 1012
  Relation of Enamel Protein to Dental Caries.—Dr. Paul Pincus . 1014
  Microflora of the Rumen.—C. A. McGaughey and K. C. Sellers . 1014
  Chromosome Number of *Cardamine pratensis*.—Miss F. Hussein 1015
  Distribution Patterns in European Basidiomycetes with Reference to Some British Species.—R. W. G. Dennis . . 1015
  Puffinosis, a Virus Epizootic of the Manx Shearwater (*Puffinus p. puffinus*).—J. A. R. Miles and M. G. P. Stoker . . . 1016
  Theory of Superconductivity.—Prof. Max Born, F.R.S., and Kai Chia Cheng 1017
  Mechanism of the Emission Spectrum of Active Nitrogen.—L. Herman and R. Herman 1018
  Reported Radioactivity of Osmium.—A. H. W. Aten, jun. . 1019
  The Metallic State.—Prof. Linus Pauling, For.Mem.R.S. . 1019
  Adsorption on to Ionogenic Surfaces.—Dr. P. H. Plesch and R. H. S. Robertson 1020
  A Simple Moving-Boundary Apparatus.—R. H. Davies . . 1021
X-Radiation from a 20-MeV. Betatron. By W. Bosley, Dr. J. D. Craggs, W. F. Nash and R. M. Payne 1022
Effect of Ion-Exchange Treatment on the Stability of Apple Juice. By Dr. S. W. Challinor, Margaret E. Kieser and Dr. A. Pollard . 1023
The Royal Sanitary Institute 1025
Wigan Mining College 1027
Recent Scientific and Technical Books . . . . . . Supp. ii

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ETHICAL BASIS OF ATOMIC ENERGY CONTROL

THE debate in the House of Commons on May 14 on the international control of atomic energy added little to what had been said earlier in the House of Lords. Mr. Mayhew, Under-Secretary of State for Foreign Affairs, made it plain that the Government accepts the view that in the present circumstances no progress is possible on the Atomic Energy Commission; but that if a solution of the atomic energy problem could be reached at all, it will be through the machinery of the United Nations. The Government has agreed to the suspension of the discussions for the time being because no effective system of international control is possible without a voluntary merging of some part of national sovereignty. Unlike ten out of the twelve nations represented on the Commission, Soviet Russia, he said, is unwilling to take this step, just as she refuses the complete openness also essential for the success of a scheme of international control.

The most interesting feature of the debate was the reference in Mr. Blackburn's speech, in raising the question, to Sir Edward Appleton's remark on May 13 that there is unlikely to be any final solution to this problem merely along technical lines. Mr. Blackburn added that he does not believe this problem will be solved without a religious revival, which would concentrate the minds and hearts of men upon loftier ideals than the materialistic ends with which we are so often confronted. This sentiment was echoed in other speeches in the debate, and was reflected both in the meeting held in London in the Albert Hall on April 26 to demonstrate the support of the Christian community for the idea of Western union and in other comments on that proposal, and in Mr. Churchill's notable speech at The Hague to the United Europe Congress on May 7.

Mr. Churchill urged that the movement for European unity must be a positive force deriving its strength from our common sense of spiritual values. It is a dynamic expression of democratic faith based upon moral conceptions and inspired by a sense of mission. In the centre of the movement stands a charter of human rights guarded by freedom and sustained by law. Moreover, the movement aims, he said, at the eventual participation of all peoples throughout the Continent of Europe, whose society and way of life are not in disaccord with a charter of human rights and the sincere expression of free democracy.

Mr. Churchill recognized that the world organisation cannot function without the active help of the third great and equal partner, nor can the shadow of war be lifted yet from the hearts and minds of men and nations. Meanwhile, we can create and combine the great regional unities and endeavour to prepare by patient and faithful service for the day when an effective world government will rest on the chief groupings of mankind. This main endeavour can lay the moral and spiritual foundations on which the statesmen of the Western democracies will be able to build the organisation which will achieve freedom from fear—the freedom that matters most to-day.

Mr. Churchill's speech and the Congress itself should do something to foster a return to the confidence in Western democracy and in the personal and spiritual values upon which it rests.

Whatever form Western union may take—and the growth of the movement in the last six months has been remarkable—it represents a real determination among the peoples of Western Europe to preserve and strengthen their free way of life against the threat of Communism; and at the same time, it means not only a belief in the true values of Western civilization but also a knowledge of what Western democracy ought to represent. That implies a task of education as well as readiness to work for the ideal and determination to uphold it against challenge. Only as that task of education proceeds can there be created the volume of informed opinion which will afford not merely the moral support but also the close and understanding criticism which the statesmen of Western Europe will need as they deal with the many thorny problems confronting the working out of concrete proposals for closer union, with the sacrifices in national sovereignty that are involved.

It was a main purpose of the Albert Hall meeting to mobilize Christian effort and Christian faith in Western Europe behind the political, social and economic drive to turn our future into ways of peace and harmony. Material means, as Sir Stafford Cripps said, must be directed by spiritual vision, and the methods used inspired by those great traditions that have been built up in Western Europe through the centuries; and in a message to the meeting, Mr. Churchill asserted that the movement for Western union would come to naught unless the structure of the new Europe was built firmly upon moral and spiritual foundations. The question of atomic energy is only one facet of that problem of building an order in which there is freedom from fear. The report of the commission appointed by the Archbishops of Canterbury and York in 1946 to consider the British Council of Churches report on "The Era of Atomic Power" is, as might be expected, largely concerned with the moral issues which have been so prominent in the movement for Western union; and it indicates very clearly how much there is to be done before we can achieve a common mind on questions of policy which touch spiritual issues, or even make clear precisely what we understand by the moral and spiritual foundations of Western democracy.

The scope of the report is better indicated by its sub-title, "A Study of the Moral and Theological Aspects of Peace and War", than by its title, "The Church and the Atom"*. Indeed, it scarcely touches on the ethical aspects which have so much concerned scientific workers, and which found a place in the B.B.C. talks on atomic energy in March last year. The Commission is, however, somewhat critical of the earlier report, "The Era of Atomic Power", one chapter seeking to correct the work of that Commission by setting atomic warfare in the context of warfare in general and of the doctrine of 'the just war', and to disentangle the moral question from that over-insistence on the divine right of Western democracy which in "The Era of Atomic Power" tended to darken counsel.

What is said in this chapter should be pondered carefully. After setting forth the three accepted grounds or causes of a 'just war', it is observed that if in future the nations agree to establish an international tribunal, the definition of 'just cause' will have to be modified accordingly; the Commission then proceeds to elaborate the Christian tradition that a belligerent should always have as his ultimate end the establishment of peace founded on justice. It insists that there is also a proximate end which is determined by the particular justifying cause, and in this connexion it insists that a belligerent ought not to use more force on the whole than is needed to bring the enemy to terms, and that in the choice of weapons and methods of warfare he should always keep the limited end steadily in view, preferring methods of which the ill-effects are least persistent. A belligerent should do nothing unnecessarily to prejudice the incorporation of his enemy into the community of nations when once the war is ended. In short, the object of warfare is not to kill the enemy, but to disarm and so overpower him.

This is the doctrine by which the validity of strategic bombing and atomic weapons are assessed. The Commission is agreed that the 'obliteration' bombing of whole cities with high-capacity and incendiary bombs must be condemned. It is inconsistent with the limited end of a just war and violates the principles of discrimination just noted: it constitutes an act of wholesale destruction that cannot be justified.

Moral principle thus imposes, in the view of the Commission, considerable restriction on the use of strategic bombing as a means of warfare. Nevertheless, while maintaining that weapons of destruction should only be used in accordance with the moral rules that apply to them, and that these rules cannot be disregarded if the intention is not primarily to destroy but to administer "psychological shock", the Commission does not condemn outright all use of atomic power in war. Refusing to abandon the medieval conception of 'the just war', the majority of the Commission rejects Mr. Henry Stimson's justification of the use of atomic bombs in 1945, but believes that in certain circumstances defensive 'necessity' might justify their use against an unscrupulous aggressor. On the assumption that possession of atomic weapons to-day is genuinely required for national preservation, a Government is entitled to manufacture them and hold them in readiness. Moreover, the Commission considers that if any nation, or any group of nations, which is resolved to resist unscrupulous aggression, lets it be known that it holds itself entitled to defend itself in this way, such warning might go far to prevent the abuse of atomic weapons.

On moral grounds, therefore, the Commission appears to support the opinion that has often been expressed that, in view of Russian intransigence on the vital question of inspection, those nations prepared to make the sacrifice of national sovereignty should go ahead with such a scheme as has been approved by the majority on the Atomic Energy Commission. Even more pointedly, the Commission observes in its conclusions that the law of Nature requires all peoples to co-operate in promoting a world-order based on justice, and that at present the chief obstacle to such co-operation is found in the quasi-religious convictions and claims made by the U.S.S.R. The duty of fashioning a world-order remains none the less, and the Commission believes that Christians and all who recognize the claims of reason and justice should combine in attempting this work.

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* The Church and the Atom: a Study of the Moral and Theological Aspects of Peace and War. Pp. 130. (London: Church Assembly, 1948.) 4s.

Other sections of the report, for all its caution and qualifications, are no less clearly a challenge to thought on the problem of power and its control, and the cultural, political and religious aspects of that problem. The Commission accepts Dr. Toynbee's view that the breakdown of civilizations has been due to internal and not external causes. The task that confronts us to-day is in part, as the movement for Western union recognizes, that of achieving political co-operation and spiritual unity; but it is bound up with the fact that the vast resources of physical and mechanical power which science and technology have put into man's hands can only be developed by the governments of wealthy and highly organised nation-States.

The Commission addresses itself to these questions in its final chapter, "Christian Duty in a World of Power", in which the man of science will find much to weigh and develop. In an earlier chapter, the Commission does not reject as explicitly as some have done the doctrine of neutrality in warfare, though by inference it appears to do so; but it does call for an effort to achieve a fuller understanding of the true order of human purposes which knowledge ought to serve. It upholds the emancipation of science and rejects the suggestion of an arbitrary restriction of scientific research, setting science rather in its true context as one phase of culture. Like the earlier report, "The Era of Atomic Power", it pleads for the achievement of 'wholeness of life', in which all science and all activity are duly subordinated to the knowledge and love of God to cure the fragmentation and distortion of truth caused by excessive specialization.

It is interesting to note the suggestion that science and religion should find their common meeting place not only in the field of reason but also of the imagination. We need to recognize, the Commission urges, far more commonly than we do, the large part played by intuition and imagination in scientific and technological research. Moreover, human society cannot do without the kind of insight and imagination which humane interests and studies alone can give; it is indeed for lack of these that civilization is perishing. The real safeguards against the abuse of knowledge are, in fact, spiritual and educational.

A better balanced education and the breaking down of barriers between the various fields of knowledge are necessary means to the achievement of unity, and the Commission welcomes the foundation of the United Nations Educational, Scientific and Cultural Organisation as evidence that most civilized nations recognize the importance of the cultural factor. It insists, however, that the exclusion of religion from its purview vitiates the work of the Organisation, no less than its failure to recognize the need for a principle of unity in the cultural realm. Once again, in relation to proposals for a world authority or for an effective organisation for the control of atomic energy, the Commission records its conviction that fundamentally the problem of peace is spiritual rather than political.

Here the Commission goes down to fundamentals, and in this respect the report is of more value than the comments now included with the symposium of talks on atomic energy arranged last year by the B.B.C. (see p. 995 of this issue of *Nature*). Mr. N. Loewenstein, it is true, points out that we are still in search of some international code of morality as a substitute for a previous international religious faith, but no other commentator appears to see further than the necessity for some surrender of national sovereignty.

In the talk by Mr. H. A. Wallace with which the book concludes, it is pointed out that there may be no future unless the freedom of man and the peace of the world are preserved. Freedom is essential to science, nor can science come to full fruition except in a world at peace. Science is one of the cultural activities of man, one of the ways in which his creative powers and his questing spirit find expression. For that reason, if for no other, scientific workers cannot stand apart, either from the study of the moral and spiritual aspects of peace and war of which the report "The Church and the Atom" is one expression, or from those movements which, like that for Western union, are bringing about a rebirth of the European spirit and a fresh affirmation of the faith on which European civilization, to which science itself owes so much, has been built. However imperfect may have been the formal resolutions adopted at the Hague Conference, all present realized that the foundation of European unity is not material but spiritual, a common sense of ultimate values transcending all national ideological and religious differences. Science, which in itself makes such an important contribution to cultural unity, cannot but applaud the rebirth of that spirit of unity.

MINERAL RESOURCES OF THE UNITED STATES

Mineral Resources of the United States

By the Staffs of the Bureau of Mines and Geological Survey. Pp. x+212. (Washington, D.C.: Public Affairs Press, 1948.) 5 dollars.

THE pre-eminent industrial position of the United States is based upon her vast mineral resources. In many fields, her production of mineral raw materials exceeds that of any other country, a fact which had an important effect upon the course of the Second World War. The war-time acceleration of production revealed, however, that some branches of the mining industry were not equal to the strain, emphasizing, in addition, that for a few essential mineral commodities, the United States are necessarily dependent on foreign sources. To meet anxious questionings at the end of the War, a quantitative appraisal of mineral reserves was jointly undertaken by the United States Bureau of Mines and the Geological Survey, these organisations having carried out, with Congressional authority, very extensive investigations for new and marginal sources of supply. The results of the survey were given in evidence before a sub-committee of the Senate Committee on Public Lands, a small edition being published late last year. This does not appear to have been available in Great Britain. The present edition, with the text unchanged, is welcome because it will bring the facts to a wider public; and because the mineral resources of the United States have more than a purely domestic interest.

Owing to the complexity of geological conditions, no assessment of mineral reserves 'in the ground' can be more than an approximation; the available data vary from deposit to deposit and in general become less reliable as the appraiser passes from the single mine to the mining district, and thence to the country as a whole. Estimates of measured (proved) and indicated (probable) reserves must come in the main from industry itself. In highly competitive branches of the mining industry there is a natural reluctance on the part of the companies to divulge their reserves. Assessment of inferred (possible and speculative) ore can best be carried out by government agencies, who are in a better position to see the picture as a whole. The account recognizes frankly the inadequacies of the data but maintains, I think rightly, that within their limitations the figures give a useful picture of the present situation and the possibilities of the immediate future. It is not claimed that they portray the ultimate mineral wealth of the United States.

The overall picture is, on the whole, a favourable one. Thirty-eight mineral products are discussed, with tables, maps and curves of production. Virtual self-sufficiency, even in times of emergency, is assured for a long time in bituminous coal, lignite, anthracite, natural gas, magnesium, molybdenum, metallurgical-grade fluorspar, helium, magnesite, nitrates, phosphates, potash, salt and sulphur. Improvements in technology and economic changes sufficient to bring submarginal reserves into use would add petroleum, aluminium, copper and iron ores to the list. Dependence on foreign sources is confined to chromite, ferro-manganese, nickel, the platinum group metals, tin, diamonds, quartz crystals and asbestos. In the remaining minerals there are partial deficiencies.

Not merely the actual or impending shortages, but also the needs of production lead inevitably to the recognition of the importance of scientifically planned exploration, in which the geologist, geophysicist, geochemist and mining engineer each has his part to play. Behind the technologists there is the dilemma: Should the search be left to private industry, or should it be integrated in a national plan? The authors have no doubt that the latter alternative would give the best results, and it should be remembered that their view is based upon war-time experience of integrated research.

This unique assessment of a nation's mineral resources, valuable to legislators, producers and consumers under a 'free' economy, would appear to have double value in a 'planned' economy. Could such an appraisal be made for British resources? Many of the basic data are in existence. Coal reserves, first estimated by the Royal Commission on Coal Supplies, 1905, are given region by region in the series of regional survey reports published by the Ministry of Fuel and Power during 1945–46. Iron ore reserves have been studied in detail by the Geological Survey and publication is in progress. For the non-ferrous and allied minerals, Geological Survey investigations in collaboration with the war-time Non-Ferrous Development Committee (Ministry of Supply) cover most of the facts. Since the War a Minerals Development Committee (Ministry of Fuel and Power) has been set up. Possibly, however, a more useful picture would be obtained were an attempt made to sum up the resources of the Commonwealth and Empire rather than the reserves of the British Isles alone, considerable as they have been, and great as they still are in some fields.

Estimates of mineral reserves must necessarily have no lasting character. Not only are they affected by extraction as it proceeds, but also they are profoundly influenced by changes in the economic situation, and by improvements in the technology of extraction and recovery. The waste of yesterday becomes the submarginal reserve of to-day and the ore of to-morrow. Perhaps, therefore, any estimate of workable resources is a little more pessimistic than it need be. If, however, it results in a stimulation of scientific effort in the search for new sources and in the development of improved technical methods, it will have served a useful purpose. K. C. DUNHAM

CHEMISTRY FROM THE SCHOOL TO THE UNIVERSITY

Chemistry for Matriculation

By Dr. G. H. Bailey and H. W. Bausor. Fourth edition, revised and rewritten by Dr. Dudley Ridge. Pp. iv + 487. (London: University Tutorial Press, Ltd., 1947.) 7*s*. 6*d*.

Chemistry for Schools

By C. Jenkins and E. H. Foinette. Part 3. Pp. vi + 254. (London and Toronto: William Heinemann, Ltd., 1947.) 4*s*. 6*d*.

Practical Chemistry

By John Lambert and T. A. Muir. Pp. xx + 383. (London: William Heinemann, Ltd., 1947.) 12*s*. 6*d*.

Fundamental Chemistry

An Elementary Textbook for College Classes. By Prof. Horace G. Deming. Second edition. Pp. xvi + 752. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 24*s*. net.

General Chemistry

An Introduction to Descriptive Chemistry and Modern Chemical Theory. By Prof. Linus Pauling. Pp. vii + 595. (San Francisco: W. H. Freeman and Co., 1947.) 4.25 dollars.

Chimie organique

Par Prof. A. Kirrmann. (Collection Armand Colin: Section de chimie, Nos. 246, 247.) 1: Chimie organique générale. Pp. 220. 2: Fonctions simples. Pp. 195. (Paris: Armand Colin, 1947.) 100 francs each vol.

DESPITE the revision by Dr. Ridge, "Chemistry for Matriculation" still gives the impression of being old-fashioned both in content and in presentation, although it will presumably meet the rather limited demand for this type of book. The reviewer believes that no text-book of chemistry can go through several editions over many years and still retain its initial appeal; after a time it is surely better to write a new book than to over-extend the useful life of the original.

"Chemistry for Schools", by Messrs. Jenkins and Foinette, the last of a trilogy, is intended to cover the final period of a course leading up to the school certificate examinations. To facilitate revision some of the ground covered in earlier volumes is treated again. It is pleasingly produced, and will be readily acceptable to schools where the earlier volumes are in use.

"Practical Chemistry", by Messrs. Lambert and Muir, is designed for students in the latter part of their school certificate course, and throughout their preparation for higher school certificate examinations and the First M.B. examination. To this end the three hundred experiments are divided into six sections. Physical chemistry is treated first, then inorganic chemistry on the basis of the Periodic Table, and organic chemistry subdivided into aliphatic and aromatic divisions. Volumetric analysis, which has previously appeared separately as "The Essentials of Volumetric Analysis", is followed by qualitative analysis based on ionic reactions, with organic reagents introduced for the confirmatory tests, and an introduction to gravimetric analysis. The book is completed by a section on elementary biochemistry. Each experiment is clearly described, together with a brief theoretical explanation, while the apparatus and chemicals required are listed. This book has been carefully compiled from the long experience of the authors, and is well produced. It should meet with ready acceptance as a comprehensive practical book for senior school work.

The two American texts are in pleasing contrast to the first three books, both for the quality of their production and for the refreshingly new approach to the subject. Whereas the former are limited by the school examinations system in Britain and are largely descriptive in character, in the latter much greater attention is paid to the theoretical foundations of the subject. There is no hesitation in introducing the atom and electrons at the earliest stage in a stimulating manner. These two books are introductory texts for a one-year course, and probably would be best used for students meeting the subject for the first time at sixth-form level or as a subsidiary subject at university level. Their prices compare unfavourably with the equivalent British texts, and make it unlikely that they will be widely adopted in Britain. Nevertheless, they can be recommended wholeheartedly to first-year university students.

Prof. Deming's "Fundamental Chemistry" differs from his "General Chemistry" and "Introduction to College Chemistry" in giving fuller treatment of the principles and less space to the historical, cultural and industrial aspects of the subject. In this edition the earlier chapters are simplified by presenting the internal structure of atoms in an elementary way and postponing the details of nuclear chemistry to near the end of the book, when the fission of uranium and plutonium and the creation of synthetic elements is considered. Inorganic complexes and silico-organic compounds are introduced to show that inorganic chemistry is not limited to acids, bases and salts.

Prof. Pauling is known to every university student for his outstanding achievements in theoretical chemistry and their application to problems in inorganic and organic chemistry and biochemistry. He will now reach a younger body of students through his introduction to theoretical and descriptive chemistry. After a discussion of the properties of substances, their atomic and molecular structure, and a survey of descriptive chemistry in relation to the Periodic Table, there are given thorough discussions of weight relations in chemical change, valence and electronic structure, and oxidation-reduction reactions. The first detailed chapter of descriptive chemistry deals with chromium, manganese, and their congeners. These elements are selected for this prominent place for the interest of their chemistry and as excellent examples of oxidation-reduction reactions. The remaining chapters deal with descriptive chemistry and theoretical topics, such as thermo- and radiochemistry. The text gains much from the unconventional diagrams by Roger Hayward, with their emphasis on structural and crystal chemistry.

In the two volumes by Prof. Kirrmann, organic chemistry is presented in pocket form, and the half-hour spent in cutting the pages open is well rewarded. These volumes are recommended to undergraduate chemists who wish to consolidate their knowledge of French. In the first volume general theoretical topics are developed, and the sections on structure and reactions well repay reading. The second volume introduces systematic organic chemistry without the conventional division into aliphatic and aromatic sections, the classification being on the basis of functional groups. The treatment of heterocyclic compounds is less satisfactory, being considered in a separate chapter in rather sketchy fashion. A further volume on multiply functional compounds is promised and will be awaited with interest.

S. H. HARPER

CHEMICAL PROMOTION OF ROOTING IN PLANTS

The Use of Auxins in the Rooting of Woody Cuttings

By Kenneth V. Thimann and Jane Behnke. (Maria Moors Cabot Foundation, Publication No. 1.) Pp. iii + 272. (Petersham, Mass.: Harvard Forest, 1947.) 1 dollar.

In 1937, the Maria Moors Cabot Foundation was established in the United States to "promote education in the art of increasing the capacity of the earth to sustain human life"; the growth and propagation of trees and other plants as a source of fuel and energy was to be a primary study, and its subsidiary purpose was "to disseminate information helpful and stimulating to others who may wish to enter this field of effort". The book under review, which is the first special publication produced by the Foundation, certainly serves this subsidiary purpose for one of the topics of study in wide-ranging investigations the results of which have been mainly reported in ordinary scientific journals.

Prior to resuming their experiments on vegetative propagation, the authors decided to collect and collate all available published data of a quantitative or semi-quantitative kind on the use of auxins in the promotion of rooting. Gratitude will be felt to them for publishing the results of their labours, which must have been considerable. In the bibliography there are 274 citations—about three times the number in Mitchell and Rice's summary in 1942. The publications cited report work done up to 1946 in a number of widely scattered countries but mostly in greater America. (The reviewer has failed to find any references to papers published in Scandinavia, France or Italy. Is this because interest in the root-forming powers of chemicals has not yet been aroused in these countries ?) Most of the reports are no more than a few pages long. Few of them can be considered as making, by themselves, solid contributions to scientific knowledge; but, read with other texts (for example, the appropriate chapters in Went and Thimann's "Phytohormones" (1937), and in "Hormones and Horticulture" (1947), by Avery *et al.*), the information collectively contained in them, assembled as it has been by Prof. Thimann and Miss Behnke, may well assist in the design of future experiments by plant physiologists who, working on ideas derived from those of Sachs and Beyerinck, seek to unravel the complexities of reacting systems which are competent to produce lateral and adventitious roots.

Up to the present, in this field practical control has outdistanced intellectual control. For the physiologist there may therefore be too little about too much in this book; but gardeners and foresters will find in it a mine of information to guide them in their efforts to establish the conditions which will, with surety, accelerate the rooting of cuttings from ornamental plants or from herbs, shrubs and trees of economic importance. The authors give accounts, ingeniously condensed, of five thousand trials on nearly four hundred genera, with species, varieties and hybrids of *Rhododendron*, *Prunus*, *Pinus*, *Picea*, *Citrus* and *Rosa* among those most used. In these trials, observations have been made of the influence on powers of quick rooting (taking a week or two) or of slow rooting (taking up to a year or more) exerted by one or more of twenty-one synthetic chemicals and sixteen commercial auxins (only one of British manufacture) applied in a variety of ways (basal dipping, coating, etc.) to different kinds of cutting (leafy and leafless softwood or hardwood, leaf, leaf-bud, etc.). Clearly the authors have disseminated much helpful and stimulating information.

M. THOMAS

SERVOMECHANISMS

Theory of Servomechanisms

Edited by Prof. Hubert M. James, Nathaniel B. Nichols and Assoc. Prof. Ralph S. Phillips. (Massachusetts Institute of Technology; Radiation Laboratory Series, No. 25.) Pp. xiv + 375. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 5 dollars.

IT is appropriate that one of the first major works to be published on the theory of servomechanisms is a product of Massachusetts Institute of Technology. The contributions during the past few years of both the M.I.T. Servomechanisms Laboratory and Radiation Laboratory to the theory and practice of automatic control are well known and highly respected by specialists in the subject, and this book, which is volume 25 in the Radiation Laboratory Series, will be welcomed universally. Notwithstanding the fact that there are ten contributing authors, the editors have arranged the mass of new material at their disposal admirably, and continuity in the development of the main ideas is maintained throughout. Several chapters include hitherto unpublished work. For example, a chapter is devoted to the conditions for stability of filter networks and control systems which are actuated by intermittent data; to the reviewer's knowledge no previous quantitative studies of these important systems have been undertaken.

The authors have been influenced in their treatment of the servo problem by modern electric filter design theory and communication engineering techniques. This is no doubt due to the nature of the servo design problem with which they were concerned during the War, namely, the design of automatic following radar equipment. In the development of such equipment the major problem is to minimize the effect of spurious misalignment signals, a problem which is analogous to that of increasing 'signal to noise' ratio in a communications system. An interesting method of dealing with such a situation is described by Prof. Phillips in Chapter 7. If the input 'noise' is assumed to be purely random and optimum performance of the system is assumed when the value of the root mean square error is a minimum, the method shows how optimal values for the control parameters can be obtained without the necessity of deriving the roots of high-degree characteristic equations; the method is illustrated by numerical examples.

The introductory chapter by Prof. Getting is excellent both in its conciseness and quality; it is, in fact, the best short introduction to the basic philosophy of servo system design known to the reviewer. Another valuable feature is the chapter devoted to the study of the behaviour of typical elements used in the design of control systems, such as error measuring devices, servo motors, power amplifiers and gear trains.

The chapter on general design principles introduces the Nyquist stability criterion, the concept of 'equalization' (for example, stabilization) of servo loops, and an elegant application of the attenuation (expressed in decibels) – log frequency and phase – log frequency diagrams to illustrate the frequency response characteristics of a control system and their use in the important problem of controller synthesis. In order to exemplify the power of these new theoretical techniques, a typical radar tracking control system is analysed in detail and, as a second example, the design of a low-power servo system incorporating a two-phase induction motor is discussed.

In view of the authoritative nature of the book it is perhaps somewhat disappointing that it is devoted exclusively to linear systems, especially since it is becoming increasingly clear that non-linear effects such as backlash in gear trains, static friction, saturation of amplifiers, resilience in shafts, etc., constitute the most important factors which limit the performance of modern servo systems. Admittedly, the difficulty of handling such problems is considerable and probably justifies their omission.

A minor criticism concerns the introduction of the problem of designing a manual control system in the last chapter. Despite considerable advances in the design of manual controls, it is unlikely that the transfer function of a human operator will be known with any accuracy for a considerable time to come. The assumption that an operator in tracking a target turns a handwheel at a rate proportional to the error which existed, say, 0·3 sec. previously, cannot be substantiated by experiment and can be misleading.

A. PORTER

Atomic Challenge

A Symposium by Prof. J. D. Cockcroft, Prof. M. L. Oliphant, Group-Capt. G. L. Cheshire, Dr. J. Bronowski, Sir George Thomson, Capt. Cyril Falls, Prof. P. M. S. Blackett, Sir Henry Dale, Bertrand Russell, Sir John Anderson and Henry Wallace; with Commentaries by Students of Different Nationalities. Pp. x + 180. (London: Winchester Publications, Ltd., 1947.) 8*s.* 6*d.*

The talks on "Atomic Energy: the Present and the Future" which the British Broadcasting Corporation arranged during March last year, first in the Home Service and afterwards in the 'third programme', have now been published in book form. To them have been added a series of comments by younger men and women representing American, Russian, German and Chinese points of view, and the talk on atomic energy which was given by Mr. H. A. Wallace in the third programme of the British Broadcasting Corporation during his recent visit to Great Britain. While these comments are of interest as indicating the attitude of the younger generation to the problems which atomic energy presents, and in particular reveal a general readiness to face the sacrifice of national sovereignty involved in any scheme of control, they add very little to the substance of the symposium. Moreover, the comments are not very clearly distinguished from the actual talks: the reader who missed the actual broadcasts is left to identify them chiefly by the biographical notes. The titles of the broadcasts have been discarded, and the substitutes are scarcely an improvement on the originals. An equally important blemish is the omission of any indication as to the dates when the broadcasts were given; those who wish to study the actual broadcasts may well be better served by *The Listener* of May 13, 1947, in which the series was first published.

Annual Review of Microbiology

Charles E. Clifton (Editor), Sidney Raffel (Associate Editor), and H. Albert Baker (Associate Editor). Vol. 1. Pp. vii+404. (Stanford, Calif.: Annual Reviews, Inc., 1947.) n.p.

In the preface of this latest 'Annual Review' it is explained that a canvass of representative microbiologists indicated that their interests were not sufficiently covered by an already large number of periodical reviews covering at least many parts of the same subject. Time alone will show whether this opinion is justified. The term 'microbiology' may be taken to cover the whole physiology of organisms too small to observe without a microscope. It includes, therefore, morphology, biochemistry, genetics and all interactions with external environments of Protozoa, Bacteria, Fungi and so forth. Until recently, these subjects have been the concern of different groups determined by differences in technique, and undoubtedly this has led to a poor diffusion of knowledge of matters which are applicable to all groups. In some sections, however, this deplorable situation has been relieved by the publication of reviews in existing periodicals. Particularly this has been so in the chemical field, and it may now be doubted whether there is much ignorance of the biochemistry of one form of life among the students of another; at least in the particular field of biochemistry the student is interested in. It can scarcely become practicable for anyone to develop an abiding interest in many branches of a subject which has no biological limits. The present volume presents articles of widely diverse interest. The fractions of each subject covered are necessarily so small that the reader must still rely on the many reviews appearing elsewhere on practically the same field. Any of the articles could properly have appeared in existing reviews and, curiously enough, one of them has already done so. The articles which the reviewer is capable of judging are of a high order and presented with a personal touch which is valuable. Certainly an active worker must run his eye through this further addition to his survey of information, but he must not expect that this annual review alone is going to keep him abreast of developments.

Paul Fildes

A Text-Book of Practical Organic Chemistry

Including Qualitative Organic Analysis. By Dr. Arthur I. Vogel. Pp. xxiii+1012. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 42*s.* net.

Dr. Vogel's books on analysis are widely used in teaching practical inorganic chemistry. His new volume is intended as a comprehensive laboratory manual for students of organic chemistry. It gives a full and valuable description of organic chemical technique, details of preparation of more than six hundred compounds, and a scheme of qualitative organic analysis. There are appropriate notes on the preparative reactions described and on the properties of the various classes of organic compounds. A curious omission is the almost complete absence of reference to quantitative organic analysis. It seems to the reviewer that some practice at least in quantitative elementary analysis is of value in the student's training, even in these days when the fully fledged organic chemist hands his analysis specimens to the microanalyst for determinations which he is usually quite unable to carry out himself.

It is a little doubtful whether such an elaborate laboratory text-book will attract the average undergraduate student, who would certainly not wish to work through all the preparations described. It will have a greater appeal to teachers and research workers, although the almost complete absence of references limits its usefulness to these. The book is well produced and well illustrated, and the only error which has been noticed is in the structure assigned to hexamethylene tetramine.

J. W. Cook

The Right Way to Understand the Countryside

By Stanley A. Manning. (Right Way Books.) Pp. viii+116+4 plates. (London: Rolls House Publishing Co., Ltd., n.d.) 5*s.*

In attempting to provide information about "trees, shrubs and woodlands, wild flowers and plants (including fungi, mosses, etc.), insects, animal life, birds, countryfolk, customs and folk lore", as well as "information on the National Forest Parks, Youth Hostels Association, local clubs, research areas, etc.", in 113 pages, Stanley Manning might well have considered if he might not have made his book a little longer. He might also have considered whether the use of technical terminology is advisable in a book meant for beginners and whether the introduction of controversial issues should not be left to a later place than the first chapter. This is particularly so since anyone who reads right through the book will realize that Manning has much of value to offer to the novitiate in country ways and customs. The scraper-board drawings by Elaine Hancock are attractively done, but perhaps not so suitable as line drawings for a book of this kind.

T. H. Hawkins

ORIENTATION OF BIRDS ON MIGRATORY AND HOMING FLIGHTS

A GENERAL discussion on the "Orientation of Birds on Migratory and Homing Flights" was held at a meeting of the Linnean Society of London on May 13, the president, Prof. G. R. de Beer, being in the chair. A full report will appear in due course in the *Proceedings of the Linnean Society* (160, Part 2; 1948).

The opening speaker, Dr. W. H. Thorpe, discussed the extent to which the facts of bird migration and homing could be accounted for on the basis of known senses and sense organs. There are two aspects of the problem: (*a*) the ability of a migrating or homing bird to take up the right direction of flight, and (*b*) the ability to maintain a given direction once started even though unfamiliar with the territory and in bad visibility. Observations and theories dealing with the second aspect were discussed in detail. It was concluded that while we need to know very much more than we do about the extent of night migration in overcast weather, theories of visual orientation already go a very long way towards accounting for the known facts, and no other type of theory appears inevitable at present.

The ability of birds to take a correct initial direction of flight perhaps provides more difficult problems. This raises the question of the existence of some innate sense of direction, and in this connexion the recent work of Ruppell[1] on the movements of hooded crows (*Corvus c. cornix*) displaced from their normal migration routes was described. It was argued that these results provide good evidence for the ability of young hooded crows to maintain an approximately correct general direction of migration independently of the company of experienced birds and knowledge of the landmarks. This work, however, does not require the assumption of any mysterious sense of direction since this species migrates by day and the general direction may well have been maintained by a combination of time sense and orientation by the sun.

The work of Griffin[2] on the homing and migration of birds was then discussed, and it was pointed out that provided we assume that the bird is familiar with a considerable area of country around its nest and is not, therefore, homing to a restricted point, random radial scatter and very approximate spiral exploration might account for a very large proportion of the published experiments on homing. In this connexion the importance of obtaining evidence as to the actual course followed by individual birds when released in unfamiliar territory was stressed and the work of Griffin on the herring gull (*Larus argentatus*)[3] and gannet (*Morus bassanus*)[4] was described. It was pointed out, however, that there are some observations on the direction-finding of homing and migrating birds which seem at present inexplicable on the basis of known senses and sense organs, and that a careful search for other possible methods of orientation was fully warranted. Orientation by kinæsthetic receptors seems ruled out, and it was assumed that there is no satisfactory evidence for infra-red vision among birds. Finally, the recent work of Yeagley on the homing and orientation of pigeons was described and critically discussed. Yeagley[5] now claims to have shown that trained homing pigeons can navigate by correlating visual estimation of instantaneous land speed with sensitivity to the vertical component of the earth's magnetic field and to a Coriolis force. These two influences together form a navigational gridwork of two sets of lines. By this means the bird is supposed to be able to fly to its home, which is a unique point in the gridwork, or to a related 'conjugate point' existing in the gridwork at a position other than its home. Yeagley's first experiment, the 'magnetic wing' experiment, which the author regards as securing "positive though limited data for the electromagnetic phase of the theory", was criticized in detail by Dr. Thorpe and found quite inadequate as a basis for such conclusions. The rest of the 'evidence' produced by Prof. Yeagley consists of a series of experiments in which a total of more than five hundred pigeons were used. The method adopted depends on the fact that for any point in the eastern coastal States of the United States having a particular magnetic-Coriolis characteristic there will be one other, and only one other, 'conjugate point' having the same characteristics at a corresponding latitude somewhere in the Dakota–Nebraska–Kansas region. Thus "if a bird locates its home by navigating to the intersection of the proper magnetic vertical and the proper latitude he should as readily navigate to the conjugate point as to his home if released nearer the former". Pigeons were trained at State College, Pa., to return to a conspicuous mobile loft from up to seventy miles in various directions. Loft and pigeons were then transported to Nebraska and the pigeons released mostly at distances between twenty-five and seventy-five miles from the conjugate point. On the theory, it would be expected that pigeons should be able to home to the new locations as easily as to the old.

It was pointed out that the method of presentation adopted by Prof. Yeagley in his paper, and particularly his method of total flight vectors, was highly misleading. Moreover, two thirds of the birds used were lost during the course of the experiment —the results described referring to the remaining third only. Yeagley does not subject his data to any statistical analysis, nor are enough details given to enable any satisfactory assessment to be made by others; but such statistical significance as the results appear to possess may be accounted for by observational bias. The experiments involved transporting and setting up large mobile lofts which were rendered as conspicuous as possible in order to increase the chance of the pigeons finding them, although far less than 1 per cent of the birds succeeded in doing so. Thus, for 'returns' the experimenters had to rely on the birds being found and records sent in by pigeon fanciers, farmers and others up and down the country. It seems only reasonable to assume that large-scale experiments of this kind with the lofts set up in the region where the birds are expected to return were likely to attract a good deal of local interest and attention. Unless great care had been taken to prevent any information about the experiments becoming public, or to ensure that the birds were looked for equally intensively in the areas where they were not expected to appear, the results are open to great suspicion. No mention is made in Prof. Yeagley's paper of any precautions having been taken in this connexion, and so it must be assumed that they were not, in fact, taken. It is also unfortunate that there were no control releases of Pennsylvania-trained birds farther from the conjugate point. Thus, after careful examination of Prof. Yeagley's paper one is forced to conclude that no evidence has been produced that birds can navigate by a magnetic-Coriolis grid.

Dr. D. H. Wilkinson discussed recent theories of bird orientation which have invoked the use of Coriolis forces for determining latitude, and the vertical component of the earth's magnetic field for supplying the second co-ordinate. If a bird is to 'home' to within twenty-five miles at latitude 45° the effects by which it does this must be measured to an accuracy of about 0·5 per cent. The characteristics of home must, of course, also be remembered to the same accuracy.

The magnetic effect was discussed first. If the bird responds directly to a magnetic field, its problem is simply the measurement of it to 0·5 per cent. It is unlikely that birds have such a response, and it has been suggested by Yeagley that the potential difference induced by the linear translation of a conductor through the field may be detected. The first comment is that this potential difference would be unable to supply a current, and so the bird is called upon to make a purely electrostatic measurement of 10^{-5} volts per cm. of conductor to an accuracy of 0·5 per cent. These figures assume a bird flying at 40 m.p.h. at latitude 45°. The second comment is that there are present in the atmosphere potential gradients of the order of 1 volt per cm. These fluctuate widely and may change by several per cent in a mile. Even if there were no fluctuations the bird's problem would not be the measurement to 10^{-7} volts or so in 10^{-5} volts, but in 1 volt, an accuracy of 1 part in 10^7, not 1 part in 100. Such a measurement is impossible even leaving out of account the bird's necessity of knowing its air-speed accurately to 0·5 per cent. A second type of induction method which should be mentioned would consist in the rotation or oscillation, by the bird, of some conducting loop contained within its anatomy. Such a method gives a current of order $10^{-8}/R$ amp. for a loop of area 1 cm.^{2} and resistance R ohms oscillated with a period of 1 second. This method would remove the objection on the grounds of the earth's electrostatic field, the current due to this being of the order $10^5/R$ times smaller. Neither would the air-speed have to be known, though this would be replaced by a knowledge of the period of oscillation. The effect is again far too small to be considered, both in view of its absolute magnitude and of the existence of far larger natural currents in the bird's body. One therefore concludes that any measurement of the earth's magnetic field with the required precision is most highly improbable.

The Coriolis force is a sideways force experienced by a point which moves in a path the centre of curvature of which itself moves in a curve. It is then a purely geometrical effect, and has no explicit connexion with the rotation of the earth. It is only when the instantaneous rotation of the bird's flight is essentially that of the earth that the Coriolis force effects can be interpreted to yield the latitude. This means, in effect, that the bird must fly an extremely true course—and know that it is so flying. For the spurious Coriolis forces due to the inaccuracy of the bird's flight not to become comparable with those due to the rotation of the earth, the flight must have an instantaneous radius of curvature of about 100 miles or greater. This means a flight true to 1/50 in. in 100 ft., which is manifestly impossible. Though consideration of this fact alone is enough to show the impossibility of using Coriolis forces, the magnitudes are again far too tiny. As for the magnetic effects, there are two ways of using Coriolis forces, one crude and one refined. There is, indeed, close similarity in the analytical expression of the effects. The first suggestion to be considered is that of Yeagley, who supposed the bird to perceive the Coriolis force acting sideways on its body when in level flight. For our typical 40 m.p.h. bird this amounts to 1/6,000 g. As this force is no different in effect from the gravitational force, the only difference to the bird is that gravity now seems to act at a small angle to its true direction. The 0·5 per cent accuracy requirement means that this angle must be measured to about 0·2″ of arc. The bird has no idea where to measure this angle from, since gravity itself is not available, neither does gravity act at right angles to the earth's surface. In any event, if the bird's flight is not true to an extreme degree (the same order as remarked above) plain centrifugal force will exceed the Coriolis. The second suggestion came first in time, being that of Ising[6]. He considers the swirling motion of the fluid in an oscillating ring induced by Coriolis forces. Criticism has already been made[7] of the magnitude of the effects, which would be lost in the Brownian motion of the detecting organ. In any event, Ising's considerations are only of interest for a sitting bird because of the above remarks as to truth of flight. The conclusion, then, is that the Coriolis force is as useless as the magnetic field for bird orientation.

Finally, Dr. Wilkinson discussed the interpretation of homing experiments which seek to establish the existence of a double co-ordinate system. If a method such as Yeagley's 'total flight vector' be employed, the releases must not be symmetrical with respect to either of the co-ordinates or their normals through the point towards which flight is sought. If the homing then were only in one co-ordinate and the releases had such symmetry, the 'total flight vector' would point to the desired point, and no conclusion could be drawn as to the double co-ordinate homing.

The possibility that birds 'home' in one co-ordinate only should be seriously considered since the random search labour in which a bird is involved when it can home in, say, latitude only is enormously reduced. It may be that it is unnecessary to explain how birds 'home' to a point, but merely how they 'home' to a line. Such latitude homing may surely be accomplished with the aid of the sun-determination of its highest point to one diameter, giving latitude to thirty miles.

Prof. R. J. Wojtusiak, who had hoped to be present, had unfortunately to return unexpectedly to Poland. In his absence, Mr. H. W. Parker gave a brief summary of his paper entitled "Polish Investigations on Homing in Birds and their Orientation in Space"[8]. This paper summarizes the published work on the homing of wild birds, especially swallows and storks, hitherto carried out in Poland. Evidence was produced that visual recognition of landmarks plays a very important part in the homing orientation of swallows, and that once a homing flight from a particular locality has been accomplished, subsequent flights by the same bird over the same route will be performed at a much greater average speed. The possibility of infra-red vision as an aid to orientation was discussed and evidence brought forward[9] that the eyes of water tortoises are sensitive to infra-red. Similar experiments now in progress with pigeons were briefly mentioned, and it was claimed that positive results had already been obtained.

Dr. A. Landsborough Thomson pointed out that our ignorance of bird navigation is so great that we cannot afford to neglect any suggestions however far-fetched they may seem. He did not think that the suggestion that young birds migrating for the first time without their parents might merely have a tendency to go southwards towards the sun would carry us very far, since so much migration is not in the north-south line. He had no doubt at all that visual recognition plays a very large part in the orientation and migration of birds; but it does not, so far as we can see at present, give us a complete answer. Dr. Thomson agreed with previous criticisms of Yeagley's experiments, particularly because the birds were taken to the conjugate point and in some cases had been accustomed to that point before being taken to the release point. They should have been taken to the release point first.

Prof. V. C. Wynne-Edwards gave an account of his experiences with the release of herring gulls, and expressed agreement with the criticisms of Yeagley's work. He adhered to the view that in the end we shall find everything can be explained on a visual basis. He also suggested the possibility that the excellent time sense of birds might enable a bird to recognize a particular latitude by the time of sunrise.

Mr. James Fisher suggested that operating on a deliberate bias might be one of the methods by which birds can find their way in unknown country more efficiently than by theoretical spiral travelling. Thus if Lack and Lockley's famous shearwater released at Venice had operated on the principle of going along a right-handed coast it would eventually have reached the Bay of Biscay and thus presumably familiar territory.

Mr. B. W. Tucker agreed with the criticisms of Yeagley's experiments which had been put forward. But while much migration and homing can be explained in terms of visual responses, he felt that this cannot at present account for everything, and there are phenomena which are not completely explicable on the basis of any of the straightforward known senses. He pointed out that particular difficulties were raised by migration to oceanic islands and by the orientation behaviour of birds such as penguins.

Dr. M. H. Pirenne dealt with the subject of the sensitivity of birds' eyes and gave details of his experiments on owls and their response to infra-red rays. Discussing the work of Wojtusiak, Vanderplank and others, he pointed out various difficulties of interpretation and concluded that satisfactory evidence for infra-red vision is still lacking both in reptiles and birds. The fundamental difficulties raised by the infra-red radiation of the eye itself and associated tissues and by the infra-red absorptive power of the water in the eye were also discussed.

Mr. R. G. Newton suggested various possible methods by which the exact route taken by birds on release might be more easily traced.

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[2] Griffin, D. R., *Quart. Rev. Biol.*, **19**, 15 (1944).
[3] Griffin, D. R., *Bird Banding*, **14**, 7 (1943).
[4] Griffin, D. R., and Hock, R. J., *Science*, **107**, 347 (1948).
[5] Yeagley, H. L., *J. App. Physics*, **18**, 1035 (1947).
[6] Ising, G., *Ark. Mat. Astron. och Fysik*, **32 A**, N.18.1 (1945).
[7] Thorpe, W. H., and Wilkinson, D. H., *Nature*, **158**, 903 (1946).
[8] Wojtusiak, R. J., *Proc. Linn. Soc.*, **160**, Part 2 (in the press, 1948).
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MEDICAL RESEARCH DURING WAR-TIME

CRITICS of science, whatever their motives, have not neglected to make capital out of the destructive uses to which scientific results have been put by man; and critics of planned research, moved no doubt by purely scientific reasons, have vigorously asserted that planning hampers and may ruin the creative abilities of scientific men. To both these groups of critics the Report of the Medical Research Council for the years 1939–45, entitled "Medical Research in War" (Cmd. 7335. London: H.M. Stationery Office, 1947. Pp. 1–455. 7*s*. 6*d*. net), is to be commended. For in it the former will find a long record of beneficent uses to which scientific results have actually been put; and the latter will learn from it that planning, provided that it is wisely done by broadminded men who understand, and themselves experience, the mental processes and disciplines of scientific work, can produce both useful results and fundamental discoveries which advance the frontiers of knowledge. The proviso is a *sine qua non*; for planning that fails to recognize the basic individualism of scientific men and their kinship with artists imposes fatal limitations upon the research worker. The report is, for this reason, a tribute, not only to the men and women who have done the humane work that it records, but also to those who have, in their several ways, created and woven the themes treated, made the opportunities and provided the money and equipment without which the work could not have been accomplished.

The report, as its title implies, covers work done during the period of the Second World War. Military and industrial requirements, and also the health of the civil population therefore dominate its contents. The extent of the achievement recorded and the variety of the different, but often related, subjects investigated make it impossible, in a short review, to do much more than whet the appetite, so to speak, of potential readers and to invite them to read the report itself.

Apart from the information given about the composition and functions of the Medical Research Council and its committees, its arrangements for liaison with other men of science and scientific organisations in the United Kingdom, in other parts of the Commonwealth and in Allied countries, the names of its personnel, the publications of its research workers and the Council's own reports and a good deal of kindred information, there are fifteen sections which describe specific researches in considerable detail. These are summarized in a valuable "Introduction".

The subsequent sections deal with work on wounds and injuries; war diseases; therapeutics, including a useful account of the work on penicillin; war-time nutrition; personnel research done to increase the efficiency of the Fighting Services; health research in industry; special emergency services, such as blood transfusion, the emergency public health laboratory service in Britain and the supply of necessary immunological sera and antitoxins; the preparation and maintenance of biological standards of such substances as penicillin, vitamins A and E, heparin and certain serological reagents, together with the maintenance of the national collection of type cultures of micro-organisms; and a great deal of other work done either at the National Institute for Medical Research or elsewhere on a variety of subjects, of which the control of cross-infection in hospitals, the birth-rate, population trends, air-borne infection, the remarkable work on scrub-typhus and research on burns and scalds and applied psychology are a few examples. The report, in fact, amounts to a guide to the major trends of medical research in Britain at the present day.

The three main objectives of all this work have been: (1) the maintenance of the health of the Armed Forces and the civilian population, with special regard for malnutrition and the prevention of infectious diseases; (2) the restoration of the wounded and sick to full health; and (3) the creation of conditions which will ensure the highest possible efficiency, safety and comfort of fighting personnel and industrial workers in time of war.

The effort to attain the first of these objectives was very successful. Epidemic infective disease has always been a military menace, but during the Second World War it was reduced to military insignificance. In civil life it was also checked, although the common cold, influenza and a variety of industrial hazards remain and are recognized as urgent problems which are now being energetically investigated. The value of the nutritional work done during the War is so well recognized that it needs no comment here.

The success of the attack on the second objective is probably not fully appreciated outside the medical profession. Powerfully aided by the discovery of the sulphonamide drugs and the effects of penicillin, and by remarkable advances in surgical treatment, the work done in this field saved the lives and returned to useful occupation many men and women who formerly would have either died or would have survived only in helplessness and misery.

The story of the attack on the third objective is in some respects the most interesting part of the report. It includes accounts of the work on the physiology of flight at high altitudes and of deep-sea diving; the design of clothing for airmen and for life in arctic and tropical climates; the human problems associated with submarines and surface ships; the design of aircraft, guns and armoured vehicles in relation to the abilities and needs of the men who use them; and the special problems, physiological and psychological, arising from the use of complicated panels of instruments, engine controls and similar devices inseparable from modern mechanized warfare and industry.

As the report says, the main factor limiting the efficiency of a machine or weapon may be the human being using it, so that machines and weapons should not be designed by physicists and engineers without the co-operation of the psychologist, the physiologist and the medical man. To industry the same considerations apply. Lighting, heating, ventilation, noise, dust, toxic products of the factory—all these, as well as the relations between the machine and the people who use them, need scientific study if the best economic, social and humane results are to be attained.

During the period covered by the report the Medical Research Council has unhappily lost by death or retirement the services of men whose experience and creative ability were very valuable. The deaths of Sir Patrick Laidlaw and Sir Thomas Lewis, to whose influence and achievement the report pays tributes, were grievous blows. Although Sir Henry Dale retired after twenty-eight years of active service, he remained on the Council for four years longer, and his wide experience and outstanding ability are still happily available in consultation. Sir Edward Mellanby, secretary of the Medical Research Council, is fortunately still in office. He must be well satisfied with this record of the work to which he has devoted so much wise counsel and prolonged hard work.

G. LAPAGE

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, AUSTRALIA

ANNUAL REPORT

THE twentieth annual report of the Council for Scientific and Industrial Research, Commonwealth of Australia, covering the year ended June 30, 1946 (Canberra: Gov. Printer. *5s. 4d.*), now available, refers to the decision to establish a Division of Textile Research as a result of the visits of Mr. B. H. Wilsdon, Prof. J. B. Speakman, Dr. F. T. Peirce and Dr. A. C. Goodings mentioned in an earlier report; negotiations are in hand for the acquisition of a site for the headquarters laboratory at Geelong. Some work in the wool textile field will be undertaken by existing divisions.

The Building Materials Research Section and the Flax Research Laboratory came into existence during the year, and experimental work in nuclear physics and metallurgy was initiated in collaboration with the University of Melbourne. The Council has resumed its earlier practice of sending members of its scientific staff overseas to collect information on new developments and to acquire general experience in research and training in new techniques. A series of studentships is also to be offered each year to enable recent graduates of Australian universities to gain general research experience and training overseas in subjects related to the Council's programme of research, and then to return to Australia as members of the Council's staff. The Council's scientific liaison offices in London and Washington are now being maintained on a restricted basis to serve the peace-time needs of the Council.

With the end of the War, the Division of Plant Industry is devoting much more time to a study of pasture and weed problems, and the joint State and Council Weeds Co-ordination Committees are being revived. The North Australian Development Committee established by the Commonwealth Government and those of Queensland and Western Australia initiated a rapid examination, in the Katherine–Darwin–coast area, of the vegetation in relation to geology, soils and climate, the distribution, grazing and quality of stock, etc., during the 1946 dry season. Another committee on which the Council is represented, with the Waite Agricultural Research Institute and the Departments of Agriculture of South Australia and Tasmania, has been established to supervise investigations of dieback or 'gummosis' of apricots. Pasture investigations have included the management of *Phalaris* – subterranean clover and of Wimmera rye grass – subterranean clover in sown pastures, and a large-scale grazing trial of natural pasture in co-operation with the New South Wales Department of Agriculture. Mineral deficiency, pasture establishment under cover crops, various studies of mixtures of lucerne and *Paspalum sero-*

biculatum, and studies of cattle pasture and native legumes are also reported. Weed investigations have ranged over the control of galvanized burr, mintweed, capeweed in flax crops and studies of the action of plant poisons. Facilities for plant testing were re-organised and developed, some 510 species and varieties being received from abroad for trial during the year, while more than a thousand samples of seeds of Australian native and crop plants were sent to overseas agricultural and botanical institutions. Trials of introduced linseed varieties gave particularly promising yields, and linseed is believed to have good prospects as a commercial crop in southern Queensland. Experiments with the guayule rubber plant continued, and plants grown at Lawes under natural rainfall compared favourably in yield and rubber content with the best irrigated plantings in South Australia. Wheat investigations covered take-all disease. The study of fruit storage problems was again taken up, and work on the vitamin C content of tomato varieties continued. Trials with dichloroethylene and dichloroethane gave good results in the control of woolly aphis in propagating beds, and aspects of the dieback disease of apricot have been surveyed. Drug plant investigations have been concentrated on the study of *Duboisia* spp. as sources of hyoscine and atropine; the study of varieties of *Papaver somniferum* as sources of opium alkaloids; and the systematic search for sources of pharmacological and insecticidal substances in native plants. Vegetable investigations have included genetical work aimed at producing hybrids resistant to the potato viruses A, X, Y and leaf roll; agronomic studies of selected varieties of tomatoes; peas and beans; the use of zinc oxide as a disinfectant on cut potato setts; and spotted wilt of tomato.

Reports from the Divisions of Economic Entomology and of Animal Health and Production both give some prominence to trials with D.D.T. and 'Gammexane'. A preparation of the former, known as 'Rucide' and containing 50 per cent of the *pp*-isomer, which forms a stable fine emulsion when melted and poured into water, has given very promising results against cattle tick, in control of buffalo fly on dairy cattle and beef cattle, oriental peach moth, potato moth and cabbage moth and butterfly. D.D.T. has also given promising results in control of sheep blowfly. Other work by the Division of Economic Entomology has been concerned with the biological and clinical determination of D.D.T. and other insecticides, the biological control of cabbage white butterfly, citrus red scale, brown olive scale and potato moth, the insect control of St. John's wort, and insect vectors of plant viruses. The Division's work on wheat-storage problems terminated during the year; but promising results were obtained both with D.D.T. and '666' against hoppers and adults of the Australian plague locust. In the Division of Animal Health and Production, systematic epidemiological studies of mastitis were continued on the experimental herds of dairy cattle, and the good results obtained with penicillin in bacterial infections of the udder have been confirmed. Other investigations have covered toxæmic jaundice in sheep, contagious abortion of cattle and the toxicity of wheat for stock, while at the McMaster Animal Laboratory studies have been made of anthelmintics against *Hæmonchus contortus*, *Trichostrongylus* spp. and *Œsophagostomum columbianum* as well as of the administration of phenothiazine in salt lick and in small repeated doses, the effect of worm parasites on body weight and wool growth, external parasites of sheep and the blowfly strike problem. Biochemical studies have included the mineral metabolism of sheep and poisonous plants; studies in wool biology have included specifications of sheep types for wool production and histological studies of the sheep's skin. At the F. D. McMaster Field Station, studies have been made of the inheritance of skin wrinkles in sheep and of various faults and specific breeding groups. An investigation has been commenced into beef production in Australia, and an officer has been appointed for poultry breeding investigations.

The study of the nutritional physiology of ruminants has again been undertaken, particularly with the view of extending knowledge of the chemical, microbiological and physiological mechanisms involved in rumination and in the production of wool fleece, and the detailed study of the influence of protein intake on the latter has already indicated several broad principles. Other studies in the biochemical field have covered chronic fluorosis, the influence of deficiencies of minor elements, cobalt and copper deficiency and the effect of copper and cobalt dressings on grazing sheep. Soils investigations have been concerned mainly with problems in land settlement; surveys of various types have proceeded in five States. Considerable attention has been given to the place of soil investigations in research on building problems with particular reference to foundations, but lack of qualified research staff has hampered development. Irrigation settlement investigations at Merbein, Victoria, and Griffith, New South Wales, have proceeded on the usual lines, covering irrigation and drainage problems, soil moisture problems of irrigated lands, soil deterioration from irrigation, viticulture, fruit processing and vegetable agronomy.

In the field of forest products there has been a rapid transition from war-time problems to research on peace-time problems, and heavy demands from industry for assistance, particularly in connexion with housing, have been received when the Division concerned was short of staff through transfers. A feature of the year was the first Forest Products Conference, to which representatives from all the State forest services and from the Commonwealth Forestry and Timber Bureau and the Forest Department of the New Guinea and Papua Administration were invited. A major purpose of the Conference was to discuss programmes of work of the Division, the Division of Wood Technology of the New South Wales Forestry Commission and the Queensland Sub-Department of Forestry. Co-operation with the pulp and paper industry in the field of wood chemistry continued, and further work was carried out on lignin and pulp evaluation. The Timber Physics Section continued its work on wood–water relations and the physical properties of wood, while the Timber Mechanics Section, in addition to testing work, also made fundamental studies of the properties of wood, long-time loading and the strength and deflexion of floors. Work was also carried out in the Division on the development of building materials from wood products and other organic substances and on timber preservation, marine borer attack, fundamental factors affecting the penetration of preservatives under pressure, the diffusion of soluble preservatives into green timber, veneer and glueing, and the development and testing of adhesives.

Important changes have been made in food preservation investigations. All short-term investigations to maintain or increase the output of canned foods have been terminated to permit concentration on such long-term projects as the effects of maturity and variety on the quality of certain processed fruits and vegetables. Investigations on the storage of egg powder have been terminated, and work on the processing and storage of dehydrated vegetables curtailed; while studies on preventive measures for bacterial rotting in shell eggs have been resumed, as have some fundamental studies on the metabolism of fruit in cold storage and on problems of heat transfer and evaporation in cooling meat in refrigeration chambers. Other investigations have dealt with the organisation of the plant cell and its relation to cell stability and the respiration of the plant cell, particularly the organic acid metabolism and the nature of the oxidative enzymes, skin coatings for apples, the effectiveness of 'Pliofilm' wraps, 'stretch wraps' and case liners compared with a standard wax treatment for storing oranges. Features of the year's work on canning and fruit products were modified procedures for canned citrus juices, the canning of Freestone peaches, the steam-flow, hot-lid method of obtaining vacuum in commercial automatic can-closing machines and the maintenance of colour by addition of soluble tin to fruit packed in lacquered cans.

The exceptionally interesting report from the Fisheries Division refers to the return of the Division's research vessel from the Royal Australian Navy and the gradual resumption of research activities. The routine testing of the new southern trawling grounds with the Danish-seine net continued, and biological investigations covered Clupeoid fish, whitebait and *Tuna* species, salmon and mullet. Hydrological and seaweed investigations are also recorded, including both the production of agar and the use of seaweed as fodder; many aerial observations of pelagic fish were made from aircraft allotted by the Royal Australian Air Force.

The work of the Division of Electrotechnology has been devoted almost entirely to the establishment of the facilities required for the maintenance of standards and for measurements, and release of the staff of the Physics Division from routine testing has permitted further attention to research. Fundamental investigations on the physics of wool fibres, particularly in relation to their frictional properties, have been continued and extended to include studies of the ultimate structure of the fibres. Further work has been done with the view of maintaining the International Temperature Scale quite independent of secondary standards calibrated elsewhere, and an instrument has been developed for measuring the temperatures of estuarine muds and waters. Some work on solar physics has been commenced, and the nucleus of a section to work on the physics of solids has been established.

The Division of Aeronautics is now concentrating on more fundamental and long-range problems, turbine engine research being particularly prominent. The instability characteristics of flat and curved plates of both isotropic and orthotropic material have been investigated, and work on plywood plates subjected to end compression has been carried further. Preliminary work has been undertaken on tungsten-chromium alloys, and tests on the corrosion of the alloys of mock-up cooling systems by inhibited and uninhibited ethylene glycol has been continued with a coolant containing sulphonated gyro-oil as inhibitor. A study has been made of the mechanism of corrosion and film formation in aluminium and its alloys. In the Division of Industrial Chemistry the process devised for the preparation of chrome chemicals from chromite by an acid treatment reached an advanced stage in pilot plant, and pilot plant tests have also been undertaken on the chemical isolation of cerium, thorium and lanthanum compounds from monazite. A survey is being made of Australian ceramic materials, and the Physical Chemistry Section has continued its work on surface chemistry with particular reference to aspects affecting the flotation process for the separation of minerals. Corrosion in aircraft engine cooling systems and condenser tubes in power generating plant, the adsorption of surface-active agents from organic solvents, sugar-cane wax, the pilot-scale isolation of mannitol from the exudate of sugarwood, catalytic oxidation of ethylene to ethylene oxide and catalytic dehydration of 2 : 3-butylene glycol to butadiene, the loosening of wool from skins by sweating and with depilatories are among other problems which received attention during the year.

In returning to the study of fundamental problems, the Division of Radiophysics has placed emphasis on researches into the propagation of radio waves, atmospheric physics and vacuum physics. The Lubricants and Bearings Section, renamed the Tribophysics Section, has been concerned with the mechanism of boundary lubrication, surface damage and wear, silicones, surface-active compounds and mechanical properties, the deformation of metals by heating and cooling, deformation and recrystallization of duplex alloys and the electrolytic polishing of metals.

OBITUARIES

Sir George Newman, G.B.E., K.C.B.

GEORGE NEWMAN was born at Leominster, Herefordshire, on October 23, 1870. He was the second son of Mary Anna Pumphrey and Henry Stanley Newman, who for twenty years edited the Quaker weekly, the *Friend*. Sir George was educated at Bootham School, York, and the University of Edinburgh. He graduated M.B., C.M. in 1892 and proceeded to the M.D. in 1895, his thesis on leprosy qualifying for the gold medal. In the same year he obtained the Cambridge D.P.H. During 1896–1900 he was senior demonstrator in bacteriology and lecturer in infectious diseases at King's College, London, of which he was later to become a fellow. During 1900–7 he was medical officer of health of the County of Bedfordshire and of the Metropolitan Borough of Finsbury; and lectured on public health at St. Bartholomew's Hospital. He early acquired reputation as an energetic administrator, and published works on the bacteriology of milk, on the relation of bacteriology to public health and on infant mortality.

In 1907, Newman was appointed the first 'chief medical officer' of the Board of Education. With Sir Robert Morant, the permanent secretary, and his able colleagues, Dr. Eichholz, Dr. Ralph Crowley and Dame Janet Campbell, Newman built up the school medical service and extended its scope and opportunities. As a result, the mental and physical education of the children of Britain has improved beyond all comparison with the past. The years from 1900 to 1919 were years of strenuous endeavour, and were perhaps the most constructive periods of Sir George's life-work.

The First World War gave a new impetus to preventive medicine, and in 1919 Dr. Addison, president of the Local Government Board, appointed Sir George Newman medical officer of the Board. However, the Ministry of Health was established in June of that year and took over the functions of the Local Government Board, the National Health Insurance Commission and other health activities; Sir Robert Morant became its secretary and Sir George Newman its chief medical officer, retaining his position under the Board of Education.

Newman's main task at the Ministry was to consolidate and develop the health services which had been established by the Local Government Board. Having to deal with wide issues, he was content to exercise general direction of the whole service. He therefore allowed his senior medical officers full scope in their respective spheres of work, although he was always ready to discuss important questions and decisions with them. In addition to his heavy responsibilities as chief medical officer of two departments, Sir George Newman undertook much other work. During the War of 1914–18 he was chairman of the Health of Munition Workers' Committee, which survives as the Industrial Health Board; he promoted the cause of temperance as medical member of the Central Control Board (Liquor Traffic); and served on many departmental and other committees. He rendered great service to medical education, not only in his special reports—"Outline of the Practice of Preventive Medicine" (1919) and "Recent Advances in Medical Education" (1923)—but also as medical assessor to the University Grants Committee, as Crown nominee on the General Medical Council during 1919–39, and in his work for the British Postgraduate Medical School and the London School of Hygiene and Tropical Medicine.

Newman was an indefatigable worker, a fluent speaker, an expert diplomatist, a philanthropist, and a lover of books and medical history. In his writings and in his long series of annual reports of his department, adorned with pregnant phrases and quotations, he maintained the literary traditions of his predecessors, Simon and Buchanan. These reports exercised great influence upon the general public, impressing upon them the importance and value of public health. At various times he delivered the Yale, Linacre, Gresham, Halley Stewart and Heath Clark Lectures and the Harveian Oration. He retired in 1935.

Sir George received many honours. He was knighted in 1911, created K.C.B. in 1918 and G.B.E. in 1935. His honorary degrees included D.Sc.(Oxon.), D.C.L.(Dunelm) and the LL.D. of London, Edinburgh, McGill, Toronto, Glasgow and Leeds. He was also F.R.C.P.(Lond.) (1918), Hon. F.R.C.S.(Eng.) (1928), and honorary freeman of the Society of Apothecaries. He received the Bisset Hawkins Medal of the Royal College of Physicians in 1935 and the Fothergill Gold Medal of the Medical Society of London.

Short of stature, with abundant white hair and white moustache, Newman was a well-known figure in Whitehall. His conversation was vivacious and dramatic. He married Adelaide Constance Thorp in 1898, and with her lived a happy and secluded home life. Lady Newman died in 1946. Sir George died on May 26, 1948, at York, at the age of seventy-seven, after a long illness.

ARTHUR S. MACNALTY

Dr. George H. Pethybridge, O.B.E.

GEORGE HERBERT PETHYBRIDGE, for many years one of the leading personalities in plant pathology in Great Britain, died in his native town of Bodmin on May 23 at the age of seventy-six. Born in 1871, of a family well known in legal, medical and banking circles throughout Cornwall, he passed from Dunheved College, Launceston, to the University College of Wales, Aberystwyth. He took an honours degree in science in the University of London, and, after a short period as science master at Kingswood School, Bath, and elsewhere, proceeded to the University of Göttingen in 1897. Here he studied under Prof. Berthold and obtained his doctorate for a dissertation on the effect of inorganic salts on the development and structure of plants.

Returning to Britain, he joined the staff of the Science and Art Department in the Royal College of Science, Dublin. When, in 1900, this body was taken over by the newly created Department of Agriculture and Technical Instruction for Ireland, Pethybridge became the first head of the Seeds and Plant Diseases Division of the Department. During the next twenty-three years he carried out a long series of researches on diseases of potato, flax and other crop plants. It was mainly his work on potato diseases that gained him world-wide recognition, including the award in 1921 of the Boyle Medal of the Royal Dublin Society. One of his innovations was to establish field laboratories in areas where the diseases were most prevalent.

By his thoroughness, enthusiasm and rigorous experimental methods he greatly stimulated the study of plant diseases in Ireland and set a very high standard for those who followed him. He was, moreover, a keen field naturalist, and in 1905 collaborated with R. Ll. Praeger in an account of the vegetation of the district lying south of Dublin, while in 1910, with J. Adams, he published a "Census Catalogue of Irish Fungi".

On the change of government in Ireland, Pethybridge resigned his post, and shortly afterwards in 1923 he became mycologist to the Ministry of Agriculture and Fisheries and assistant director of the Ministry's Plant Pathology Laboratory at Harpenden. From then onwards his work was of an administrative rather than a research nature; but he played a large part in promoting research in plant diseases—notably into virus diseases of plants—and under his guidance intelligence work on plant diseases occurring in England and Wales was second to none. His long and valuable services were recognized by the award of the O.B.E. shortly after he retired in October 1936.

Pethybridge clung tenaciously to his ideals, perhaps even at times in the face of progress, but to the many who came under his influence he was a most generous, helpful and homely friend, a delightful correspondent and a wise counsellor, at work as well as by his fireside. His scientific writings bear the stamp of careful preparation and of the thoroughness that characterized his whole life: he gave and demanded the best and despised the shoddy. Shy and retiring by nature, he usually avoided public life and office, though he was persuaded to accept the presidency of the British Mycological Society in 1926. Among other activities he served the *Journal of Pomology* in an editorial capacity from 1936 until 1948, and it is a fitting and timely tribute that the current volume is dedicated to him.

W. C. MOORE

Dr. A. S. Corbet

ALEXANDER STEVEN CORBET was born on August 8, 1896; on May 16, 1948, he collapsed from heart failure after hurrying for a train, and died shortly after. He was educated at Bournemouth and University College, Reading, taking honours in chemistry. Afterwards he took the Ph.D. degree, and in 1935 his D.Sc. in biochemistry. He joined the staff of the British Museum (Natural History) in May 1939, after an already varied career which had included appointments as bacteriologist at the School of Agriculture, Cambridge, bacteriologist and entomologist to the Rubber Research Institute, Kuala Lumpur, F.M.S., soil microbiologist at the I.C.I. Experiment Station, Bracknell, and bacteriological work with the Water Pollution Research Board.

Wide experience, linked with a life-long interest in entomology, resulted, when Corbet was enabled to devote his whole energies to the study of the butterflies of the world, in an approach and a method of treatment such as had not before been applied to these popular insects. A particularly successful example of his work was his treatment of the common and very variable sulphur-yellow butterflies of the genus *Eurema*, which had been a happy hunting ground of the name-coining 'splitters' of earlier days. Another was his revision of the rather intractable species of the 'Blues' of the Oriental genus *Arhopala*. In his work on the latter genus he made use of the parallel variation of a number of species occurring side by side throughout the Malaysian sub-region in a taxonomically novel way; he succeeded in defining the island races of particular species by reference to the general characteristics of each island group, thus eliminating a great deal of rather repetitive descriptive matter. The same parallelism among island species also emerged clearly from his revision of the species of the genus *Euplœa*, a large group of butterflies which also had until then resisted many attempts by more orthodox methods to reduce them to order. In a few years he had, in fact, overcome most of the systematic difficulties which had hitherto dogged the attempts of less gifted students of the systematics of the oriental Rhopalocera. His results are contained in the new edition of his "Butterflies of Malaya", which he has left ready for the press. The collections he formed in Malaya are bequeathed to the nation.

During part of the First World War Corbet served with the Royal Engineers; in the Second World War he was seconded to the Pest Infestation Branch of the Ministry of Food, where he was able, among other things, to carry out research on the taxonomics of insect pests of food which has proved of direct economic value.

Corbet was a prolific writer who had the rare merit of not wasting words. Though his entomological work cannot now be rounded off, the results of his soil research in Malaya have already appeared in highly condensed form in a single slim volume, his "Biological Processes in Tropical Soils". As a colleague he was invaluable, his unassuming modesty cloaking a width of experience and interest, and a personality of great charm. N. D. RILEY

WE regret to announce the following deaths:

Prof. Alfred C. Lane, emeritus professor of geology at Tufts College, Massachusetts, president in 1931 of the Geological Society of America, on April 15, aged eighty-five.

Sir D'Arcy Thompson, C.B., professor of natural history in the University of St. Andrews, on June 21, aged eighty-eight.

NEWS and VIEWS

Geology at Newcastle-upon-Tyne:
Prof. H. G. A. Hickling, F.R.S.

PROF. H. G. A. HICKLING is to retire at the end of this session from the chair of geology at King's College, Newcastle-upon-Tyne, which he has held since 1920. During this period he has greatly extended his own work in some of the branches of geology to which he had earlier made contributions, and his students have shown that wide range of interest which is characteristic of him. Already as a lecturer at Manchester he had investigated the Old Red Sandstones of east Scotland, described the footprints of fossil reptiles, examined the variations of gastropods, studied the structure of fossil plants, the microstructure of coals and the stratigraphy of the Lancashire coalfield; the latter topics he made his own at a time when coalfield work was thought by some to be scarcely suitable for academic geologists. At Newcastle he has added much to our knowledge of coals, and especially (by his development of techniques of section cutting) to the understanding of 'vitrain'. He has fittingly combined an active interest in the economic problems of the north of England with a full appreciation of the necessity for less obviously useful studies: all this has been to the advantage of his students. His work was recognized by the award of the Murchison Medal by the Geological Society in 1934 and by his election to the Royal Society in 1936.

Dr. T. S. Westoll

DR. T. S. WESTOLL, who is succeeding Prof. Hickling in the chair of geology in King's College, Newcastle-upon-Tyne, has had a distinguished career in geology and vertebrate palæontology. Graduating in 1932 in the College to which he now returns, he commenced research on the famous fish fauna of the Permian rocks of that area. He was awarded a Ph.D. and a senior research award of the Department of Scientific and Industrial Research, with which he proceeded to University College, London, to work with Prof. D. M. S. Watson. During his three years in that position, he visited many of the principal museums in Europe and commenced the work to which he has since contributed most widely, namely, the further study of the Old Red Sandstone and its faunas, particularly in the north of Scotland. In 1937, with grants from the Geological and Royal Societies, he spent several months in the United States and Canada, visiting the principal universities and museums, and commencing stratigraphical and palæontological field-work in the Gaspé Peninsula, New Brunswick and Nova Scotia. The latter important work was interrupted by his election to a senior lectureship at Aberdeen, though not before it had led to important results both in the stratigraphy and palæontology of the Devonian and Carboniferous rocks of that region. In Aberdeen, field-work on the Old Red Sandstone of various areas of north-east Scotland, the Orkneys and Shetlands and on their faunas has been actively continued, along with investigations of the morphology and relationships of the various groups of fishes and the origin of tetrapod structures. This work has become of international repute. In 1941 the University of Aberdeen conferred on him the degree of D.Sc. In the following year Dr. Westoll was elected a fellow of the Royal Society of Edinburgh and a member of the New York Academy of Sciences. In 1947 he was invited to the Princeton Bicentenary Celebrations to participate in the conference on palæontology, genetics and evolution, and afterwards to the Paris conference on palæontology.

Chemistry at University College, Swansea : Prof. J. E. Coates, O.B.E.

THE pending retirement of Prof. J. E. Coates from the chair of chemistry marks the close of an important period in the history of the University College of Swansea, for, of the professors of scientific subjects appointed at the time of its foundation, he is the last remaining in the service of the College. After a brilliant career as student at Bangor, in London and at Karlsruhe, and distinguished service during the First World War in the Royal Naval Air Service, he was in 1920, when a member of the staff of the University of Birmingham, called to the professorship of chemistry at the newly established Swansea College of the University of Wales. It then fell to his lot to start, build up and maintain one of the major departments of the College, and the magnitude of his success in this arduous and responsible labour is demonstrated by the rapid advancement of the Chemistry Department to its present prosperous condition, and great service to the important industrial area in which it is situated. Under his direction, a foremost feature has been activity in research in physical chemistry, in which branch he was trained during his early investigations under the great masters, Ramsay and Haber. Among his studies while at Swansea have been the physical and chemical properties of hydrogen cyanide and its solutions. His past and present students, his colleagues and his numerous friends will all wish Prof. Coates many years of further fruitful activity.

Dr. C. W. Shoppee

DR. C. W. SHOPPEE has been appointed to the chair of chemistry in the University of Wales, tenable at University College, Swansea, in succession to Prof. J. E. Coates. Dr. Shoppee's earliest research work was carried out in 1923 at the Imperial College with Dr. C. K. Ingold and the late Sir Jocelyn Thorpe. In 1924, he accompanied Prof. Ingold to the University of Leeds, and in 1928, after having held an 1851 Senior Studentship, was appointed to the staff of that University. In 1939, he was elected to a Rockefeller Research Fellowship, which he chose to hold in the laboratory of Prof. T. Reichstein at the University of Basle. In 1944, he was appointed to a readership in chemistry in the University of London, tenable at the Royal Cancer Hospital (Free). Dr. Shoppee is distinguished for his researches on the mechanism and kinetics of tautomeric change, and for his work on the hormones of the adrenal cortex, which led to the establishment of the detailed structures of these physiologically important compounds. At the Chester Beatty Research Institute of the Royal Cancer Hospital (Free), he has applied his special knowledge of the microchemical and chromatographic investigation of natural products to the isolation and identification of the endogenous carcinogenic substances present in human tissues. In the steroid field, he has gained an international reputation, and his most recent work involves application of the new conceptions of the mechanism of organic reactions to the determination of chemical configuration in natural products, an ultimate aim being to illuminate the highly specific relationship between chemical configuration and physiological activity.

Engineering at University College, Swansea : Mr. L. J. Kastner

MR. L. J. KASTNER, of the Department of Engineering, University of Manchester, has been elected to the chair of mechanical engineering at University College of Swansea, which became vacant by the appointment in 1946 of Prof. R. N. Arnold to the regius professorship of engineering in the University of Edinburgh. Mr. Kastner took the Mechanical Sciences Tripos at Cambridge in 1934. Following a period of practical workshop training with Messrs. Davis and Metcalfe, of Romiley, he went to the University of Manchester to do research on internal combustion engineering, which led to the degree of M.Sc. In 1938, he was appointed to the staff of the Engineering Department at Manchester, and in 1945 became senior lecturer in the Department. While there he has been responsible for the advanced teaching in thermodynamics at Manchester and has also taken a large part in running the Engineering Laboratories. He has been actively engaged in research, more especially in the field of internal combustion engineering, and has published several original papers dealing with various aspects of this work. It is of interest to note that Mr. Kastner is now the third in the family line of university professors, his grandfather and father having in turn held the chair of French in the University of Manchester.

Department of Scientific Research, India

THE Government of India has created a Department of Scientific Research with effect from June 1. The Department will be in the charge of the Prime Minister of India, and Sir Shanti Bhatnagar, director of scientific and industrial research, has been appointed secretary and principal executive officer. The Department will take over the work of the Board of Research on Atomic Energy and the Council of Scientific and Industrial Research. The latter body, although attached to the new Department, will retain its unofficial character and will continue to function as before. The new Department will deal also with scientific advice to Government departments, *ad hoc* scientific research in universities and research institutions, research scholarships in applied scientific subjects, international scientific unions, scientific liaison offices, the Scientific Consultative Committee and such other subjects as may be transferred to it. The Department will co-ordinate the scientific activities of the other Ministries, and in this work it will be assisted by a co-ordination committee consisting of eminent men of science.

Engineers and the Community

In an address delivered at the annual luncheon on June 8 of the Institution of Gas Engineers, the president, Dr. Harold Hartley, made some interesting comments on the relation of the engineer to the community. The term 'engineering', he suggested, should be extended to cover all endeavour utilizing the processes of Nature or scientific knowledge for the benefit and pleasure of mankind. This wider concept of the functions of engineers would bring the professional bodies closer together and give them increased influence in public affairs. The professional institutions set the standard for their members, and they can use their influence to ensure that, in the struggle for economic development, the fundamental cultural freedoms are not sacrificed. They can see that conditions are created which will enable everyone to give of his best in his own particular field; they should strive after something of the character of the old craft guilds, with their care for the reputation of their craft and their members, but also with a deep sense of public service. Dr. Hartley's audience consisted largely of gas engineers, and he rightly emphasized his points by reference to their special branch of the profession of engineering. He referred to the spirit of tolerance and loyalty which has characterized the gas industry in the past, and expressed the belief that this state of mind would enable the industry to overcome the difficulties inherent in the fundamental re-organisation which nationalization of the gas industry in Britain will involve. The Institution of Gas Engineers as a corporate body represents a limited number of types of men with specialist knowledge who are accustomed to thinking along similar lines; they should not find it difficult to co-operate with other specialists concerned in different ways with the industry, and with them to solve the problems lying ahead.

Acta Crystallographica

Acta Crystallographica is a new journal of crystallography published for the newly formed International Union of Crystallography by the Cambridge University Press. It is intended to replace the former *Zeitschrift für Kristallographie*, which between the two World Wars had attracted most of the original accounts of crystal structure analyses. In scope, however, it is intended to be wider, and sets out to reassemble the crystallographic work now scattered through a great variety of journals, and to be the main journal for experts in crystallography the world over. Six numbers are to be issued annually at a moderate cost made possible through subsidies from Unesco, and from numerous research associations and industrial firms in Britain and the United States. The first number, published in March, contains six full-length papers and three short communications on structure determinations of organic and inorganic substances; together with notes and book reviews. The papers are clearly illustrated, and data and methods are set out in sufficient detail for assessing their reliability. Linked with this new publication will be periodic structure reports analogous to the seven volumes of "Strukturbericht" (1931–39) and also a second revised edition of the "International Tables for the Determination of Crystal Structure" (1935). The editor and co-editors are to be congratulated on so promising a first number of a new scientific journal which is really necessary.

World Power Conference

A two-day meeting of the International Executive Council of the World Power Conference has been held at Stockholm. Nineteen countries were represented: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Great Britain, Hungary, India, Italy, Netherlands, New Zealand, Norway, Poland, Sweden, Switzerland, Turkey and the United States. The British delegates were Sir Harold Hartley, chairman of the International Executive Council and of the British National Committee of the World Power Conference, who presided; Mr. Harold Hobson, vice-chairman of the British National Committee and lately chairman of the Central Electricity Board; and Dr. A. Parker, director of fuel research, Department of Scientific and Industrial Research. It was announced that the Fourth Plenary World Power Conference in London will be held in July 1950 at the house of the Institution of Civil Engineers. The theme of the Conference was approved; it will be "World Energy Resources, and the Production of Power". The future activities of the World Power Conference were discussed, and tentative invitations were received from India, for a sectional meeting to be held in 1951 concurrently with the Fourth Congress of the International Commission on Large Dams of the World Power Conference; and from Italy and Switzerland, who may be the joint hosts at an 'Alpine' Sectional Meeting in 1952 or 1953. The Hungarian delegates suggested a 'Danubian' sectional meeting, to be organised jointly by the national committees of the Danubian countries, on a 'regional' basis. At the request of the Economic and Social Council of the United Nations—which has conferred consultative status upon the World Power Conference—consideration was given to the 'Fuels' and 'Power' Sections of the Provisional Programme of the United Nations Scientific Conference on the Conservation and Utilization of Resources, to be held in the United States in May 1949. It was announced that the first post-war Statistical Yearbook of the World Power Conference will be published shortly; it will contain data on resources and annual statistics covering the eleven years 1936–46. The next meeting of the International Executive Council will be held in Brussels during the first week of July 1949. The new edition of the booklet showing the names of national committees and representatives has been published; copies can be obtained upon application to Mr. C. H. Gray, secretary, International Executive Council, World Power Conference, 201/2 Grand Buildings, Trafalgar Square, London, W.C.2.

Cattle Health and Milk Production

The three Fison Lectures, made possible by the generosity of Messrs. Fisons, Ltd., are part of the educational programme of the Animal Health Trust and were delivered last May by Prof. L. Seekles, of the Veterinary Biochemical School, University of Utrecht. Prof. Seekles chose "Mineral Disturbances of Cattle" as the theme of his first lecture. Our food-producing animals have, he said, become physiologically artificial beings. Experiments carried out in his laboratory strongly suggest that the forced development of the cow as a milk producer causes over-activity of the pituitary gland. Discussing this idea in relation to milk fever, Prof. Seekles suggested that preventive measures against this disease should be designed to prevent over-development of the pituitary gland during pregnancy. The biochemical features of grass tetany and 'Utrecht abnormality of milk', which results in curdling of the milk of apparently healthy cows during transportation of their milk or when it is boiled, were also discussed. The second lecture, entitled "Gastro-intestinal Auto-intoxication in Cattle and Horses", included a discussion of Dutch methods of treating acetonæmia. Much attention has been recently given to treatment with potassium chlorate, which may be beneficial if the liver is not seriously damaged. Lactate therapy, practised since 1942, has also given good results. The third lecture dealt with the complex subject of real and conditioned deficiencies of trace elements. Evidence has been obtained that in many cases increased motility of the intestine, due to causes independent of the amounts of trace elements in the food, such as the intake of protein and other components of rank spring grass, nematode infestations and paratuberculosis, may cause decreased absorption of trace elements. Intravenous administration of radioactive copper salts had shown that the liver plays an important part in the accumulation of copper. No relation between grass tetany of Dutch cattle and the intake of manganese could be obtained, but significant differences between the manganese content of grass from different soils were noted, the more alkaline soils containing the least manganese.

Earthquakes Registered in New Zealand during February 1948

SIX strong earthquakes were registered by the seismographs in New Zealand during February 1948. They were on February 9 (2), 10, 14, 16 and 23, that on February 9 being felt in Anatolia (Turkey). In addition, eighteen local earthquakes were felt in some place in New Zealand during the month. The greatest intensity of any one of these was scale 5 (Modified Mercalli intensity scale) in the Cook Strait region of both islands on February 4, the epicentre being near lat. 40·95° S., long. 173·6° E., and depth of focus approximately 50 km. Earthquakes with scale 4 intensity occurred on February 9 in the Wellington and Wairarapa Regions, on February 18 in the Uruwera District and on February 29 near Lake Coleridge.

Union Catalogue of German Books and Periodicals

OWING to the scarcity of German books and periodicals published since the beginning of the Second World War, the Foreign Office has requested the National Central Library to compile a union catalogue of such of these publications as have reached the United Kingdom. A circular has been issued asking libraries and other institutions to co-operate by amending a check-list indicating their holdings. Anyone who is willing to assist but has not seen the circular should write to the National Central Library (German Union Catalogue), Malet Place, W.C.1.

Geophysics at Hamburg

AT Hamburg, the University Meteorological Institute, the Centre for Earthquake Research and the University Institute for Oceanography have been amalgamated to form the Geophysical Institute of the University of Hamburg. The address is now Hamburg 13, Rothenbaumchaussee 33. The new Institute is working under difficulties, and would welcome exchanges of geophysical publications.

Society for the Bibliography of Natural History

AT a general meeting of the Society for the Bibliography of Natural History held at the British Museum (Natural History) on February 28 the following officers were elected: *President*, Dr. J. Ramsbottom; *Secretary and Treasurer*, Mr. A. C. Townsend, British Museum (Natural History), Cromwell Road, London, S.W.7; *Committee*, Prof. F. Balfour Browne and Messrs. J. Delacour, W. N. Edwards, F. J. Griffin, Francis Hemming and C. Kirke Swann. It is hoped to revive the activities of the Society, which was founded in 1936, and it was announced at the meeting that a further part of the second volume of the Society's *Journal* is in the press. This consists of a bibliography of whaling by Dr. J. Travis Jenkins. The last part of the *Journal* to be published was Vol. 2, Part 3, issued in April 1946.

Research on Nematology

THE Institute of Agricultural Parasitology, Winches Farm, 395 Hatfield Road, St. Albans, Herts, formally ceased to exist as such on September 30, 1947. So far as plant-eelworm work is concerned, its place has been taken by a new Nematology Department of Rothamsted Experimental Station with the following scientific staff: Dr. T. Goodey (head of the Department), Dr. B. G. Peters, Dr. Mary T. Franklin, Mr. D. W. Fenwick, and Mr. J. B. Goodey. From June 30 this Department will be housed at Rothamsted Experimental Station, Harpenden, Herts. Winches Farm is continuing as a field station of the London School of Hygiene and Tropical Medicine, with Mr. J. W. G. Leiper as administrative officer.

University of Leeds

THE University of Leeds has received a further grant of £10,000 from the Worshipful Company of Clothworkers, making a total grant of £30,000 to meet the capital cost of the extension of the Textile Industries Department now in course of construction. The British Hat and Allied Feltmakers' Research Association has given £1,000 for research in the same Department.

The following appointments have been made: Dr. F. Henriques, lecturer in social anthropology; Mr. A. N. Greenwood, lecturer in electrical engineering; Mr. C. Kisby, lecturer in textile design.

Commonwealth Fund Fellowships

THE list of awards of Commonwealth Fund Fellowships tenable by British graduates in American universities for one year, beginning September 1948, includes the following: E. R. Andrew, Christ's College and Pembroke College, Cambridge, to Harvard University, in physics; J. R. G. Bradfield, Trinity College, Cambridge, to the College of Medicine, University of Illinois, in biology; S. L. Bragg, Trinity College, Cambridge, to the Massachusetts Institute of Technology, in engineering; Dr. Archibald Brown, University of Glasgow and Trinity College, Cambridge, to Yerkes Observatory, University of Chicago, in astronomy; Dr. C. A. Bunton, University College, University of London, to the College of Physicians and Surgeons, Columbia University, in biochemistry; Dr. G. M. Carstairs, University of Edinburgh, to Cornell University, in cultural anthropology; R. B. Hunter, University of Edinburgh, to Johns Hopkins School of Medicine, in medicine; Dr. D. O. Jordan, University of London and University College, Nottingham, to Princeton

University, in chemistry; A. M. Macbeath, Queen's University, Belfast, and Clare College, Cambridge, to Princeton University, in mathematics; G. D. S. MacLellan, Pembroke College, Cambridge, to the Massachusetts Institute of Technology, in mechanical engineering; J. H. Paterson, St. Catharine's College, Cambridge, to the University of Wisconsin, in geography; S. V. Perry, University of Liverpool and Trinity College, Cambridge, to the School of Medicine, University of Rochester, in physiology; R. W. Riddell, University of London, to Duke University, in medicine; Dr. G. A. Smart, University of Durham and University of Bristol, in medicine; I. G. Stewart, University of St. Andrews, to the University of Chicago, in economics; Dr. Alwyn Williams, University College of Wales, Aberystwyth, and University of Cambridge, to the National Museum, Washington, D.C., in geology.

The following have been appointed to Commonwealth Fund Fellowships tenable by candidates from the Home Civil Service: Philip Allen, Queens' College, Cambridge, of the Home Office; R. E. L. Cleaver, New College, Oxford, of the Ministry of Fuel and Power; T. D. Haddow, University of Edinburgh and Trinity College, Cambridge, of the Department of Health for Scotland.

Cambridge Summer Course in Food Science

A SUMMER course in food science will be held in the University of Cambridge, in co-operation with the Department of Scientific and Industrial Research, at the Low Temperature Research Station during August 30–September 11. The whole field of food science will be surveyed, with the view of suggesting the emphasis which should be placed on various aspects in the basic training of scientific workers for the food industries. A substantial knowledge of chemistry, and some knowledge of biology will be assumed. A detailed syllabus and form of application for admission may be obtained from G. F. Hickson, secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge, to whom the completed application form should be returned not later than July 10.

International Holiday Centre

THE French Association of Scientific Workers is organising an International Holiday Centre at Morzine (Haute-Savoie) during July 15–September 1. Morzine, without being a fashionable holiday resort, is one of the beauty spots of the French Alps. It lies to the south of Thonon at a height of about 1,000 metres; and around it are ranges rising to about 2,500 metres. So far as hotels are concerned, the French Association of Scientific Workers can secure accommodation at 800 and 700 francs a day (including service and taxes). It has also secured some good camping sites, and is trying to make arrangements for a canteen. Bookings can only be made for whole weeks (from Monday morning to Sunday night) and for a minimum of two weeks; registration fee, 500 francs each person. Applications should be made as soon as possible to the Association des Travailleurs Scientifiques, Maison de l'Université Française, 47 Boulevard St. Michel, Paris 5.

Modern Applications of Liquid Fuels

A JOINT conference, arranged by the Institute of Petroleum and the Institute of Fuel, will be held in the University of Birmingham during September 21–23 to discuss "Modern Applications of Liquid Fuels". The president of the Conference, Mr. J. A. Oriel, will give an address on "The Place of Liquid Fuel in the British Economy"; subsequent sessions will be devoted to the discussion of papers circulated in advance on fuel oil in the steel industry, other metal industries, glass and ceramic industries; domestic heating; gas turbines for land and marine power purposes; agricultural drying processes; diesel engines; and oil for gas making. Further particulars can be obtained from the general secretary, R. W. Reynolds Davies, 18 Devonshire Street, London, W.1.

Announcements

THE Minister of Fuel and Power has appointed Dr. H. Roxbee Cox, at present director of the National Gas Turbine Establishment, to be chief scientist at the Ministry of Fuel and Power. Sir Alfred Egerton, professor of chemical technology at the Imperial College of Science and Technology, London, has accepted the invitation of the Minister to be chairman of the Scientific Advisory Council which will be set up to advise him on the scientific aspects of his statutory duties.

SIR NORMAN HAWORTH, Mason professor of chemistry and director of the Department of Chemistry in the University of Birmingham, retires at the end of the present session under the age limit. He is to be succeeded by Prof. H. W. Melville, professor of chemistry in the University of Aberdeen. Dr. K. Mather, head of the Genetics Department of the John Innes Horticultural Institution, Merton, has been appointed to the newly established chair of genetics at Birmingham.

MR. J. E. CUMMINS, formerly officer-in-charge of the Information Service of the Council for Scientific and Industrial Research, has been appointed chief scientific liaison officer for Australia in London. He expects to remain in the United Kingdom for about five years, and will direct the future work of the Australian Scientific Research Liaison Office.

AWARDS from the Daniel-Pidgeon Fund have been made by the Council of the Geological Society of London to Dr. J. S. Webb, who proposes to investigate the tin-tungsten mineralization in the Hercynian geosyncline as exposed in western Europe, and to Mr. W. S. McKerrow, who proposes to undertake a statistical investigation of the variation of the brachiopods from fullers' earth.

THE Council of the University of Sheffield has made the following appointments: J. C. Gilbert, senior lecturer in economics; A. Gilbert, lecturer in psychology; J. H. Davies and S. J. Langley, assistant lecturers in economics; Brian E. Heard, assistant lecturer in pathology; Peter Freeman, research assistant to the professor of engineering.

THE second annual exhibition organised by the Birmingham Branch of the Society of Inventors will be held in the Chamber of Commerce Building, Birmingham, during October 25–30. The object of the exhibition is to show manufacturers and members of the public new devices that have been produced during the year. Entries for the exhibition are accepted, both from members of the Society and from non-members. Anyone wishing to enter an exhibit, which must be either patented, protected or of registered design, should write to the secretary, Mr. B. Thornton Clark, 244 Stoney Lane, Yardley, Birmingham 25.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Amino-Acid Metabolism of Tissue Cells *in vitro*

EMPLOYING a technique which at the time was far from being perfect, we were able in 1941 to demonstrate the general importance of amino-acids in connexion with the maintenance and growth of tissue cells[1]. It was found that cystine occupies a key position among the amino-acids; if absent from a diet that contains all the other amino-acids, the cells cannot be kept alive, but die within twenty-four hours. The relative significance of the other amino-acids could not at the time be tested similarly, because of the imperfection of our technique.

The technique has now been improved. Practically normal growth of cells has been obtained in a synthetic medium on a basic diet consisting of groups of substances known empirically to be of significance to the whole organism, namely, amino-acids[2], the methylating system, the SH–SS system, the vitamins, choline, creatine and the C_4-acids functioning in the Krebs cycle. If amino-acids are lacking in this basic diet, it is impossible to keep the cells alive in the dialysed plasma medium for any length of time.

In order to gain information regarding the importance of the individual amino-acids in Rose's mixture, the following technique was employed. Control cultures were kept on the basic diet including the whole series of amino-acids: lysine, arginine, tryptophane, methionine, histidine, glutamic acid, aspartic acid, proline and cystine. Experimental mixtures were then prepared, leaving out the one amino-acid the significance of which was to be investigated. Fig. 1 illustrates the growth of myoblasts in the control mixture, and in the experimental mixture, which in this case had lysine omitted; the lysine deficiency caused only a slight reduction in the rate of growth as compared with that of the control. The same experiment on osteoblasts showed these cells to be much more sensitive to lysine deficiency than myoblasts (Fig. 2). Apparently this amino-acid is more essential to osteoblasts than to myoblasts.

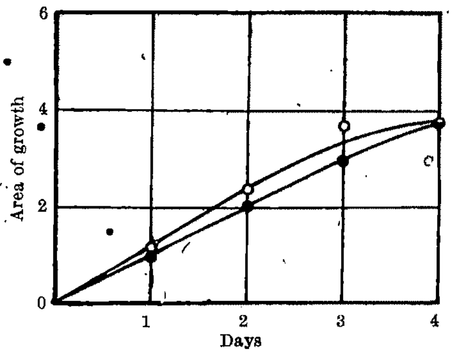

Fig. 1

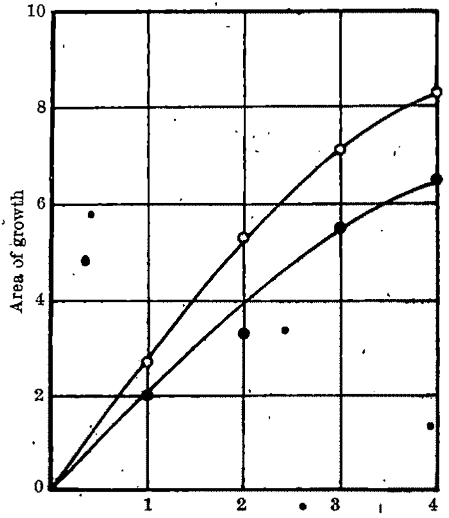

Fig. 2

Each one of the amino-acids mentioned above has been tested in our experiments. If graded according to the difference in growth between the control culture (in which the medium contains the complete set of amino-acids) and the experimental culture with one of the amino-acids omitted, the following sequence is obtained (Fig. 3).

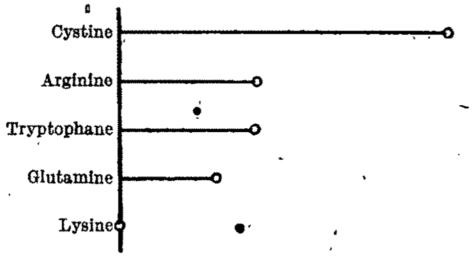

Fig. 3

It shows the difference in areal growth between control and experiment on the fourth day of cultivation caused by the omission of one of the amino-acids.

A more detailed account of the investigation will be published at a later date.

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Absence of Correlation between Respiratory Inhibition of Plasmodia by Acridines and Antimalarial Action

THE suppressive action of 'Mepacrine' on the oxidation of glucose by *Plasmodium gallinaceum* has recently been described[1]. Since comparatively large concentrations of the drug (1 in 6,000) were necessary to produce an appreciable inhibition of respiration, it is questionable whether this effect is a measure of the specific antagonistic reaction responsible for the *in vivo* antimalarial properties of 'Mepacrine'.

More information on this point has now been obtained by comparing the inhibitory effects of the following acridines: 5-aminoacridine, 'Mepacrine' (2-chloro-7-methoxy-5-(δ-diethylamino-α-methylbutyl)aminoacridine), and the intermediate substance, 2-chloro-7-methoxy-5-aminoacridine. The accompanying table shows the action of these three acridines on the oxygen uptake of heavily parasitized, washed

COMPARISON OF EFFECTS OF ACRIDINES ON PLASMODIAL RESPIRATION, MAMMALIAN TOXICITY AND ANTIMALARIAL ACTIVITY

Compound	Mol. wt. of substance	% inhibition of oxygen uptake of *P. gallinaceum* (Conc. 1 in 6,000)	Toxicity; $L.D._{50}$, mice, subcutaneous (gm./kgm., base)	Antimalarial activity; quinine equiv. (*P. gallin.*)
5-Aminoacridine, HCl,H_2O	248	80·5 78·0 73·0	0·08	<0·02
2-Chloro-7-methoxy-5-aminoacridine (free base dissolved in acetic acid)	259	78·5	0·11	<0·06
2-Chloro-7-methoxy-5-(δ-diethylamino-α-methyl-butyl) aminoacridine, $2HCl,2H_2O$ ('Mepacrine')	508	38·6 44·4 43·3	0·28	2 to 6

chick red cells, suspended in buffered saline containing glucose. The concentration of acridines in the respirometer flasks was 1 in 6,000 of the compounds as tabulated. The toxicities to mice[2] and the antimalarial action *in vivo* against chicken malaria[3] are also included.

It will be seen that the *in vitro* inhibitory action of the less complex molecules is greater, weight for weight, than that of 'Mepacrine', and follows more closely the order of general systemic toxicity rather than the *in vivo* antimalarial action, which is in the reverse order. These results indicate that the observed inhibitory action of 'Mepacrine' on the respiration of the malarial parasite may represent the toxicity which high concentrations of acridines exert on living cells in general, but not the specific action of 'Mepacrine' on the malarial parasite.

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Studies with Radioactive Penicillin

THE work of Gale[1] points to the possibility that penicillin may act by depriving sensitive organisms of glutamic acid, which is probably essential to their life. The present work was instituted to find out whether penicillin, by being itself adsorbed, blocks the passage of glutamic acid through the cell wall.

Whatever the mode of action of penicillin, it is to be expected that there would be a quantitative relationship between the amount of penicillin and the number of bacteria killed by it. Several workers have attempted to measure the amount of penicillin directly involved in the killing of a certain number of susceptible bacteria[2], but without success, as the amount of penicillin, if any, taken up by the organisms is too small to detect by biological methods. By using radioactive penicillin of a high specific activity, it should be possible to detect any uptake of penicillin by the bacteria.

For the preparation of the radioactive penicillin, we used 0·1 millicurie of S^{35} present in 0·014 mgm. of sulphur. This was diluted to a total of 0·109 mgm. of sulphur in order to give 2 ml. of broth in all. The medium used was based on that recommended by Jarvis and Johnson[3], modified by reducing the sulphur content to 0·0055 per cent, at which point sulphur became the factor limiting penicillin yield. After autoclaving, the medium was inoculated with a vegetative culture of the *Q* 176 strain of *P. chrysogenum* and was shaken for four days at 24° C. in a 50 ml. conical flask. After filtration, the penicillin was extracted from the cooled broth with ether and re-extracted into dilute phosphate buffer at *p*H 7·5. The solution was adjusted to *p*H 6, and 0·1 per cent of sodium hexametaphosphate was added to stabilize the penicillin[4]. The yield was 250 I.U. of penicillin, representing a 12 per cent conversion of the sulphur in the broth into penicillin with a specific activity of 0·05 microcurie per I.U.

It is perhaps noteworthy that the presence in the medium of 50 millicuries of S^{35} per litre did not adversely affect the growth of the mould.

The preparation of radioactive penicillin with a very much weaker specific activity has recently been reported from the United States[5], using 272 litres of broth containing 24·2 millicuries of S^{35}. They obtained 3·4 per cent conversion of the sulphur into penicillin with an activity of 0·00006 microcurie per I.U.

The radioactivity of the penicillin was measured by means of a Geiger-Müller counter, having a background rate of 14 counts per minute. The activity of a sample producing a counting-rate of 50 per minute could therefore be measured with an error of ± 3 per cent in a little more than an hour. Correcting for absorption of the radiations in the material of the sample, it was possible, in this time, to measure 0·004 I.U. of penicillin with an error of ± 5 per cent.

For the absorption experiments *Staphylococcus aureus* was grown on agar plates at 37° C. for 9 hours, scraped off, transferred in sufficient quantity to 25 ml. broth, so as to give a thick suspension, and incubated for a further 2 hours. A measured amount of radioactive penicillin was then added, and an aliquot portion of the suspension removed for radioactive assay; this removal of a standard volume of the suspension was repeated at intervals as a control. During the course of an experiment, these samples should give equal counts. After ½, 2, 6 and 24 hours, 5 ml. of the suspension was removed and filtered through a 'Gradocol' membrane and washed through with 2 ml. water into a graduated receiver. Aliquot portions of these filtrates were taken, dried on planchettes, weighed and counted. Any uptake of penicillin by the bacteria should be manifested by a decrease in penicillin concentration in the filtrate.

The accompanying table gives the results of an experiment in which 0·07 I.U. per ml. was employed in a suspension containing approximately $3·2 \times 10^9$ viable organisms per ml.; after 24 hours there were $0·24 \times 10^9$ viable organisms per ml.

Time (hr.)	Actual count per min. minus background		Count per 200 c.mm. per min. fully corrected		Penicillin units per ml.	
	A	*B*	*A*	*B*	*A*	*B*
0	36	42	49	48	0·068	0·067
½	33	41	45	48	0·063	0·067
2	31	37	43	43	0·060	0·060
6	41	40	43	46	0·060	0·064
24	36	36	47	42	0·066	0·059

A represents filtrates. *B* represents suspension.

From these results it is seen that the greatest difference between the penicillin concentrations in the filtrates is no greater than that for the suspensions; the latter difference represents experimental error.

Corresponding results were obtained from other experiments, where the penicillin concentration varied from 1 down to 0·05 unit per ml. From these experiments it is possible to say that absorption of penicillin, if any, probably amounts to less than ten molecules per bacterium.

The work is continuing, and further details of it will be published elsewhere.

We should like to thank Sir Alexander Fleming for his interest in this work, the Medical Research Council for the gift of the S^{35}, and Dr. W. F. Widdas for help with the construction of the counter.

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Effect of Antibacterial Analogues of Vitamin K on *M. tuberculosis*

I would like to record some experiments made three years ago and recently repeated with a different technique. During a search for chemically defined growth-factors for *M. tuberculosis*, it was decided to investigate vitamin K. The role of vitamin K in bacterial metabolism has not been determined; but this vitamin is present in many organisms and is probably of nutritional importance[1,2,3]. Anderson has isolated from a laboratory strain of human tubercle bacillus a pigment, 'phthiocol' (2 methyl 3 hydroxy 1 : 4 naphthoquinone), which has vitamin K-like activity[4,5]. It has been postulated that phthiocol is derived from vitamin K_2 during the extraction of the bacteria[6]. For many years it has been known that *M. paratuberculosis* when freshly isolated will grow only on media containing extracts of other acid-fast bacteria, notably *M. phlei*. The claim has been made that phthiocol and 2 methyl 1 : 4 naphthoquinone can replace *M. phlei*[7]; but the stimulant action is not so marked, and hence it does not follow that the *M. phlei* growth-factor and these compounds are the same. *M. tuberculosis* var. *hominis* can also have its growth accelerated by extracts of other acid-fast bacteria, and for these reasons this investigation was undertaken. Reports in the literature on the action of phthiocol and 2 methyl naphthoquinone are not consistent[8,9], but naphthoquinone derivatives have been claimed as inhibitory[10]. In the accompanying table compounds 1 and 2 are water-soluble synthetic vitamin K derivatives and both inhibit growth.

Medium: Long's plus Tween 80, 0·01 per cent; bovine plasma fraction *V*, 0·2 per cent. Inoculum: 1 mgm. virulent *M. tuberculosis* var. *hominis*

Compound	Amount causing inhibition at eight days	
	Molarity	Parts per million
1 4 Amino 2 methyl 1 naphthol hydrochloride	10^{-5}	3
2 Tetrasodium 2 methyl 1 : 4 naphthohydroquinone diphosphate	4×10^{-4}	166
3 Quinoxaline di N-oxide	2×10^{-4}	33
4 2 Methyl quinoxaline di N-oxide	5×10^{-4}	80
5 Methyl pentyl quinoxaline di N-oxide	10^{-4}	25
6 2 Hydroxy quinoxaline	5×10^{-2}	1000
7 1 : 2 : 3 : 4 : Tetrahydrophenazine di N-oxide	2×10^{-4}	20
8 1:2:3:4 :Tetrahydrophenazine	5×10^{-4}	100
9 Phenazine mono N-oxide	10^{-4}	25
10 Phenazine di N-oxide	5×10^{-6}	1
11 Dihydroxy phenazine di N-oxide (iodinin) (impure preparation)	10^{-5}	2

As recently isolated virulent strains of *M. tuberculosis* require complex media of unknown composition, an indirect approach to the problem was sought by the use of antibacterial analogues of the vitamin K series. Such compounds have been made by McIlwain[3], and their effect is shown in the table. The results are parallel to those obtained with other organisms, and I have obtained similar but not identical results with different culture substrates. The phenazine derivatives are of interest because of their relation to the bacterial pigments pyocyanine and chlororaphin, and iodinin itself is obtained from *Chromobacterium iodinum*. Compound 10 is non-toxic to guinea pigs and mice, and *in vivo* tests are now in progress.

Thus the original hypothesis that vitamin K-like compounds are necessary for the nutrition of *M. tuberculosis* has not been proved; but the results listed do suggest that similar substances play some part in the metabolism of the organism. Recent advances in vitamin K research may have an application to this problem[11,12,13].

This work has been helped by a grant from the Medical Research Council.

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Dicumarol Poisoning and Vitamin K Deficiency in Relation to Quick's Concept of the Composition of Prothrombin

In 1943, Quick[1] published some experiments which were taken as evidence for the multiple nature of prothrombin. In the same paper Quick expressed the opinion that the hypoprothrombinæmia in vitamin K deficiency might be due to the disappearance of the same constituent of prothrombin as that which is lacking in dicumarol poisoning, namely, the component which is relatively stable during storage.

Shortly after the appearance of the above-mentioned paper, I carried out a few simple experiments in order to establish whether these two forms of hypoprothrombinæmia are due to the lack of one and the same factor, as suggested by Quick.

The experiments consisted in mixing the plasma from vitamin K – deficient chicks with plasma from chicks poisoned with dicumarol and determining the clotting time by the addition of diluted chicken thromboplastin. If the components lacking in the two kinds of plasma were different, suitable mixtures of the plasmas should clot almost as fast as normal chicken plasma in the circumstances chosen. This was not found to be the case, the clotting times of the mixtures lying largely in the interval between the clotting times of the two different plasmas.

Recently, Quick[2] has elaborated his hypothesis on the nature of prothrombin further, and now claims that the relatively stable component consists of two factors. He suggests that dicumarol poisoning is concerned with one of these factors and vitamin K deficiency with the other. The simple experiments mentioned above show that a difference between the two forms of hypoprothrombinæmia cannot consist *merely* in the absence of one factor in dicumarol poisoning and of another in vitamin K deficiency in such a way that the clotting anomaly will be compensated by mixing the two plasmas.

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Chemical Breakage of Chromosomes

IN a paper under the above title, Darlington and Koller[1] have analysed the close similarity between chemical and radiation-induced breakage of chromosomes, and have rejected the physical 'target' theory of the X-ray phenomenon as propounded by the late Dr. D. E. Lea[2]. First, they criticize the data on which this theory was based, asserting that "temperature control has been largely dispensed with in the experiments used by Lea as evidence"; and secondly, they conclude that "it is scarcely possible to doubt that both X-rays . . . and chemical breakage are immediately determined by chemical processes which in the X-ray case intervene between an ionization and breakage". In fairness to Lea, we feel that we should point out that neither of these statements is a valid criticism of the target theory. The effects of temperature on radiation-induced breakages have been taken into consideration, and it has been almost axiomatic among physicists that chemical processes follow on the initial act of ionization.

Sax[3] demonstrated that the yield of structural changes during X-irradiation is dependent upon the temperature of the material at the time of exposure, but is independent of the temperature before and after the exposure. Experiments by Lea and Catcheside, which will be reported in detail elsewhere, corroborate this result. Flowering shoots of *Tradescantia* were maintained at the same constant temperature before and after irradiation with X-rays and were irradiated at temperatures between 1° and 30° C. Fixations of dividing pollen grains were made at a series of times subsequent to irradiation. By this means the frequency of structural changes in relation to the rate at which mitosis proceeded after different treatments could be followed. The highest yield of structural changes was observed in the material irradiated at the lowest temperature; but the rate at which mitosis proceeded when the shoots were restored to their standard temperature after irradiation was independent of the temperature at which they had been irradiated. On the other hand, if the shoots were kept at a high temperature in the period after irradiation, mitosis was speeded up, so that the irradiated cells took a shorter time to reach metaphase; but the final yield of structural changes was not affected. This latter effect was recognized by Darlington and La Cour[4], who, however, did not observe the dependence of yield on the temperature during the irradiation.

Giles[5] irradiated *Tradescantia* pollen grains with neutrons, and found that two-break structural changes were independent of intensity. With X-rays such structural changes are less frequent per unit dose at lower intensities. This result with neutrons shows that breakage is almost instantaneous, and affords clear evidence that breakage occurs inside the ionization track. The observation with X-rays that either a lower temperature during irradiation or a higher intensity favours new unions as against old unions (restitutions), even though the treatment occupies only a few minutes, shows that the rearrangements are mostly completed within a short time of the irradiation.

That chemical processes form part of the sequence of changes which occur between an ionization and its biological effect was stated explicitly by Crowther in his Silvanus Thompson Memorial Lecture ten years ago. Discussing the target theory, he said, "the majority of upholders of the target theory would tend to look to chemical action as the first link in the chain"[6]. The point at issue is not whether chemical changes are involved or not, but where these changes start[7]. In the case of chromosome breaks, Lea's theory postulates that they must start inside, or within a few millimicrons of, the track of a single ionizing particle[8]. This conclusion was based on analyses of the relationship between the number of chromosomes affected and the dose of radiation administered, of the effect of varying the dosage-rate of the radiation, and of the effects produced by different types of radiation. It provides a satisfactory quantitative prediction of the biological phenomena under each of these headings. Recent work by Weiss[9], based on the hypothesis that ionization in an aqueous medium releases free hydrogen and hydroxyl radicals, shows that, quantitatively, the phenomena are consistent with interaction of hydroxyl radicals with large 'receptor' molecules: but an investigation by Lea[10] of the kinetics of the recombination of hydrogen and hydroxyl radicals led to the conclusion that the chemical effects of α-particles would be confined to the immediate vicinity of the α-ray tracks, though a rather wider range might be possible with X-rays. So far, the chemical approach has provided no specific mechanism by which hydroxyl radicals produced by ionizations outside the range postulated by the target theory could cause the observed biological changes in the same quantitative way. Until it has done so—and many workers in this field believe that it ultimately will—the target theory must be retained as the most satisfactory working hypothesis of the origin of the phenomena.

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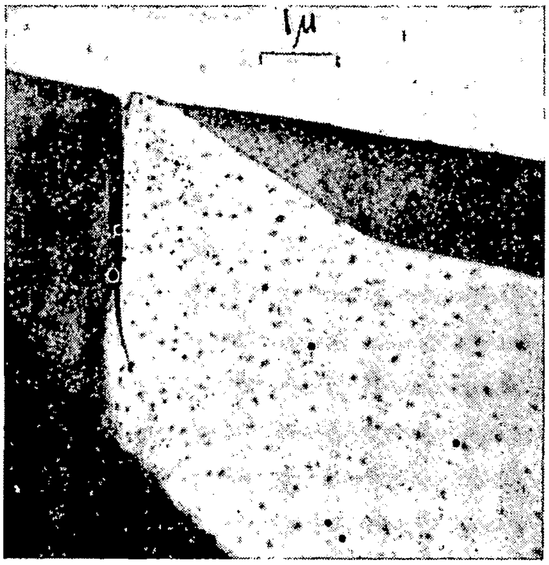
Electron Microscopy of the Sarcolemma

STRIATED muscle fibres are surrounded by a delicate membrane or sheath, the sarcolemma. It has frequently been stated[1,2,3] that this sheath is composed of a network of collagenous or reticular fibrils, arranged like a knitted sock. One of us (R. B.) in an investigation to be described elsewhere has failed to find any evidence of fibrillar structure using various methods of microscopy, including phase contrast and dark-ground illumination. We have, therefore, investigated the structure of the sarcolemma by means of the electron microscope (R.C.A. console model).

Frog's thigh muscles were teased roughly and allowed to soak for periods of up to a few hours in Ringer's solution. This produces numerous retraction clots in the fibres, leaving clear areas of empty sarcolemma. The fibres were then fixed or treated with various chemical reagents and dried in a desiccator. Unfixed fibres were also examined. After drying, the fibres were mounted on the usual 200-mesh specimen grid of the electron microscope. The accompanying photograph shows a strip of sarcolemma (formalin fixed) × 11,000 (initial magnification in microscope 5,000 times). No fibrils were seen at magnifications up to 25,000. The main feature is the presence of numerous small spots, of the order of 0·04–0·1 μ in diameter. In places where the membrane has become folded it appears that the spots lie *on* the membrane rather than *in* it. In some cases the spots seemed to form a more or less regular pattern, but this may not always appear to be the case owing to distortion of the membrane. The spots were seen in unfixed material, but were clearer after formalin fixation. Sheets of membrane were often observed to split under the action of the beam; the membrane tears linearly and cleanly without leaving fibrous strands, in marked contrast to high-polymer membranes which have frequently been studied by the electron microscope.



The nature of the spots is at present unknown. They are not seen in specimens which have been treated for some hours with dilute citric acid. It is possible that they might be points of attachment of either connective tissue fibrils or myofibrils. They are usually about 0·5 μ (or less) apart, a distance which does not correspond to any known periodicity within the myofibril; but it is possible that the sarcolemma has become shrunk or distorted by drying. The thickness of the sarcolemma is usually given as 1 μ. Electron microscopy suggests that it may be less than 0·1 μ, though a tenfold shrinkage is not ruled out.

These experiments are still in an early stage. The work is being continued with improved technique and a more detailed account will appear elsewhere.

We wish to thank the Ministry of Supply for the facilities which enabled us to carry out the investigation.

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Capillary Distribution in Cow Skin

IN studies on the nature and distribution of the 'sweat' glands of Ayrshire cows, shortly to be published in detail elsewhere, a close relationship has been found between the distribution of blood capillaries and hair follicles.

Other workers[1-3] have been concerned with all or some of the following structures, (1) the hair follicle, (2) the sebaceous gland located near the middle of the hair follicle and opening into it, (3) the arrector pili muscle and (4) the 'sweat' gland lying at the base of the hair follicle and with independent duct opening on the surface of the skin close to the point of emergence of the hair. The number of hairs has been used as an index of the number of 'sweat' glands in different regions of the skins of buffaloes, Zebu, Formosan and Freisian cattle[1].

These structures appear to form a unit, and in our observations on twenty-one different skin regions of each of five four-year-old Ayrshire cows, we have been unable to find any one of these structures not associated with the others. This also applies to

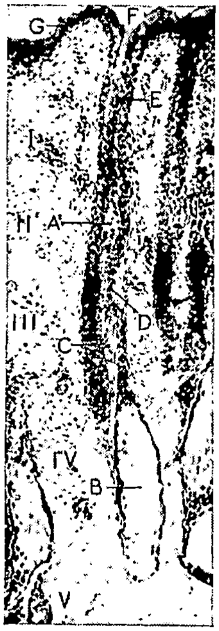

Fig. 1. VERTICAL SECTION OF CALF SKIN IN THE FLANK REGION. × 80. DELAFIELD H.-E. STAIN

A, sebaceous gland; *B*, 'sweat' gland; *C*, hair follicle; *D*, arrector pili; *E*, 'sweat' gland duct; *F*, emergence of hair; *G*, epidermis.

I, sub-epidermal level; II, sebaceous gland level; III, sub-sebaceous gland level; IV, 'sweat' gland level; *V*, sub-'sweat' gland level

the calves and embryos we have studied. The number of hairs per unit area of skin surface may therefore be taken as a direct index of the number of any of these four structures per unit area.

Cow skin may be divided into two distinct layers: the epidermis and the corium. In the corium the following five levels may easily be identified: (1) the sub-epidermal level roughly corresponding to the papillary layer and uppermost portion of the reticular layer of human skin, although in cow skin papillæ are generally absent and when present are not so prominent as in human skin; (2) the sebaceous gland level; (3) the sub-sebaceous gland level; (4) the 'sweat' gland level; and (5) the sub-'sweat' gland level. The latter four levels are all in the reticular layer. These levels and the structures referred to are shown in Fig. 1.

In the sub-epidermal level fine-calibre capillaries anastomose to form a network each loop of which encircles a hair follicle as seen in Figs. 2 and 3. This network is located in a position similar to that of rete subpapillare in human skin. In the sebaceous gland level this does not occur, though capillaries or fine arterioles running from the sub-sebaceous gland level almost vertically to the sub-epidermal level supply the sebaceous gland through fine branches. In the sub-sebaceous gland level and in the 'sweat' gland level the capillaries surround groups of two or more hair follicles, as seen in Fig. 4. In the sub-'sweat' gland level arterioles and venules are found but are few in number.

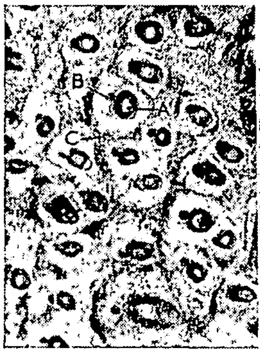

Fig. 2

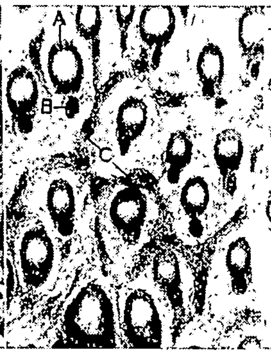

Fig. 3

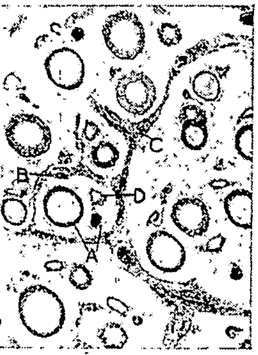

Fig. 4

Fig. 2. SUB-EPIDERMAL LEVEL OF COW SKIN. FOREHEAD REGION. × 40. *A*, hair follicle; *B*, 'sweat' gland duct; *C*, capillary

Fig. 3. SUB-EPIDERMAL LEVEL OF COW SKIN. LUMBAR REGION. × 33. *A*, hair follicle; *B*, 'sweat' gland duct; *C*, capillary

Fig. 4. 'SWEAT' GLAND LEVEL OF COW SKIN. FOREHEAD REGION. × 40. *D*, 'SWEAT' GLAND. OTHER DATA AS IN FIG. 2

Since every hair follicle possesses a capillary loop, in the sub-epidermal level the number of capillary loops is directly related to the number of hair follicles. According to our microscopic counts for one of these cows, the number of hair follicles per sq. cm. of skin surface was 940 ± 73 in the sacral region of the back and 3,000 ± 255 in the lateral region of the neck. The average diameter of the capillaries associated with each hair follicle in the sub-epidermal level was 0·086 ± 0·030 mm. for the sacral region of the back and 0·040 ± 0·005 mm. for the lateral region of the neck. The average circumference of the capillary loops was 1·043 ± 0·255 mm. for the sacral region of the back and 0·758 ± 0·089 mm. for the lateral region of the neck.

The capillary surface per sq. cm. of skin surface in the sub-epidermal region may be calculated by means of the equation:

$$S \doteq \frac{\pi dC}{2} \times n,$$

where S is the capillary surface per sq. cm. of skin surface, d is the average diameter of the capillaries, C is the average circumference of the capillary loops and n is the number of hair follicles per sq. cm. of skin surface in the chosen region. Since πdC is the capillary surface area of the whole loop, the area of the loop associated with one hair follicle (because of loop sharing) is $\pi dC/2$.

Hence the capillary surface per sq. cm. of skin surface may be calculated to be 1·33 sq. cm. for the sacral region of the back and 1·43 sq. cm. for the lateral region of the neck.

These calculations, of necessity, make no allowance for distortion during histological preparation or for physiological variation during life.

Hairs in the same skin site generally slope in one direction and the hair follicles incline to one side, forming an acute angle with the epidermis. The arrector pili muscle, the sebaceous gland and the 'sweat' gland are located in the obtuse angle. Hence, when the arrector pili muscle contracts, as in conditions of external cold, pressure will be exerted on the capillaries. This will probably supplement cutaneous vasoconstriction under such conditions and the peripheral blood flow will be reduced with consequent increased heat conservation. This function of the muscle is additional to its function in increasing heat insulation by the erection of hair. In human skin this latter function adds little to heat conservation but the capillary constriction effect may yet remain.

These studies form part of a project on the acclimatization of dairy cattle being undertaken at this Institute.

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Relation of Enamel Protein to Dental Caries

I MADE some observations on the nature of enamel protein in 1936 [1]. The possible role of enamel protein in the production of caries is described below.

(*a*) Micro-analysis of enamel protein (Weiler) gave N 12·1 per cent, S 1·2 per cent; other nitrogen determinations (Schoeller) were 9·2 and 11·1 per cent. Levene[2] gives nitrogen determinations for mucoproteins as ranging from 6·7 to 13·3 per cent; nitrogen values for proteins are generally accepted as 12–18 per cent.

(*b*) Sections of developing human enamel stained with thionin provide evidence of limited value of the presence of material resembling mucin. Wassermann[3] has illustrated the secretion of globular material by the enamel-forming cells, the ameloblasts, in guinea pigs.

(*c*) A substrate resembling chondroitin sulphuric acid by qualitative tests has now been prepared from dentine by the use of calcium chloride[4]. Dentine is reduced to powder by the use of a dental engine and a bur, defatted with acetone and ether, and extracted with 10 per cent calcium chloride; the extract is deproteinized with a chloroform – amyl alcohol mixture and centrifuged. Chondroitin sulphuric acid is separated from the supernatant liquid by alcohol and glacial acetic acid, then washed with alcohol. A solution of chondroitin sulphuric acid prepared in this manner reduced Fehling's solution, and was not fermented by yeast. No pentose was detected; naphthoresorcinol gave a brown to purple colour; phloroglucinol a red colour. No free sulphate was detected.

From this substrate, enzymes of a Gram-negative bacillus in pure culture have been found capable of quantitative release of sulphate. The organism used is No. 3247, National Collection of Type Cultures, *Ps. non-liquefaciens*. Neuberg[5] has described three sulphatases in Gram-negative bacilli, of which two are of interest in connexion with the present work: chondrosulphatase, which releases sulphate quantitatively from chondroitin sulphuric acid, while a similar type of enzyme releases sulphate from the mucoitin sulphuric acid of mucin.

An explanation of caries developing in enamel may be as follows. Enamel protein resembles a mucoprotein in its properties. Gram-negative bacilli, commonly found in caries, can release sulphatase. Enamel is made up of hexagonal prisms each surrounded by a sheath of enamel protein. Enzymatic hydrolysis of these sheaths in caries, with release of sulphuric acid, would result in attack on each prism from the periphery inwards; the relatively insoluble calcium phosphate which forms the inorganic part of the enamel would be slowly changed to the relatively soluble calcium sulphate. It is of interest to notice that Frisbie *et al.*[6] show enamel caries proceeding in just such a manner, each prism decreasing in size from the outer edge inwards.

To summarize: (1) quantitative estimations of nitrogen and of sulphur, together with evidence from the developmental aspect and from histochemical tests, suggest that enamel protein is a mucoprotein; (2) the presence of a chondrosulphatase in certain Gram-negative bacilli is confirmed; (3) the mode of progress of caries in enamel, studied histologically, can be accounted for by the present hypothesis.

The Medical School of the Middlesex Hospital gave facilities for this work through the kindness of Prof. Samson Wright. Dr. Alan Morgan, Westminster Hospital Medical School, kindly gave access to histological material. The Medical Research Council provided financial assistance. Grateful thanks is made for these facilities.

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Microflora of the Rumen

QUIN[1], in his study of the rumen micro-organisms occurring in sheep fed exclusively on lucerne hay, noted the appearance of large numbers of ovoid, clear cellular organisms with an average size of 8 μ × 4 μ. He showed that rumen fluid rich in these organisms rapidly fermented glucose with the evolution of gas, and that under these conditions the organism stained mahogany brown on the addition of aqueous iodine solution. He did not state whether these organisms were motile, nor did he record any attempts at isolation by cultural methods. On the basis of their apparent reproduction by binary fission and their fermentative powers, Quin considered that these organisms were a type of false yeast, and accordingly named them '*Schizo-saccharomyces ovis*'.

Baker[2] and Elsden[3] have confirmed these observations, apparently acquiescing in the use of the term '*Schizo-saccharomyces ovis*'.

We have examined repeatedly the rumen contents of sheep, with permanent fistulæ, fed on a diet of meadow hay and mangolds, and have found that ovoid yeast-like forms are the overwhelmingly predominant organisms. In sheep fed on meadow hay only, these ovoid organisms are absent or in small numbers; but within three days of the addition of mangolds to the diet, they appear in great numbers.

In wet preparations under a coverslip, examined under the 1/6th eyepiece of the microscope soon after sampling, the majority of the ovoid forms are seen to be actively motile; but so far, no flagella have been detected either in stained or unstained preparations. Many of the forms appear to have an outer layer resembling an envelope or capsule, around the periphery of which there are a number of small granules, brightly refractile in unstained preparations and staining intensely with Giemsa.

As well as the ovoid forms, there are numerous crescent-shaped forms of approximately the same dimensions; in some individuals one long flagellum, in others two flagella, attached to the centre of the concave side can be detected.

If a relatively pure suspension of these ovoid and crescentic organisms is obtained by fractional centrifugation, mixed with 10 per cent glucose solution and incubated at 37° C., there is a rapid evolution of gas and reduction in *p*H. On microscopic examination, the organisms are found to be non-motile; on mixing with iodine solution, they stain deep mahogany brown, indicating the formation of glycogen.

Thus it would appear that we are dealing with the organisms termed '*Schizo-saccharomyces ovis*' by Quin, and, in disputing the use of this term, we wish to direct attention to a publication by Woodcock and Lapage[4], in which they describe observations on an oval and crescentic organism found in great numbers in the rumen contents of sheep and goats. They were able to demonstrate a single flagellum arising from the centre of the body in the crescent-shaped forms, but were unable to demonstrate a flagellum in the oval motile forms. After examination of authenticated strains of *Schizo-saccharomyces*, they stated that, in their opinion, these organisms were not related to that yeast. On the grounds that similar organisms had been described by Certes[5], they preferred to name them *Selenomastix ruminantium* (Certes). This protist is now referred to as *Selenomonas ruminantium* in the standard text-books on protozoology[6,7].

We have made numerous attempts to culture the ovoid and crescentic organisms using various media, incubated at temperatures ranging from 20° C. to 45° C., aerobically, anaerobically and in vessels containing additional carbon dioxide, but so far without success. At least four different types of yeasts have been recovered by one of us (C. A. McG.), but none of these appears to belong to the genus *Schizo-saccharomyces*. In view of the statement of Klein and Müller[8] that nectar yeasts play an important part in ruminant digestion, a detailed examination of the yeasts isolated is being pursued. It must be admitted, however, that yeasts appear to be present only in small numbers.

In conclusion, we suggest that the yeast-like organisms observed in the rumen contents are not *Schizo-saccharomycetes* but are the protists described by Certes[5] and by Woodcock and Lapage[4] and now named *Selenomonas ruminantium* (Certes).

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Chromosome Number of *Cardamine pratensis*

I notice with interest Dr. Howard's records of chromosome counts of $2n = 56$ for several plants of *Cardamine pratensis* growing in damp places[1]. I have been working on British plants of this species for the last two years, with the help and guidance of Dr. K. B. Blackburn, and I have collected a very considerable amount of information on its chromosome number. The normal plant which grows in damp meadows has constantly the chromosome number $2n = 56$, judged from the evidence of seventy plants collected from eighteen vice-counties. Plants with semi-double flowers, first described by Dr. Wilfred Robinson[2] in 1925, have been found in fifteen localities in wet places, chiefly in the north of England. They have the same chromosome number $2n = 56$. Plants with $2n = 30$ chromosomes seem to be characteristically from the south of England. Those examined include five normal plants and seven completely sterile double-flowered plants. No other chromosome numbers than these have so far been encountered.

The ecological difference found by Lövkvist holds good in most of the cases recorded; for example, Prof. R. D'O. Good, who kindly provided material from Dorset, noted particularly that the large plant, now found to have the low chromosome number, occurred in quantity on the damp roadside banks characteristic of Marshwood Vale, whereas the smaller darker-leaved one ($2n = 56$) grew in wet meadows.

As I am now trying to map the distribution of the different forms of *Cardamine pratensis*, I should be very grateful for living plants particularly from Scotland, the south and east coasts of England and Ireland.

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[1] *Nature*, **161**, 277 (1948).

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Distribution Patterns in European Basidiomycetes with Reference to Some British Species

Nineteenth-century mycologists, impressed by the wide distribution of agarics and polypores, were inclined to regard them as truly cosmopolitan. Subsequent experience has modified this view by indicating that, at least as regards Basidiomycetes, the flora of tropical regions does not usually consist of the same species as that of the north temperate zone. It is also often doubtful whether a specific epithet has been applied to the same species in North America as in Europe. Even within a rather small area such as Europe, gradually accumulating distributional data have shown that not all the higher fungi occur in all parts of the Continent. Thus, in the comparatively rich British Basidiomycete flora, it is possible to distinguish components characteristic of different Continental regions. For the present it may be sufficient to recognize a northern European, southern European and Oceanic type of distribution; but when the European fungus flora has been adequately studied from this point of view, it will probably be possible not only to define these with greater precision but also to recognize other, smaller, mycological provinces.

A typical example of the northern European group is *Exidia repanda* Fr. The European distribution of this species, as quoted by Neuhoff[1], is shown in Fig. 1. Here the individual crosses in the Scandinavian peninsula do not represent separate collections but cover the reported range of the species. This very distinct and easily recognizable fungus was collected for the first time in Britain on birch trees at Shieldaig, Wester Ross, in June 1947. It seems unlikely that such a conspicuous species can have escaped observation in England; if it does occur there at all it must be rare or sporadic. Fungi of the northern European

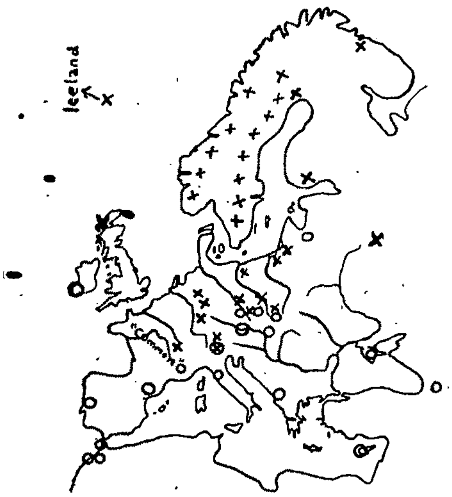

Fig. 1. ×, *Exidia repanda*; o, *Polyporus torulosus*

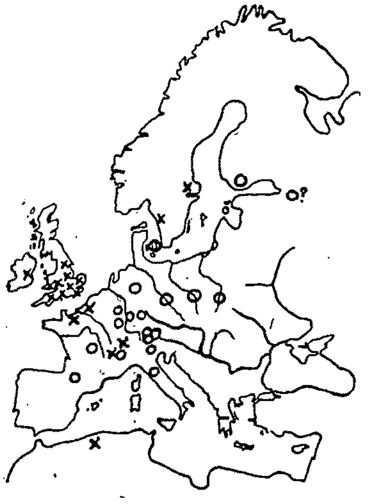

Fig. 2. ×, *Pleurotus palmatus*; o, *Ditangium cerasi*

group are likely to have a circumpolar range, and Neuhoff suggests that *E. repanda* is identical with species described from North-East Asia and from North America.

Fig. 2 shows the European distribution of a typical Oceanic species, *Pleurotus palmatus* (Bull. ex Fr.) Quél., according to Pilat[2], who rejects as erroneous all German and central European records of this fungus. If it occurs at all in central Europe it must do so very rarely, for when Pilat published his monograph of *Pleurotus* he had never seen a fresh specimen of it. Within the British Isles the species appears to be prevalent only in the south of England. There are some twenty-three published collections of it from south of the Humber, only four from England north of the Humber and none from Scotland. *P. palmatus* was not known to Lange in Denmark and the Swedish occurrences appear to constitute a somewhat anomalous extension of its range. Dr. Jørstad kindly informs me that it has not yet been found in Norway.

A species with a conspicuously southern European distribution is *Polyporus torulosus* Pers., identified by Miss Wakefield for the first time from Britain in a collection made by me on *Arbutus unedo*, Killarney, in August 1946. Its known range in Europe is plotted in Fig. 1 from the data of Pilat[3]. Except for a single record from the neighbourhood of Riga, perhaps in need of confirmation, the species appears to be unknown in Europe north of about lat. 52° N. Details are unfortunately lacking regarding its range in France; Bourdot and Galzin[4] merely state that it is common in that country. Its extra-European distribution is said to include China, Japan and the southern United States of America.

There is also a considerable group of species with a Continental type of distribution which do not reach the British Isles. Typical of these is *Ditangium cerasi* (Tul.) Cost. and Duf., the range of which is plotted in Fig. 2 for comparison with that of Oceanic species.

It is as yet impossible to estimate the relative proportions of these and other geographical components in the British fungus flora. Not only is there too little information available regarding the distribution of the larger fungi throughout Europe but also, to a greater extent than in any other group of plants, one can usually draw no reliable inferences from such local lists of species as have been published. Too often, especially in Agaricaceæ, species have been interpreted by different authors in widely differing senses. Thus, unless a full description is given of the individual collection cited, or it is definitely stated to conform to the conception of the species by some well-known authority, the published names have little value. This difficulty in standardizing the interpretation of species makes it especially desirable that British and Continental mycologists should have ample opportunity of meeting and studying disputed species together in the field. The attendance of many prominent European mycologists at the British Mycological Society's semicentenary celebrations in 1946 was a welcome step, made possible by the British Council; but much more frequent contact is required, and especially the provision of facilities for British mycologists to study the European fungus flora in the field.

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Puffinosis, a Virus Epizootic of the Manx Shearwater (*Puffinus p. puffinus*)

In the years 1946 and 1947, epizootics have been observed among the manx shearwaters on the island of Skomer off the Pembrokeshire coast[1]. The birds affected have been juveniles nearly ready to leave the island. The disease is characterized by the occurrence of large blisters on the web, either plantar or dorsal surfaces. In 1946 severe conjunctivitis was also a notable feature, but was rare in 1947. Some birds show spasm of the legs shortly before death. It is estimated that at least 90 per cent of the birds with clinical signs die of the disease.

At post-mortem some birds show no definite lesions other than those in the web. Others have round patches of consolidation in the lungs. Histologically, the web around the blisters shows great inflammatory change, and acidophil cytoplasmic inclusions may be seen in the cells of the epidermis. Cultures of the blister fluid yield either a mixed culture or a pure culture of *Staphylococcus aureus*.

Bacteriologically sterile blood from a shearwater moribund from the disease was inoculated on to the chorio-allantoic membrane of embryonated hen's eggs of varying ages, and lesions suggesting a virus infection were found. Sections of these membranes showed ectodermal proliferation, some mesodermal reaction and homogeneous acidophil inclusions in the cytoplasm of the ectodermal cells. Passage in the embryonated hen's egg did not readily yield easily recognizable macroscopic lesions, although microscopic lesions containing typical inclusions were always present. From the thirteenth passage onwards, minute pocks 0·05–0·2 mm. in diameter have been regularly observed 72 hours after inoculation; but because of their minute size, titration of the virus by pock counting methods is impracticable.

When ducklings one to two weeks old were inoculated with either original shearwater or egg-passage material by light scarification of the dorsum of the web of one foot, a disease closely resembling that in the shearwater developed after about three days. Blisters occurred on the inoculated webs, and many of the birds which died also showed lung lesions similar to those in the shearwater. Such lesions have not been found in controls.

Attempts have been made to estimate the approximate size of the virus particle by filtration through 'Gradocol' membranes. When tested either in eggs or in ducklings, it has been repeatedly shown that small amounts of virus pass through membranes having an average pore diameter of 48 m . Membranes of smaller pore diameter have not been available.

Material from the twentieth egg passage was found to give typical lesions in ducklings when diluted 10^{-7} but not at 10^{-9}. A neutralization experiment was carried out in ducklings using diluted material from this egg passage with serum from a shearwater which died in the acute stage of the disease, and a pool of serum from two which had survived exposure to the disease. With the acute serum, one duckling out of five showed infection when inoculated with material diluted to 10^{-7} and four out of five when diluted 10^{-6}. With the survivor serum no infections occurred at either dilution. The acute serum did not fix complement in 1 hour at 37° C. in the presence of antigens made either from the organs of infected ducklings or from infected chorio-allantoic membranes, while the survivor serum fixed two minimal hæmolytic doses of complement to a dilution of 1 : 10 in the presence of both antigens.

Virus was inoculated by scarification into the plucked breasts of four adult pigeons. Large blisters developed on the sixth day on two of these birds. The virus was recovered from the blister fluid. Lesions have not been produced by primary inoculation of the virus either into the comb of a cockerel or into the plucked breasts of four-week-old chicks.

Attempts have been made to pass the virus to the rodents in common use in the laboratory. The original material from shearwaters was inoculated into mice by various routes without any definite lesions being obtained. Inoculation of twentieth egg passage material into young guinea pigs, rabbits and rats or into adult mice by scarification into the pads, or in young guinea pigs and rabbits by inoculation intradermally into the dorsum of the tongue, have not yielded any definite evidence of infection.

There is some evidence that juvenile herring gulls (*Larus argentatus*) have been infected in Nature, and it is highly probable that investigations might show a wider distribution of the disease. We suggest that the name 'puffinosis' is suitable for this epizootic disease of *Puffinus puffinus puffinus*.

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May 11.

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Theory of Superconductivity

The present note is a continuation of another one submitted recently to *Nature* [see *Nature*, June 19, p. 968]. The calculations reported here are mainly due to the junior author.

The explanation given for superconductivity consisted in showing that in certain metals, characterized by a certain ratio of the lattice constant in the reciprocal space to the radius of the Fermi surface, the lowest energy state corresponds to a distribution with spontaneous currents. We obtained an expression of the correct order of magnitude for the transition temperature. Here we shall show that these spontaneous currents arrange themselves in a magnetic field in such a way that, for weak fields, London's equations between current and field hold, while for strong fields deviations are to be expected.

An investigation of the energy-levels of the electronic motion shows that they are little influenced by an external magnetic field. This effect can be rightly ignored, and the magnetic energy simply added to that of the electrons. Then the total free energy is (compare the previous note)

$$F = \int \left\{ U_0 + \frac{1}{2}\,\omega^2 \frac{h^2 n^2}{4\pi m} \left(\frac{\pi}{3n_0}\right)^{1/3} - \frac{\omega}{\omega_0} \frac{2\pi^3 m}{3h^2} \left(\frac{3n_0}{\pi}\right)^{1/3} (kT)^2 + \frac{1}{8\pi} H^2 \right\} d\tau. \qquad (1)$$

Now the spontaneous current is proportional to the number of the occupied corners of the Brillouin zone $\omega_0 - \omega$, so that the magnitude of the spontaneous current density is

$$j = \frac{nev_s}{c}\,(\omega_0 - \omega), \qquad (2)$$

where $v_s = \frac{hn^{1/3}}{m^*} \sim 3\cdot3 \times 10^7$ cm. sec.$^{-1}$ is the velocity of the superconducting electrons. Neglecting ordinary (Ohm) currents which are short-circuited by the superconductive regions, one has the relation

$$4\pi\mathbf{j} = \text{curl } \mathbf{H}. \qquad (3)$$

Introducing (2) and (3) one obtains,

$$F = F_0 + \frac{1}{8\pi} \int \left\{ \mathbf{H}^2 + \beta^2 (\text{curl } \mathbf{H})^2 - \gamma\,|\,\text{curl } \mathbf{H}\,| \right\} d\tau, \qquad (4)$$

with the abbreviations

$$\left.\begin{aligned} \beta^2 &= \frac{h^2 c^2}{(4\pi)^2 m e^2 v_s^2} \left(\frac{\pi}{3n_0}\right)^{1/3}, \\ \gamma &= \frac{hcn\omega_0}{2\pi m e v_s} \left(\frac{\pi}{3n_0}\right)^{1/3} \left(1 - \frac{T^2}{T_0^2}\right). \end{aligned}\right\} \qquad (5)$$

The field distribution is obtained by minimizing the expression (4) with respect to **H**, taking into account the continuity of **H** on the boundary. We split $\mathbf{j} = \frac{1}{4\pi}$ curl **H** into two parts:

$$\mathbf{j} = \mathbf{j}_0 + \mathbf{j}', \text{ where } (\mathbf{j}_0)_{\text{av}} = 0.$$

If $|\,\mathbf{j}_0\,| > |\,\mathbf{j}'\,|$, which happens for small fields, one gets London's equation for the stationary case:

$$\Delta\mathbf{H} = \lambda\mathbf{H}, \qquad (6)$$

with $\lambda = \frac{3}{\beta^2}$, $\frac{1}{\sqrt{\lambda}} = \frac{\beta}{\sqrt{3}} \sim 3 \times 10^{-6}$ cm.

On the other hand, if the external field is large, then London's equation breaks down and has to be replaced by the following one:

$$\Delta \mathbf{A}\left(1 + \frac{\gamma\,|\,\mathbf{j}_0^2\,|}{6\beta^2\,|\,\Delta \mathbf{A}\,|^3} - \frac{\gamma}{2\beta^2\,|\,\Delta \mathbf{A}\,|}\right) = \frac{1}{\beta^2}\,\mathbf{A}, \qquad (7)$$

where **A** is the vector potential.

Even for large fields the region where equation (7) holds is only a thin boundary layer, the thickness of which (the penetration depth δ) is obtained by postulating that the function **H** is continuous across the surface between the boundary layer and the interior where the London equation (6) holds. One obtains for very strong external fields H_0 (for which no experimental results are available)

$$\delta = 0{\cdot}47\,\beta\,\sqrt{\frac{H_0}{H_f\,(1 - T^2/T_0^2)}}, \qquad (8)$$

where H_f is a constant.

The threshold magnetic field is obtained by equating the free energy of the normal and the superconducting states. The first is $F_0 + \frac{1}{8\pi}\int \mathbf{H}_0^2 d\tau$, where $\mathbf{H}_0$ is the external magnetic field; and the second is the expression (4), where **H** is the superconductive field. The calculation leads to the formula

$$H_c = H_m\,(1 - T^2/T_0^2), \qquad (9)$$

with

$$H_m = T_0^2\,\frac{8\pi^4 m k^2}{3h^2}\left(\frac{3n_0}{\pi}\right)^{1/3}. \qquad (10)$$

This agrees with the experimental results, not only with respect to the dependence on the temperature T, but also to the order of magnitude.

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Mechanism of the Emission Spectrum of Active Nitrogen

IN a recent paper Mitra[1] has attempted to explain the remarkable features of the nitrogen afterglow, which have also been studied again by Lord Rayleigh[2] on the assumption of an emission that would follow the recombination between the ions N_2^+ with electrons. It seems difficult to explain the previous observations and those described here by this simple hypothesis.

We have shown in previous work[3] the existence of complex afterglow arising from the overlapping of several mechanisms. Besides the long duration of the yellow afterglow (α-bands) we observe a short one which consists of the first positive system without definite selectivity, the second positive and the first negative systems. The distribution of intensity of this afterglow changes with the pressure and the action of the walls.

Working with the phosphoroscope of P. Lejay[4] we have also investigated qualitatively the effect of temperature on this afterglow. A comparison was made between the emissions at the surrounding temperature and when liquid air was poured in the Dewar vessel in which the discharge tube was immersed. Under these conditions we observed the following modifications in the composition of the afterglow.

As in the case of the yellow emission, a rise of the intensity of the whole of the spectrum at low temperature is observed, but it is not of the same weight for all systems.

First positive system. At laboratory temperature, there is a strong emission without a striking selection; its relative intensity rises when the pressure decreases and the temperature increases. At low temperature, the distribution of intensity in the sequences changes because of the increase of the bands at $v' = 6$ and 10 (α-bands).

Second positive and first negative systems. At a pressure of 10^{-2} mm. to 10^{-1} mm. mercury, their intensity increases about three times at 10^{-4} sec. after breaking up the discharge. The bands with $C^3\Pi$, $v' = 3{\cdot}4$ increase in relative intensity in afterglow.

Goldstein bands. At low temperature, this system increases in relative intensity. When the discharge is cut off, it suffers less variation than the neighbouring bands of the second positive system (Fig. 1). The emission of this system follows a recombination between two atoms of nitrogen (^2D) in a similar way to the bands with $C(v' = 3{\cdot}4)$ of the second positive system. The similar behaviour of these bands belonging to different systems confirms our interpretation.

Green system. The three strongest bands λλ 5079 (0·0), 5308 (0·1), and 5570 (0·2) continue in the afterglow with greater strength at low temperature (Fig. 2).

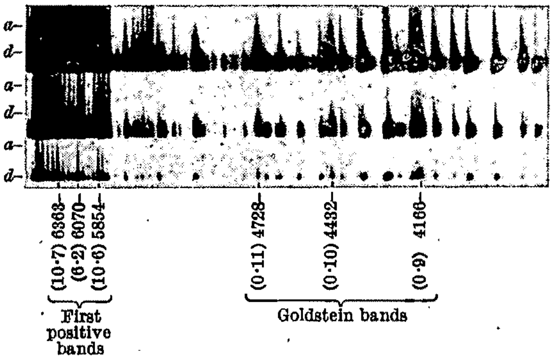

Fig. 1. CHANGES OF THE NITROGEN SPECTRUM WHEN THE DISCHARGE IS CUT OFF (LOW TEMPERATURE).
d, discharge; *a*, afterglow

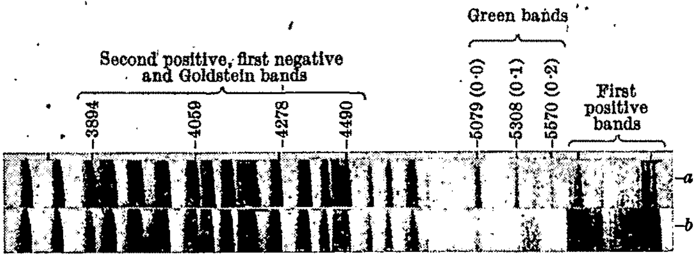

Fig. 2. COMPARISON BETWEEN THE AFTERGLOW SPECTRA AT LOW TEMPERATURE (*b*) AND LABORATORY TEMPERATURES (*a*)
The decrease of the relative intensity of the first positive and the rise of the green bands should be noted in spectrum (*a*)

Our results show that the hypothesis of Mitra is unable to explain all the features of active nitrogen. The strong emission of the first negative system must result from a recombination of the doubly ionized ions N_2^{++} and electrons. To account for the increase of the Goldstein and selected bands of the second positive system, we must assume an atomic recombination. Likewise the selective emission of the first positive system is made clear by the Carion and Kaplan mechanism in which one molecule of nitrogen ($A^3\Sigma$, $v = 0$) is excited by an atom of nitrogen (^2D) or (^2P). It is possible also that the emission of the bands at $B(v' = 6)$ results from the interaction with the $^1\Pi$-level. For example, it would not seem possible to admit that the emissions of the first and second positive systems follow the same mechanism of capture of electrons:

$$(N_2^+ + e \rightarrow C^3\Pi \rightarrow B^3\Pi + h\nu \text{ (second positive)};$$
$$B^3\Pi \rightarrow A^3\Sigma + h\nu \text{ (first positive)};$$

since it would not account for the great variations in their relative intensity with the experimental conditions.

The remarkable features of active nitrogen seem rather to result from the fact that this diatomic molecule is like an inert gas that permits many reactions between atoms, ions and electrons.

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Dec. 29.

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Reported Radioactivity of Osmium

FOR some time it has been known that two isobars which differ by unity in atomic number cannot both be stable, except for a possible influence of the neutrino if its mass has a positive value at rest. A search for radioactivity among the existing pairs of isobars led to the announcement[1] of K-electron capture in osmium (Os^{187}) with a half-life of about 3×10^8 years. However, a recent paper on beta-stability[2] contains the following remark: "The reported radioactivity of Os^{187} has recently been questioned, with indications that Re^{187} instead is radioactive"[3]. It seems worth pointing out that some time ago another argument had thrown strong doubts on the view that osmium is radioactive.

This conclusion rests on data, contained in a paper by Noddack and Noddack[4], which gives the results of rhenium determinations in a number of minerals. These authors find the rhenium content of osmiridium from New South Wales to be about 10^{-5} per cent and of a sample from the Urals about 10^{-4} per cent. From what is known about the rocks from which the platinum ores originate, we may take 2×10^8 years as a fair estimate of the age of most of the osmiridium samples investigated by Noddack. Osmiridium usually contains between 30 and 50 per cent osmium, and 1·64 per cent of the latter is Os^{187}. Therefore, if the rate of radioactive decay quoted above were correct, osmiridium should contain about $\frac{1}{4}$ per cent rhenium. Although the figures for the rhenium content and for the age of osmiridium are admittedly inaccurate, the discrepancy of at least something like 10^4 is sufficiently large to prove that, if K-electron capture occurs in osmium, the half-life must be several orders of magnitude longer than that given by Lougher and Rowlands.

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March 8.

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The Metallic State

IN the development of the resonating-valence-bond theory of metals, it has become evident that the characteristic structural feature of metals is the possession by each atom or each of many atoms in the metallic phase of an extra orbital (the 'metallic orbital'), in addition to the orbitals normally occupied by electrons. This metallic orbital permits the unsynchronized resonance of electron-pair bonds from one interatomic position to another by the jump of one electron from an atom to an adjacent atom, leading to great stabilization of the metal by resonance energy, and to the characteristic metallic properties.

For example, in lithium each atom has one valence electron, permitting the formation of an electron-pair bond for each pair of atoms. These bonds resonate among alternative positions, mainly the eight positions between each atom and its eight nearest ligands. If each atom were required to remain neutral, by retaining its valence electron, the stabilization through the permitted synchronized bond resonance,

$$\left\{\begin{array}{lll} \text{Li—Li} & \text{Li} & \text{Li} \\ & | & | \\ \text{Li—Li} & \text{Li} & \text{Li} \end{array}\right\},$$

analogous to that in the benzene molecule, would be relatively small. Much greater stabilization results from unsynchronized resonance such as

$$\left\{\begin{array}{lll} \text{Li—Li} & \text{Li}^{-}\text{—Li} & \\ & | & \\ \text{Li—Li} & \text{Li} & \text{Li}^{+} \end{array}\right\},$$

involving the use of an additional orbital on the atom receiving an extra bond. The electronic conductivity and other characteristic properties of metals may be described in terms of the transfer of the positive and negative charges from atom to atom accompanying the resonance of the valence bonds.

The resonance energy resulting from use of the metallic orbital in metals outweighs the energy of repulsion of adjacent non-bonded atoms and permits the co-ordination number of atoms to be greater than the number of valence electrons or bond orbitals. Thus tin, with 14 outer electrons and 9 stable orbitals (five *4d*, one *5s*, and three *5p*, or hybrids of them), may place electron pairs in five orbitals and single electrons in the other four; this quadrivalent tin, with no extra orbital, forms the essentially non-metallic phase grey tin, with the diamond structure (co-ordination number 4, non-resonating single bonds). However, a metallic orbital can be made available by placing six unshared electron pairs in six orbitals, and single electrons in two orbitals. This bivalent tin is present in the metallic phase, ordinary white tin, in which each atom has co-ordination number 6.

It is not necessary that every atom in a metallic system have a metallic orbital. The four bonds of each quadrivalent tin atom in the compound AuSn[1] are able to resonate among the six positions to the six adjacent gold atoms by pivoting around the tin atom, making use of the extra orbitals of the gold atoms. About one quarter of the atoms in white tin are quadrivalent, the average valence thus being about $2\frac{1}{2}$, and the average number of metallic orbitals per atom about $\frac{3}{4}$. These considerations thus explain the previously puzzling non-integral number 0·78 of extra orbitals per atom and the non-integral valencies, such as 2·44 for tin, which were found ten years ago by the analysis of magnetic data[2].

The problem of the choice between alternative structures for a metal or intermetallic compound that satisfy the metallic valencies of the atoms equally well can be discussed by a treatment resembling the customary Brillouin-zone theory, but involving the resonance of electron-pair bonds throughout the crystal, rather than of single electrons. We may, as an approximation, formulate the wave function for a crystal as an electron-antisymmetrized combination of product functions constructed of two-electron functions, each of which represents an electron-pair bond resonating among the inter-atomic positions in the crystal. These two-electron functions may be set up as a combination of bond functions multiplied by suitable Bloch factors; the resonance energy then leads to a splitting of energy levels qualitatively similar to that given by the usual one-electron molecular orbital theory, and with the same electron numbers for the Brillouin polyhedra. The agreement between the newly proposed metallic valencies of the transition metals and the electron numbers filling important Brillouin polyhedra for some filled-zone substances (the γ-alloys, α-manganese, β-manganese) has been pointed out in a recent paper[3].

Another way of discussing the choice between alternative structures is based upon the special stability associated with the resonance of valence bonds among interatomic positions when the ratio of bonds to positions is that of small integers. This effect most strongly stabilizes bonds with bond number $\frac{1}{2}$ (half-bonds), corresponding to resonance of one bond between two positions, followed by bonds with bond numbers $\frac{1}{3}$, $\frac{2}{3}$, $\frac{1}{4}$, $\frac{3}{4}$, etc. It is thus possible to understand the stability of the unusual metal structures shown by zinc, cadmium, mercury, white tin, gallium, β-tungsten, β-uranium and a few other metals, as well as that of the structures of many intermetallic compounds. For example, if zinc, with metallic valency 4·5, had a normal close-packed structure, each of the twelve bonds formed by a zinc atom would be a $\frac{3}{8}$-bond. By increasing the axial ratio of its crystal from the value 1·633 (for hexagonal close packing) to 1·861, each zinc atom is able to form six half-bonds (of length 2·660 A.) and six quarter-bonds (2·907 A.), and the crystal gains the extra stability accompanying these simpler bond numbers. Similarly, the selection of the body-centred structure by the fifth-group elements can be understood: this structure, in which each atom uses its valency 5 to form half-bonds with its nearest eight ligands and $\frac{1}{6}$-bonds with the six more distant ones, is in consequence of the simple bond numbers more stable than a close-packed structure, involving twelve $\frac{5}{12}$-bonds.

This resonating-valence-bond theory of metals will be discussed in detail elsewhere.

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At Balliol College,
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May 6.

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Adsorption on to Ionogenic Surfaces

Michaelis and Ehrenreich[1] were the first to suggest that the adsorption of large ions such as the organic dyes, on ionogenic surfaces, takes place by two distinct mechanisms operating simultaneously: one of an electrochemical nature, and in addition to this a 'normal' physical adsorption. Later, Freundlich and Poser[2] stated explicitly that the adsorption of large positive ions on clays could be explained qualitatively by the combined effects of an irreversible ion-exchange adsorption and a reversible physical adsorption, and this idea was further elaborated by Michaelis and Rona[3]. It is interesting for the historian of science that this simple idea was afterwards forgotten, but was 'rediscovered' on several occasions prior to our work. The idea of simultaneous adsorption by two different mechanisms is not mentioned by Swan and Urquhart[4] in their comprehensive review on adsorption, or in text-books. Even Freundlich himself in his "Kapillarchemie" (1930) seems to have lost sight of the implications and usefulness of the idea, but it was formulated in different ways by Stadnikoff[5], Fogle and Olin[6], Hendricks[7] and Grim *et al.*[8].

We have arrived independently at the conclusion that the adsorption of basic dyes on clays is governed by two essentially different mechanisms. It is known that when basic dyes are adsorbed on clays a certain fraction of the adsorbed amount is held irreversibly and displaces an approximately equivalent quantity of cations from the clay[3a,9]. If this exchange adsorption is absolutely irreversible, the amount of dye held in this way will be directly proportional to the quantity of clay present and independent of the dye concentration in the solution. If we bring increasing quantities of dye into contact with a given mass of clay, at first every molecule of dye added to the system will be adsorbed and held irreversibly, and this will go on until the base-exchange capacity of the clay is saturated. As soon as there is an excess of dye present, it will be physically adsorbed on to the exchange-saturated clay. The quantity of dye thus held will be a function of the concentration of dye remaining in solution after the portion held by ionic exchange has been taken out. From these considerations it follows that, in general, the number of milli-equivalents x of dye taken out of v ml. of a solution of initial concentration c_0 m.equiv./ml. by m gm. of clay will be a function of m, c_0 and v. This treatment is a first approximation: it neglects the possibility that, on account of the accessibility of exchange sites to the large dye molecules, the exchange capacity for dyes may be less than the general base-exchange capacity; it also neglects time effects and possible transitions between the two states of adsorption.

This theory of adsorption can be formulated quantitatively thus. Let x_1 and x_2 be the 'exchange' and 'physical' contributions to the total adsorption.

Then $x = x_1 + x_2$,

but $x_1 = k_1 m$, where k_1 = constant,

so that the quantity of dye remaining in solution after the exchange adsorption is given by $(vc_0 - x_1)$. This will set up a reversible equilibrium which may be described, for example, by a Freundlich isotherm with constants k_2 and n. If c is the final concentration of dye in the solution,

$$x_2 = m.k_2.c^n.$$

Therefore $x = m(k_1 + k_2c^n)$,

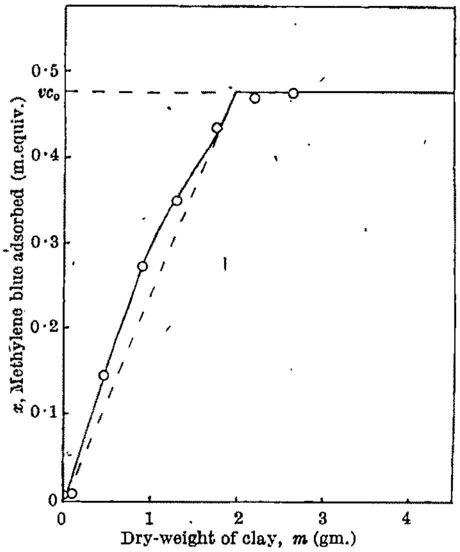
or since $c = c_0 - x/v$

$$x/m = k_1 + k_2(c_0 - x/v)^n.$$

This equation was found empirically by Gurwitsch[10] but was misinterpreted and its significance overlooked. It defines a surface in the $(x - m - c_0)$ diagram which will be characteristic for each system. At constant c_0 and v we have:

$$\frac{dx}{dm} = \frac{k_1 + k_2c^n}{1 + \frac{mn}{v}k_2c^{n-1}}.$$

As $m \rightarrow 0$ and thus $c \rightarrow c_0$, $dx/dm \rightarrow k_1 + k_2c_0{}^n$. As $c \rightarrow 0$ with increasing m, $dx/dm \rightarrow k_1$. The shape of this (x,m) curve is represented by the full line in the diagram. Experiments by one of us (P. H. P.) with various clays, in which x was measured for methylene blue as a function of m at constant c_0 and v, gave results such as those for floridin shown in the graph. The agreement with the shape of the theoretical curve is reasonable, except where $x \rightarrow vc_0$. This discrepancy is probably due to the approximations used in the theory. It is smaller for Wyoming bentonite, for example, for which k_1 is greater than k_2. For all values of m greater than a certain critical value m_0, x = const. = vc_0; m_0 is the weight of clay which is exactly 'exchange-saturated' by vc_0 m.equiv. of dye, that is, the exchange adsorptive capacity of the clay is given by vc_0/m_0. Although for some clays m_0 is rather indefinite, the value of $vc_0/m_0 = k_1$ agrees well with the base exchange capacity of the clays, as is to be expected. k_1 can be found from measurements such as those represented in the graph. Knowing k_1, then k_2 and n can be found from the plot of log $(x/m - k_1)$ against log c. Alternatively, k_1 is given by the intercept of the $(x/m, c)$ plot on the axis of x. (We are indebted to Dr. M. Szwarc for pointing this out.)



ADSORPTION OF METHYLENE BLUE ON FLORIDIN CLAY. v = 50 ml. c_0 = 0·357 PER CENT

Since the derivation of the theory outlined above is very general, it should be applicable wherever adsorption takes place by a combination of reversible and irreversible mechanisms; for example, dyeing, staining, adsorption on humus, peat, polymeric acids, ion-exchange resins, etc.

The subject will be treated more fully in a forthcoming publication.

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A Simple Moving-Boundary Apparatus

Baxter and Gold[1] in their letter under the above title appear to be unaware of a paper by Drew and Hartley[2] describing the similar use of a single three-way tap arrangement for bringing together the leading and indicator solutions in the moving-boundary method of transport number measurement. As the apparatus described by Drew and Hartley was employed in the development of a new method for the measurement of transport numbers and might be overlooked, Baxter and Gold may be justified in directing attention to this simple experimental arrangement. I do not, however, share their views regarding the superiority of the tap arrangement over certain other conventional apparatus. I have had some experience of various types of moving-boundary apparatus, including one similar to that described by Baxter and Gold. I found that the air-lock device described by Hartley and Donaldson[3] not only possessed the qualities claimed by Baxter and Gold for their tap arrangement but also was superior in other respects. Thus the air-lock device allows of greater ease of manipulation when the apparatus is supported in a thermostat, and its avoidance of a lubricant is a desirable feature in studies with non-aqueous media. Moreover, its inexpensiveness relative to a good-grade tap, its simplicity together with its ease of construction, render the device very appropriate for use in undergraduate practical courses.

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X-RADIATION FROM A 20-MeV. BETATRON

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IT is of interest and importance to know the energy distribution of the radiation emitted from betatrons and synchrotrons, since such knowledge is necessary in cases where cross-sections of nuclear reactions are to be determined[1], and in estimating the clinical effect of such radiation.

For some months we have been investigating the spectrum of the radiation from the 20-MeV. betatron (Kerst type) built in this Laboratory, using two methods, namely, the study of (*a*) electron-positron pairs produced in a thin lead sheet in a Wilson chamber, and (*b*) the protons liberated in the photodisintegration of deuterons using either a scattering chamber with a heavy wax target or deuterium-loaded plates (Ilford *C*2 Emulsion). Lasich and Riddiford[2] have investigated independently the spectrum of the X-rays from a 2·8-MeV. betatron using Compton recoil electrons.

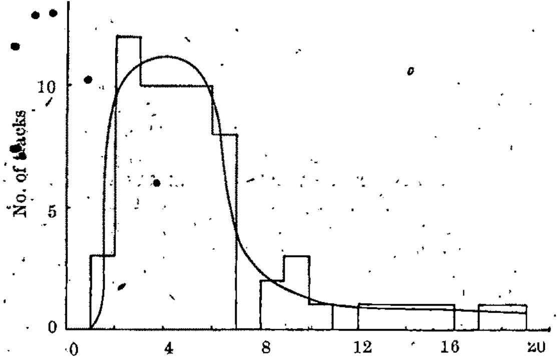

Fig. 1 (*a*)

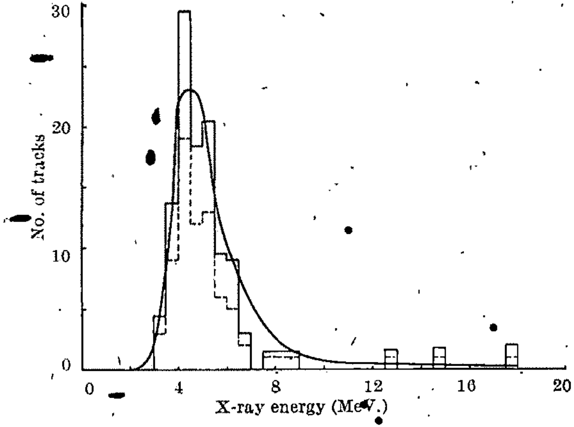

Fig. 1 (*b*)

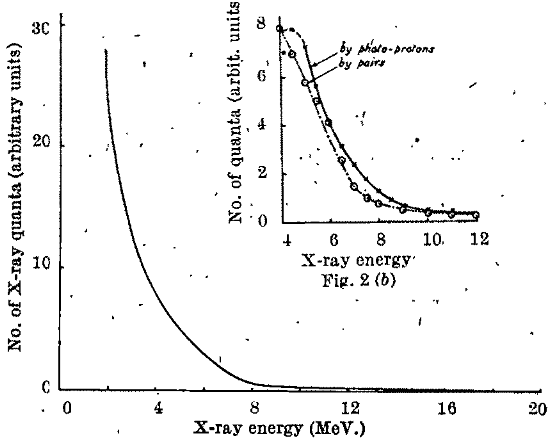

Fig. 2 (*b*)

Fig. 2 (*a*)

Method (*a*) has been used for measuring gamma-ray spectra for many years[3,4], and involves the measurement of the energy (ε) of a large number (N) of pairs (after precautions have been taken to ensure that they are produced by primary photons from the incident beam only). The plot of $N(\varepsilon)d\varepsilon$ against ε, corrected for variations in pair-production cross-section with energy[5], then gives the spectrum. Since this work was started, a modification of the method has been published by Baldwin and Klaiber[6].

Method (*b*) uses the nuclear reaction :

$$D_1^2 + \gamma \rightarrow H_1^1 + n_0^1$$

discovered by Chadwick and Goldhaber[7], who deduced from it the binding energy of the deuteron. Powell *et al.*[8] have suggested that the reaction could be used to measure gamma-ray energies, and more recently a group in the Cavendish Laboratory has used deuterium-loaded Ilford plates to investigate (at about 6 MeV.) the angular distribution with reference to the incident beam of the photo-protons[9]; and their note should be read for an appreciation of the theoretical importance of the reaction.

Fig. 1(*a*) shows a histogram constructed from 65 electron-positron pairs, and the smooth curve drawn through this gave, when corrected for the cross-section variation, the distribution shown in Fig. 2(*a*). Since the number of pairs measured was small, this may be regarded only as provisional, but there would certainly seem to be a large percentage of radiation of less than 5 MeV. energy, which does not agree with the shape of spectrum which has been assumed in some experiments[1]. It must be emphasized (see the discussion below) that Fig. 2(*a*) is not the spectrum that would be obtained if only the target radiation were measured.

Fig. 1(*b*) shows the histogram of 75 recoil proton tracks detected in an Ilford *C*2 Nuclear Research plate in a special camera designed and built by one of us (R. M. P.), so that the protons emitted at 30°–90° with the incident X-rays could be detected. All these tracks were found between 60° and 90°, and the histogram was corrected as shown to give the total number of tracks from 0° to 90°. This was done by finding the variation of angular distribution of the protons with energy from previous published work[9-11]. The smooth curve of Fig. 1(*b*), when corrected by Bethe's cross-section/energy curve, yielded a distribution in good agreement with that of Fig. 2(*a*) down

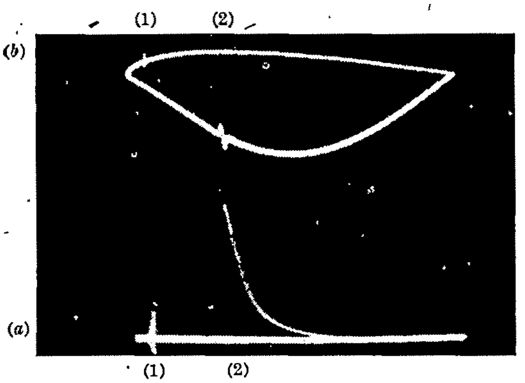

Fig. 3

to an energy of about 5 MeV., below which the proton curve fell off, possibly due to excessive adsorption of the protons in the heavy wax target. The two curves are shown together in Fig. 2(*b*) over the range 4–12 MeV. A point of interest about the two histograms is that neither pairs nor recoil protons were obtained corresponding to an X-ray energy of 7–7·5 MeV., although about five such pairs would be expected.

Although the main purpose of this note is to direct attention to the methods used, and the need for information on betatron and synchrotron spectra, it may be of interest to speculate on the shape of the curves of Fig. 2. The molybdenum target in the betatron (see Kerst[12], Fig. 2) is thin compared with the range of 20-MeV. electrons, and it appears that during the application of the expander pulse the electrons may on the average lose a little ($\sim$ 1 per cent) of their energy at the edge of the target and then oscillate about a new equilibrium orbit, arriving back at the target after several (in our case two) revolutions, then repeating the process. The amplitude of these oscillations therefore increases as the mean orbit radius decreases until the electrons bombard the inner wall of the vacuum chamber, which acts as a thick glass target from which much soft radiation may be expected. However, it should be possible for the 20-MeV. electrons to lose perhaps 10–20 per cent of their energy at the target. It is to be expected that if good collimation were used, so that only radiation arising at the target were observed, then the resulting spectrum would be of the normal *Bremsstrahlung* (thin-target) type. The present experiments are not sufficient to allow the intensities of target and wall radiation to be compared, but are described partly to direct attention to the latter.

Lasich and Riddiford[2] also found much soft radiation but suggested different explanations with which we are inclined to disagree. It is to be expected that soft radiation (probably with much less energy than, say, 2 MeV., cf. Fig. 1*b*) may arise from electrons scattered in the residual gas in the acceleration chamber soon after injection. Fig. 3*a* shows (1) a pick-up pulse due to the injector (see also Fig. 3*b*, 1) and (2) pulses, from a Geiger counter placed in the beam, which all coincide with each other (there were approximately 300 pulses in the time of exposure) at the instant of beam expansion which is shown by the pulse of Fig. 3*b*, 2, thus indicating that scattered radiation arising in the early part of the accelerating period was of negligible intensity.

The above considerations may be proved or disproved by further experiments which it is intended will be carried out. We also hope to publish a more detailed account of the work elsewhere.

We are greatly indebted to Mr. B. Touschek (University of Glasgow) and Mr. F. K. Goward (Telecommunications Research Establishment) for instructive discussions on the work.

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EFFECT OF ION-EXCHANGE TREATMENT ON THE STABILITY OF APPLE JUICE

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ION-EXCHANGE adsorbents have come into increasing use for the de-acidification of fruit juices and extracts[1-3]. In spite of the wide application of such methods in these and related fields, as summarized by Riches[4] and by Davies[5], the effect of such treatments on the 'stability' of juices has, to the best of our knowledge, received little or no attention.

In the course of experiments on the de-acidification of apple juice, a very considerable reduction in the concentration of certain cations and anions took place, as observed by other workers. It occurred to us that such treated juices would be less able to support the growth of micro-organisms and therefore less liable to undergo fermentation. If this were so, it would be of considerable practical importance. In this connexion, Dr. A. K. Zweede of Wageningen had mentioned to us that there was evidence that sugar-beet extracts after treatment with adsorbents showed an increased stability. In our own preliminary experiments, it was found that apple juices subjected to ion-exchange treatments and then freely exposed to air showed much less fermentation than juices not so treated.

In more comprehensive tests, samples of depectinized and pulp-filtered apple juices were passed through laboratory columns of the Permutit ion-exchangers 'De-Acidite *B*' and 'Zeo-Karb *H* 1'. These treatments are summarized in the accompanying table. A marked change in juice composition was produced by the removal of cations in the 'Zeo-Karb' column, accompanied by a corresponding increase in hydrogen-ion concentration. One passage through this adsorbent reduced the total ash in the Blenheim

ION-EXCHANGE TREATMENT AND ITS EFFECT ON JUICE COMPOSITION

Juice	Treatment: 'De-Acidite *D*' or 'Zeo-Karb *Z*'	*p*H	Total ash as % of juice	Constituents as mgm./100 ml. juice					
				Ca	Mg	Cu	Zn	P	N
1. Blenheim Orange	nil	3·62	0·274	14·2	7·0	0·21	0·64	12·4	14·0
2. ,, ,,	*Z*	2·30	0·048	trace	trace	0·03	0·07	12·2	7·0
3. Rival	nil	3·53	0·334	16·9	5·4	0·11	0·81	15·0	13·6
4. ,,	*Z*	2·23	0·049	trace	trace	0·03	0·15	—	—
5. ,,	*Z*, *D*, *Z*	2·33	0·003	,,	,,	0·02	0·07	1·2	1·2

Orange juice (1) to 17·5 per cent and the ash in the Rival juice (3) to 14·7 per cent of the original values. A second passage of the latter juice through the regenerated column, after an intermediate treatment with 'De-Acidite' to reduce acidity, further diminished the ash to 1 per cent of its original value. As these treatments produced a significant change in *p*H, all juices tested microbiologically were first adjusted to their original *p*H by the addition of a solution of sodium hydroxide (analytical grade) in glass-distilled water.

In the initial microbiological tests, pasteurized samples of these juices were separately inoculated as follows: (*a*) with a loopful of a pure wine yeast culture—'Herrliberg'—grown for 24 hours at 25° C. in malt extract; (*b*) with a loopful of a suspension of the same yeast in glass-distilled water, prepared from a 24-hour-old streak culture on malt extract agar; and (*c*) with a loopful of a washed suspension of the mixed microflora obtained by centrifugation from the untreated juice (Rival 3) which had been kept at room temperature for a few days and was actively fermenting. Suspension (*c*) consisted mainly of yeasts, relatively few bacteria being present. Precautions were taken to avoid introducing appreciable quantities of ions either from glassware or from the inocula. Thus, the suspensions were prepared in glass-distilled water and used immediately. The inocula were large—more than 20,000 viable organisms in inocula (*a*) and (*b*), and more than twice that number in inoculum (*c*) for each 7 ml. of juice.

In the earliest experiments—on treated juices of Bramley's Seedling—in which inocula (*a*) and (*b*) only were used, a marked reduction of the growth of yeasts was observed. These encouraging results were followed by experiments on juices which had received more thorough treatment (double passage through 'Zeo-Karb'). Each juice sample was separately inoculated with inocula (*a*), (*b*) and (*c*) and incubated aerobically at 25° C. No growth of the 'Herrliberg' yeast occurred in the treated juice even after two weeks incubation. With the mixed yeast inoculum (*c*) a small deposit formed, sufficient to impart a very slight haze to the juice after vigorous shaking. That only slight multiplication of the mixed yeasts had, in fact, occurred was confirmed by microscopic examination, which showed that the amount of such multiplication was exceedingly small. Furthermore, the yeasts had not the normal healthy appearance of those growing in the untreated juice. These results were confirmed in a subsequent experiment.

The nature of the effects observed in the treated juices presents many interesting problems. We are here interested mainly in those micro-organisms able to cause fermentation, that is, the yeasts and certain bacteria; suppression of the growth of fungi, however, is also of interest. Information on the general nutritional requirements of micro-organisms is not very detailed, but it is known that, in addition to the *main* requirements of carbon, hydrogen, oxygen and nitrogen, other elements or groups are also required. Among these are the following: phosphate, sulphate, carbonate, chloride, sodium, potassium, magnesium, iron, calcium, copper, also possibly manganese, zinc, cobalt and molybdenum. It must be remembered also that the *ratios* of the concentrations of certain ions as well as their absolute quantities may be of significance.

It has not yet been possible to investigate in detail the nutritional deficiencies in our treated juices, but in preliminary analyses the elements given first attention were nitrogen, phosphorus, calcium, magnesium, zinc and copper. The reduction in total nitrogen in the treated Rival juice (5), as shown in the table, was not such as would alone be expected to explain the present findings. The ion-exchange treatments gave most significant reductions in the concentrations of total phosphorus, calcium and magnesium, the two latter being reduced to less than 1 per cent of their original values in this juice. Copper and zinc were also considerably reduced, but to a less marked extent. Spectrographic analysis of the earlier juices, made possible by the courtesy of the International Smelting Corporation, Avonmouth, confirmed the presence of calcium, magnesium, copper and zinc in the treated and untreated juices. Traces of manganese were also present, but molybdenum was not detected.

In a further series of microbiological tests the following salts (analytical grade) were added to the treated juice, either separately or in combination, in amounts comparable with those present originally: ammonium sulphate (nitrogen and sulphate), ammonium phosphate (nitrogen and phosphate), magnesium sulphate and calcium chloride. The juices were inoculated with the microflora of the Rival juice (3) and incubated at 25° C. After a *short* period of incubation (three days), appreciable growth appeared only in the juices containing both added nitrogen and phosphorus, there being no marked difference between that containing added nitrogen and phosphorus only and that receiving nitrogen, phosphorus, magnesium and calcium; growth, however, was very considerably less than in the original untreated juice. After a further three days incubation there was a marked difference between the juice receiving the four nutrients and that receiving nitrogen and phosphorus only; in fact, the amount of growth in the former was then of the same order as in the untreated juice.

The microbiological tests have been carried out aerobically. It should be borne in mind that apple juice is normally stored under conditions of restricted oxygen supply: under such conditions, however, the effects of ion-exchange treatment on juice stability would be expected to be similar or even more marked. Some evidence that this is so has been obtained from an experiment under less aerobic conditions.

We have attempted to apply these findings by storing treated and untreated juices in the laboratory at ordinary temperatures. Although the juices were unpasteurized and no aseptic precautions were observed, the treated juice (Rival 5) showed no obvious fermentation during the period of observation (four weeks); some slight mould growth, however, occurred. Juice which had been de-aerated and bottled under carbon dioxide showed even greater stability. The untreated juice (Rival 3) was rapidly fermenting within three days.

It is thus apparent that ion-exchange treatment of apple juice effects the removal or partial removal of nutrients necessary for the growth of micro-organisms. Juices so treated become very much less liable to microbiological spoilage. Further experiments on this and other aspects of the work are in progress. If it should prove practicable to produce similar changes in juice composition affecting the growth of micro-organisms by ion-exchange treatment on a commercial scale, then the industrial production of apple juice—and possibly of other fruit juices—might be radically changed in respect of processing procedure, storage and the ultimate stability of the finished product. It is obvious also that the results here recorded open up far-reaching possibilities in connexion with the preparation and stability of other types of fruit products, for example, cider and perry.

We wish to thank the Permutit Co., Ltd., for samples of the adsorbents used in this work.

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THE ROYAL SANITARY INSTITUTE

THE Annual Congress of the Royal Sanitary Institute was held at Harrogate this year during May 24–28. On May 28, a joint meeting was held with the Food Group of the Society of Chemical Industry to discuss the cleaning and sterilizing of plant in the food industry. After an introduction by Dr. E. B. Hughes, chairman of the Food Group, papers were presented by Dr. J. G. Davis on "The Cleaning and Sterilizing of Dairy and Ice Cream Plant", by Mr. H. J. Bunker on "The Hygiene of Beer Production and Consumption", and by Mr. D. H. F. Clayson and Mr. C. W. Chater on "The Cleaning and Sterilization of Plant and Utensils in the Food Industry".

Dr. Davis defined cleaning as the removal of all residues and particularly those which serve as a food for bacteria. Sterilization is only a finishing process, cleaning being the more important operation. Unless all food residues are removed, the few remaining bacteria can proliferate rapidly in the presence of food, moisture and warmth. A reasonable standard for commercial sterility or 'sanitization' is one colony per ml. capacity or per square centimetre of surface.

Although different methods can be used successfully, all methods conform to certain fundamental principles, which were enumerated as follows:

(1) Cleaning and sterilizing must always be regarded as distinct and different operations.

(2) The first treatment should always be a cool or tepid water rinse. Cold water hardens the fat, and hot water denatures the water-soluble proteins which with calcium salts form a strongly adhering film. Hard water should be softened.

(3) The second treatment should be with a suitable detergent solution applied as hot as possible. This emulsifies the fat and proteins, partially saponifying or hydrolysing them; and finally washes away the broken-down and loosened milk constituents. The emulsifying power of the detergent solution is related to the surface tension and to its ability to penetrate between dried-on milk film and the metal surface.

(4) Should any milkstone be visible after the detergent treatment, this must be removed by a weak acid solution, as otherwise the sterilizing will not be efficient. Milkstone does not normally form unless milk is heated, and so is found chiefly in the hot sections of pasteurizing plant. Frequency of acid treatment depends on the type and individuality of the plant, the milk supply, the time of running, the temperature used and other variable factors.

(5) 'Scale', or 'fur', resulting from the use of hard water is inimical to sterilizing, and can be particularly troublesome in bottle-washing machines. As with milkstone, the dilute acid treatment is necessary for its removal. In order to avoid corrosion, inhibitor preparations should be incorporated in the acid solution. These generally consist of organic nitrogen compounds of the quinoline type.

(6) Special precautions must be observed with certain metals, particularly aluminium and tin. Detergents for use with aluminium and tin should contain at least 25 per cent silicate, and preferably no caustic soda at all. The incorporation of about 10 per cent of sodium sulphite has been recommended to prevent corrosion of tinned plate, but this is only rarely used in Great Britain. All metals, including stainless steel ('crevice attack'), can suffer corrosion with chlorine, especially if used with soft water which has a low *p*H.

(7) After cleaning, equipment should be left either dry or in contact with the sterilizing solution. The better method is to keep thoroughly clean plant in a dry condition, as bacteria cannot grow without moisture.

In discussing dairy equipment, it was emphasized that on the farm the best results can be obtained with very simple and home-made equipment. On farms where the buildings, etc., are in very bad condition it has been shown that it is possible to produce milk of good-keeping quality provided there is a good supply of clean, cold water, and the utensils are thoroughly washed.

On the other hand, in farms with excellent buildings and the very latest and often expensive equipment, poor-keeping quality in milk is sometimes found where there is a lack of clean, cold water, and where apparently trivial but, in reality, serious mistakes are made in the cleaning and sterilizing of the equipment.

Churns are generally treated by pre-rinse, hot rinse or hot detergent, hot rinse, steam, and sometimes hot air at 240° F. The author expressed his preference for a final steaming which left the churn very hot at the mouth rather than for a final treatment by hot air. For containers which have to be emptied and cleaned quickly, a preference was expressed for a chlorine wash rather than for steam for sterilizing.

Pipelines should be taken down every day; but some dairies get satisfactory results by only stripping every second or third day. On the Continent, plant is treated by dilute nitric acid, detergent and final rinse, and only rarely taken down; but this method has not been generally adopted in Great Britain. Pasteurizing plant should be dismantled at least once every day and thoroughly cleaned and sterilized. The modern high-temperature-short-time pasteurizing plant is not susceptible to thermophilic growth as is the 'holder' plant.

Only a very small proportion of bottles are now scalded with steam or hot water. Most big dairies employ bottle-washing machines which use hot detergent at 140° F., which both cleans and sterilizes bottles. It is important, however, to maintain rinse solutions in a satisfactory bacteriological condition.

In dealing with some special aspects of problems in the dairy industry, the author emphasized the significance of the individuality of utensils, and the effect of atmospheric temperature on the bacteriological condition of utensils and plant, the importance of the interval between sterilizing and use, and further pointed out that the larger the container the smaller is the relative contamination by a given number of bacteria per unit of surface.

Hypochlorite solution used for sterilizing is sometimes used at an unnecessarily high strength, about 150 p.p.m. at a minimum temperature of 120° F. for a minimum time of 2½ minutes being recommended. Too strong a chlorine solution might lead to serious corrosion, especially when the water is soft.

Mr. H. J. Bunker, in dealing with the hygiene of beer production and consumption, briefly described stages in the making of beer. The malting of the barley is followed by the grinding of malt and mashing of the ground malt or grist. The wort is next boiled for some time and the hops added. The boiled wort is then pitched or inoculated with yeast, and fermentation allowed to proceed. The beer is finally run to cellars, where it is emptied into casks or held in a container from which, after a few days, it is bottled, with or without filtration, according to the type of beer. After bottling it may be pasteurized, but in Great Britain the greater part of the bottled beer is not heat-treated.

On account of its high acidity, beer is one of the safest of foods from the bacteriological point of view. The *p*H of beer is usually about 4 and this probably explains why pathogenic bacteria are always absent. In addition, hops and alcohol are factors inhibitory to bacteria. The prolonged boiling of the wort gives complete sterility at one stage, and the author was of the opinion that the maintenance of clean mains was the most important item of hygiene in the brewery. The cleaning of these mains must be a regular operation, for which caustic soda solution is commonly used.

Beer is now generally cooled in a built-in type of cooler which has the advantage that delivery is achieved in a closed system without intermediate exposure to infection.

A point of some importance in the cleaning of brewery plant, which might consist of copper, wood, slate, aluminium, stainless steel or wax-lined materials, is the fact that in course of time a deposit known as 'beerstone' forms on the side of the fermenting vessel. The modern brewer prefers to remove this beerstone and thus eliminate what would otherwise become a dangerous lurking place for micro-organisms.

Bottles and bottle-filling machines require particular attention. In bottle-washing, caustic soda is the chief constituent of the detergent, and the general standard of cleanliness in these machines is now very high.

Preservatives are not added to bottled beers, the old idea that the brewer adds chemicals to beer being entirely erroneous. The only preservative which is permitted in brewing is sulphur dioxide.

One of the chief sources of contamination in breweries is old cellar floors which, when they become cracked, are difficult to clean. Such floors can be treated with chloride of lime or 'Antiformin' (sodium hydrochlorite and sodium hydroxide). Phenolic antiseptic should not be used, for obvious reasons.

Mr. Bunker next dealt with the very important aspect of hygiene in beer houses and named three methods for dealing with the problem of glasses: (*a*) the automatic glass-washing machine; (*b*) the self-emptying sink; (*c*) the addition of some suitable detergent or antiseptic to the rinse water. He expressed a preference for the third method and described recent work on the use of quaternary ammonium compounds for this purpose.

Dealing finally with the question of drying cloths, Mr. Bunker said that most bar-tenders prefer to dry and polish glasses after rinsing. If the cloths are allowed to get dirty they may well put back on the glasses more organisms than were there before drying. It is essential that any cloths used should be in a good bacteriological condition.

Mr. Clayson and Mr. Chater, in dealing with the present-day communal feeding in restaurants and canteens, stated that the effects of inadequate hygiene in the kitchen may be serious. Although machine-washing is growing in restaurant kitchens this method is not foolproof, and in the authors' experience there is not much difference between the results of hand-washing and machine-washing.

They pointed out that dirt is not defined from the legal point of view and that it is necessary, in order to comply with the Food and Drugs Act (1938), to define processes that can be relied upon to destroy or remove pathogenic organisms if they should be present. This definition would have to be in chemical or physical terms in relation to detergent concentrations, temperatures, times, etc. With highly glazed or polished articles the appearance is a very good guide to their hygienic condition. This question is important because the removal of soiling deposits from food utensils is an important stage in securing a satisfactory hygienic condition.

Instead of stating that a certain organism is destroyed in a certain time at a certain temperature, it is preferable to refer to destruction-rates, for example, the decimal reduction time, which is the time required to reduce the count to one-tenth of what it was originally. The decimal reduction time of most intestinal organisms is of the order of one minute at 140–145° F. At 160° F. or over the decimal reduction time values of staphylococci and streptococci are a matter of seconds only.

Thermoduric organisms are of little sanitary significance. 'Sanitization' may therefore be defined as a treatment which eliminates pathogenic and food-poisoning micro-organisms but which may not destroy thermoduric organisms.

The extent of dispersion of soiling material depends upon the volume of wash water, the mechanical force applied, the volume of rinsing water and the frequency with which the washing and rinsing waters are changed. If the sterilization process consists of immersion in hot water or disinfectant solution, a satisfactory cleaning has the additional advantage that any remaining bacteria are easily dislodged from the surface. With satisfactory washing it is possible to achieve a high degree of sterility by immersing the articles for a much shorter time in the rinse water than would be required if all the bacteria remained attached to the surface.

The United States Public Health Service Code requires: (1) a cleaning process with a detergent solution at 110–120° F.; (2) sterilization (with a choice of four methods); and (3) drying with clean cloths, or preferably by evaporation. The standards required in the United States give, apparently, a very wide margin of safety if the conditions for high-temperature-short-time pasteurization, that is, 162° F. for not less than fifteen seconds, can be taken as a guide for the destruction of pathogenic organisms. Evaporation after hot-water rinsing is preferable to drying by a cloth.

For utensils with thick or dried-on deposits, machines which allow a long period of contact with detergent solution are necessary. An important point in the design of such machines is the avoidance of excessive carry-over of the detergent solutions to the rinsing compartments.

A plant used for the preparation, service and storage of food needs the same if not more attention from the hygienic point of view than the multi-service utensils.

To obtain a bactericidal effect with steam it is essential to keep the steam in an enclosed space with a comparatively small vent and to continue steaming for at least three minutes after steam issues from the vent at over 205° F.

The authors suggested that it would be sometimes advisable to employ two different types of sterilizing treatment, for example, steam and hypochlorite solution, with the object of destroying organisms which might escape one of these treatments, but no experimental evidence was quoted in support of this view. Hypochlorite treatment must, of course, be followed by further rinsing with cold water.

WIGAN MINING COLLEGE

FOUNDED on October 27, 1857, Wigan and District Mining and Technical College has just celebrated its ninetieth anniversary. In its first session the average attendance was 15; now it has some 2,800 students. The intervening ninety years show a continuous record of expansion and progress in spite of many difficulties. Like most higher institutions of learning in Britain to-day, the College is overcrowded and badly in need of extended accommodation and additional facilities, particularly for postgraduate and research work. Founded primarily to develop mining education, and still maintaining a leading position in that field, it has never confined itself to mining alone. Its range of work covers also engineering, chemistry, physics, geology, biology, mathematics, building, commerce, economics, art, and other subjects.

A special feature of the work of the College is the provision of complete full-time courses for the degrees of the University of London in mining, engineering, general science, chemistry, physics, geology, mathematics and economics. The College is inspected and recognized by the University in connexion with the mining and engineering degree courses. It is also recognized by the Board for Mining Examinations, the Board of Trade, the Institution of Civil Engineers, the Institution of Mining Engineers, the Royal Institute of Chemistry, the Institute of Physics, etc. It is the headquarters of the Manchester Geological and Mining Society and provides accommodation for meetings of many other scientific, technical and professional bodies. A notable feature of its work is the development of its library and refectory services and of student activities. It has in Christopher Park one of the finest athletic grounds in the north of England.

A meeting to celebrate the ninetieth anniversary was held in the College hall on June 7. This was attended by a very representative gathering, including educationists, scientific workers, industrialists, and government and local officials, as well as governors, staff and students. The chairman of the Governing Body, Colonel J. S. A. Walker, presided, and the principal, Dr. J. F. S. Ross, gave a brief survey of the history and work of the College, directing attention to the devoted service it had received from its founders and their successors, its long-standing regional character and independence—it receives very substantial grants from the Lancashire and Wigan Education Authorities but possesses its own freehold land and buildings and has its own autonomous governing body—and to the development within it of a truly educational and collegiate spirit. The chairman of the General Purposes Committee, County Councillor A. Guest, who has been a governor of the College for the last third of a century, also referred to aspects of its history and directed attention to its high reputation at home and abroad. Notwithstanding the invaluable help of local authorities, the College needs greater financial resources, and he thinks it should receive these on lines comparable with those on which university colleges are helped by the University Grants Committee.

Sir Charles Ellis, scientific member of the National Coal Board, gave an address on "The Place of Science in a Technical Training". After commenting on the high reputation of the College in science and industry —he had heard from everyone in a position to judge that Wigan-trained people had a sound knowledge of and lively interest in the fundamental sciences and a genuine appreciation of the means of applying them to technological problems—Sir Charles referred to the distinction between industrial scientists and research scientists, and denied the validity of any difference of status between them. He mentioned the manifold duties of scientific men in connexion with the National Coal Board: while the majority of them are in the colliery chemical services and carry out their scientific duties in daily contact with industry, there are other groups which have more national standing. He mentioned the special group dealing with the survey of coal seams in Britain, and said that we have an accurate knowledge of the quality of our coal seams for many years ahead before they are mined. He also referred to the research group engaged on fundamental studies of coal substance. These are doing pioneer work. He went on to develop a closely reasoned argument as to the intrinsic value of scientific education, not only in relation to industry but also in inculcating a genuinely philosophical attitude to life. The address is to be published by the College in pamphlet form.

An illustrated booklet on the College has been issued in connexion with the ninetieth anniversary; copies can be obtained from the College office, price 1*s.* 6*d.* each.

FORTHCOMING EVENTS

Wednesday, June 30

Institute of Welding (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 2.30 p.m.—Annual General Meeting.

Friday, July 2

Physical Society (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. J. Hamilton: "The Theory of Radiation Damping"; Mr. R. M. Sillitto: "An Extension of Kapitza's Theory of δ-Radiation".

Geologists' Association (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Sir Arthur Russell, Bart.: "Early British Mineral Collectors and Mineral Collecting".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Anatomy, preferably with some experience in Histology—The Secretary, The University, Aberdeen (July 3).

Lecturer in Education—The Secretary, The University, Edmund Street, Birmingham 3 (July 3).

Lecturer in Physics up to B.Sc. standard—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (July 3).

Assistant Agricultural Economists (2), and a Lecturer in Agricultural Economics—The Registrar, King's College, Newcastle-upon-Tyne (July 3).

Lecturer in Statistics in the Department of Economics and Social Science—The Registrar, University College of South Wales, Cardiff (July 5).

Lecturer or Assistant Lecturer in the Department of Botany, a Demonstrator in the Department of Chemistry, and a Second Demonstrator in the Department of Zoology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 5).

Lecturer in Physiology, an Assistant Lecturer in Geography, and Tutorial Studentships in Botany, History, Mathematics, Physics and Zoology—The Registrar, King's College, Strand, London, W.C.2 (July 5).

St. Mungo (Notman) Chair of Pathology—The Secretary of University Court, The University, Glasgow (July 7).

Lecturer in Inorganic and Physical Chemistry—The Secretary, The University, Edinburgh (July 15).

Research Officer in the Division of Plant Industry, Canberra—The Secretary, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1740 (July 17).

Principal Research Officer or Senior Principal Officer (Ref. No. 1749), and Research Officers (3, Ref. No. 1750), in the Division of Economic Entomology, Canberra—The Secretary, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 17).

Research Officer in the South African National Physical Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (July 19).

Chair of Chemistry—The Secretary, The University, Aberdeen (July 31).

Librarian in the Department of the Scientific Adviser to the Army Council at the War Office, a Librarian and Assistant Librarians (2) at the Military College of Science, Shrivenham, Swindon—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2183 (July 31).

Principal Scientific Officer (responsible for advising commercial undertakings and hospitals as to the application of radioactive isotopes, and for the scientific planning for production of isotopes in close association with chemical and nuclear physics research groups), a Principal Scientific Officer (to lead a Physics Production Group for radioactive isotopes and responsible for the irradiation of materials, their standardization and packing), a Senior Experimental Officer (responsible for implementing processes evolved by a research group for production of radioactive isotopes and to head a group of chemists engaged on routine isotope production), and Experimental Officers (2, responsible for routine testing, packing and dispatch of radioactive material), at the Atomic Energy Research Establishment of the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2185 (July 31).

Professor of Organic Chemistry, and a Professor of Theoretical Physics—The Registrar, Indian Association for the Advancement of Science, 210 Bowbazar Street, Calcutta 12, India (August 1).

Scientific Assistant for the collation, abstracting and reviewing of biological literature—The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (August 1).

Heads of the Departments of (*a*) Architecture and Town and Regional Planning, (*b*) Civil and Sanitary Engineering, (*c*) Electrical Engineering, (*d*) Mechanical Engineering, (*e*) Chemical Engineering, (*f*) Geology and Geophysics, (*g*) Naval Architecture and Marine Engineering, and (*h*) Textile Technology, in the proposed Eastern Higher Technical Institution near Calcutta—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 396W (August 20).

Director of the proposed Eastern Higher Technical Institution near Calcutta—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 403W (August 20).

Entomologist to carry out a survey of the tsetse areas of the Sudan and undertake research work—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Entomologist'.

Laboratory Technician to take charge of the Physics workshop—The House Governor, Queen Elizabeth Hospital, Birmingham 15.

Laboratory Assistant (male) in the Department of Chemistry—The Steward, Department of Chemistry, The University, Manchester.

Laboratory Assistant (Grade B 1) for general laboratory and histological routine—The Professor, Department of Human Anatomy, The University, Oxford.

Student Technician for Bacteriological Department—The Secretary, University College Hospital, Gower Street, London, W.C.1.

Meteorologists in the Meteorological Service of the Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Meteorologists'.

Senior Crop Recorder—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Professor of Physics and Electrical Engineering at the Royal Naval College, Greenwich—The Director (P.A.), Education Department, Admiralty, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Agriculture and Fisheries. Bulletin No. 139: Report on Fungus, Bacterial and other Diseases of Crops in England and Wales for the Years 1943–1946. By W. C. Moore. Pp. vi+90+12 plates. (London: H.M. Stationery Office, 1948.) 2*s*. 6*d*. net. [115

Scottish Zoo and Wild Life. (The Magazine of the Zoological Society of Scotland.) Quarterly. Vol. 1, Part 1, April. Pp. 48+9 plates. (Edinburgh: Oliver and Boyd, Ltd., 1948.) 3*s*. net; annual subscription, 12*s*. [115

National Forest Park Guides. Snowdonia. (Issued by H.M. Forestry Commission.) Pp. 72. (London: H.M. Stationery Office, 1948.) 2s. 6*d*. net. [115

Forestry Commission. Empire Forests and the War: Statistics prepared for the Fifth British Empire Forestry Conference, Great Britain, June 1947. Pp. ii+18. (London: H.M. Stationery Office, 1948.) 1*s*. net. [115

British Intelligence Objectives Sub-Committee. Overall Report No. 2: Shipbuilding and Marine Engineering in Germany during the Period 1939–1945. Prepared by F. J. C. Jacob. Pp. 20. (London: H.M. Stationery Office, 1948.) 6*d*. net. [125

Commonwealth Economic Committee. Industrial Fibres: a Summary of Figures of Production, Trade and Consumption relating to Cotton, Wool, Silk, Flax, Jute, Hemp, Mohair, Coir and Rayon. Compiled in the Intelligence Branch of the Commonwealth Economic Committee. Pp. 137. (London: H.M. Stationery Office, 1948.) 5*s*. net. [12

Other Countries

Sugar Research Foundation, Inc. Technological Report Series No. 4: Use of Molasses in Grass Silage Preparation. By Prof. Carl B. Bender. Pp. v+22. (New York: Sugar Research Foundation, Inc., 1948.) Free. [115

University of Illinois Engineering Experiment Station. Bulletin Series No. 369: Studies of Highway Skew Slab-Bridges with Curbs, Part 1, Results of Analyses. By Vernon P. Jensen and John W. Allen. Pp. 62. 75 cents. Bulletin Series No. 370: The Illinois Smokeless Furnace. By Prof. Julian R. Fellows, Prof. Alonzo P. Kratz and Prof. Seichi Konzo. Pp. 78. 75 cents. Bulletin Series No. 371: Rate of Propagation of Fatigue Cracks in 12-inch by ¾-inch Steel Plates with Severe Geometrical Stress-Raisers. By Prof. Wilbur M. Wilson and James L. Burke. Pp. 14. 35 cents. Bulletin Series No. 372: The Effect of Non-Uniform Distribution of Stress on the Yield Strength of Steel. By Dimitry Morkovin and Omar Sidebottom. Pp. 72. 50 cents. (Urbana, Ill.: University of Illinois Engineering Experiment Station, 1947.) [125

University of Illinois Engineering Experiment Station. Circular Series No. 52: The Railroad Dynamometer Car of the University of Illinois and the Illinois Central Railroad. By Assoc. Prof. John K. Tuthill. Pp. 34. (Urbana, Ill.: University of Illinois Engineering Experiment Station, 1947.) 20 cents. [125

Revista del Museo de Historia Natural de Mendoza. Vol. 1, No. 1, Diciembre 31, 1947. Pp. 64. (Mendoza: Museo de Historia Natural, 1947.) [185

University of Illinois Engineering Experiment Station. Bulletin Series No. 374: The Free Surface Around, and Interference between, Gravity Walls. By Prof. Harold E. Babbitt and David H. Caldwell. Pp. 58. 50 cents. Bulletin Series No. 375: Studies of Slab and Beam Highway Bridges, Part 2, Tests of Simple-Span Skew I-Beam Bridges. By Prof. Newark M. Newmark, Asst. Prof. Chester P. Siess and Warren M. Peckham. Pp. 60. 50 cents. Bulletin Series No. 376: Highspeed Freight Train Resistance, its Relation to Average Car Weight. By Assoc. Prof. John K. Tuthill. Pp. 77. 50 cents. Bulletin Series No. 377: Flexural Fatigue Strength of Steel Beams. By Prof. Wilbur M. Wilson. Pp. 32. 20 cents. (Urbana, Ill.: University of Illinois Engineering Experiment Station, 1948.) [185

Catalogues

Botany, Birds, Sea-Life, Geology, Butterflies, Moths and Scientific Voyages round the World. (Catalogue No. 689.) Pp. 62. (London: Francis Edwards, Ltd., 1948.)

Medieval Literature: Literature and History, Philosophy and Theology, Science and Medicine. (Catalogue 9.) Pp. 88. (New York: Herbert Reichner, 34 East 62nd Street, 1948.)

Johnson Matthey Products and Services. (Publication No. 1000.) Pp. ii+30. (London: Johnson, Matthey and Co., Ltd., 1948.)

Gold—Engineering Properties and Uses. (Publication No. 2020.) Pp. 12. (London: Johnson, Matthey and Co., Ltd., 1948.)

Towers Laboratory News. No. 5 (Special B.I.F. edition). Pp. 117–164. (Widnes: J. W. Towers and Co., Ltd., 1948.)

Murfume Azobenzene Smokes for Horticultural Use. Pp. 4. (Wheathampstead: Murphy Chemical Co., Ltd., 1948.)

Plant Protection Overseas Review. Vol. 1, No. 1, May 1948. Pp. 36. (London: Plant Protection, Ltd., 1948.)